THE
PROCEEDINGS
OF THE
LINNEAN SOCIETY
OF
NEW SOUTH WALES

FOR THE YEAR

1922

Vol. XLVII.

WITH FIFTY-EIGHT PLATES.

and 268 Text-figures.

SYDNEY:

PRINTED AND PUBLISHED FOR THE SOCIETY BY

THE SYDNEY AND MELBOURNE PUBLISHING CO., LTD.,

29 Alberta Street, Sydney.

AND

SOLD BY THE SOCIETY.

1922-1923.

CONTENTS OF PROCEEDINGS, 1922.

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(Issued 21st April, 1922.)

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PART IV. (No. 188.)

(Issued 15th December, 1922.)

PART V. (No. 189.)

(Issued 15th February, 1923.)

LIST OF NEW SUPERFAMILY, FAMILY, SUBFAMILY, GENERIC AND SUBGENERIC NAMES PROPOSED IN THIS VOLUME (1922).

CORRIGENDA.

Page xi., line 7, *for* forewing, *read* hindwing.

Page 429, lines 31—2, for *E. Gullicki* Baker, read *E. Gullicki* Baker and Smith.

Page 431, line 2, *for* from, *read* to.
line 5, *for* 2 mm., *read* 0.3 mm.
line 6, *for* averaged 0.015 mm., *read* measured 0.06 mm.

Page 433, 3rd line from bottom, *for* Section, *read* Sections.

Page 539, line 47 (5th from bottom).—The name *Ptychoparia merrotskii* must lapse, being a synonym of *P. alroiensis*, under which name the specimen has already been described by Etheridge (Trans. Roy. Soc. S. Aust., xliii., 1919, 385). [Ed.]

Page 452, line 14—*for* Archizygoptera, *read* Anisozygoptera.

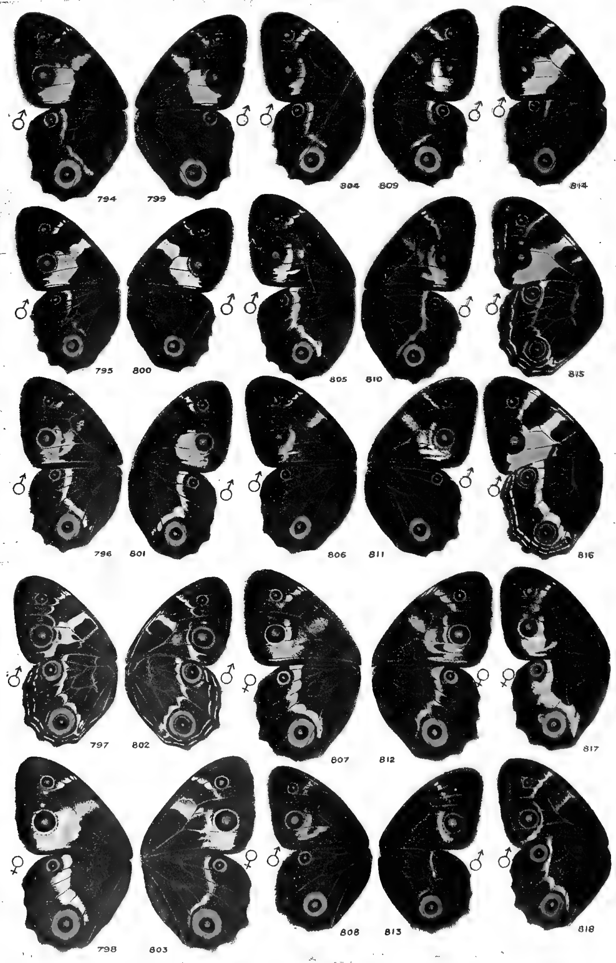
Page 454, line 11 from bottom—*for* Anisozygoptera, *read* Archizygoptera.

Page 469. Text-figure 89 is printed upside down.

LIST OF PLATES.

PROCEEDINGS, 1922.

Map
showing the distribution
of the subspecies of
Tisiphone abeona.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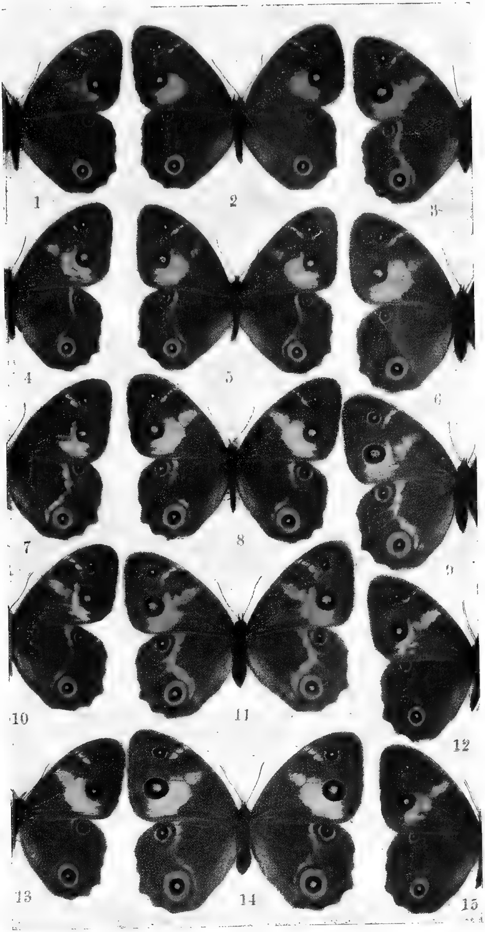

Approximately four-fifths natural size.

THE *LORANTHACEAE* OF AUSTRALIA. Part i.

By W. F. Blakely, First Botanical Assistant, National Herbarium, Sydney.

[Read 29th March, 1922.]

Introduction.

During the ordinary course of my work in the National Herbarium, I became aware of the fact that the genus *Loranthus* was badly in need of revision, so I set to work to straighten out what appeared to me to be the most composite species. After considerable investigation I found that nothing less than a thorough examination would prove satisfactory, consequently I decided to revise the Family as a whole.

I am deeply indebted to the Director, Mr. J. H. Maiden, for the encouragement and whole-hearted assistance he has given me throughout, particularly the unreserved use of the Herbarium, together with the free access to communications and reference to specimens and information from other herbaria, which enabled me to examine types and material much more satisfactorily than relying upon descriptions only. I take this opportunity to thank him for his generous assistance; also Professor Ewart of the Melbourne Herbarium; Professor Osborn of the University of Adelaide; Mr. C. T. White, Government Botanist, Queensland; Mr. J. M. Black, South Australia and Mr. Herbert Mann, of Western Australia, all of whom, at Mr. Maiden's request on my behalf, very kindly placed the whole of their material at my service. I wish also to extend my appreciation to Mr. O. Staf, of Kew, and to the official artist, Miss M. Smith, for portion of the types, and drawings of rare specimens. To Professor Le Comte, Professor of Botany, Museum D'Histoire Naturelle, Paris, I am very grateful for information relating to Van Tieghem's, Lehmann's, and Miquel's species.

To Mr. George Weir, Forest Pathologist-in-Charge, Bureau of Plant Industry, U.S. Department of Agriculture, my sincere thanks are due for a copy of Martius 'Flora Braziliensis," dealing with Eichler's classification of the *Loranthaceae* of Brazil; also to Major C. C. Calder, of the Calcutta Herbarium, for the loan and gift of several specimens of the *Loranthaceae* of Ceylon, and to Dr. B. L. Robinson, Curator, Gray Herbarium, United States, for a sketch of *L. Cunninghami* A. Gray (L. congener Sieber).

I also wish to express my sincere thanks and appreciation to Miss Margaret Flockton, artist, National Herbarium; Mr. A. H. S. Lucas, Headmaster, Sydney Grammar School; Mr. E. Cheel; Mr. A. A. Hamilton; Mr. J. C. von Hagen; Messrs. D. W. C. and R. Shiress; Mr. H. Bott; and Mr. D. Gorman.

With the aid of the additional material from nearly all parts of the Commonwealth I have been able to make a more complete examination of almost every species, which enabled me to describe more fully the imperfectly known species and to define their affinity.

The classification adopted is that of Engler's "Pflanzenfamilien," which is closely followed with slight modifications. It is obvious from my investigations that Engler did not himself examine some of the Australian species. The genera affected by my review are *Atkinsonia,* which is superseded by *Gaiadendron;* the species belonging to the versatile section of *Loranthus,* which are transferred to *Phrygilanthus;* and two species of *Viscum,* which have been placed in *Korthalsella.* In the genus *Loranthus,* I propose to restore 5 old species, and shall offer as new 13 species and a similar number of varieties. The additions will bring the total number of species to 40, with 20 varieties, an increase of 21 species and 17 varieties since the publication of the "Flora Australiensis" in 1866. They are distributed among the undermentioned sections as follows: *Amyema,* 25 sp., 12 vars.; *Diplatia,* 1 sp.; *Treubella,* 4 sp.; *Lysiana,* 4 sp., 6 vars.; *Amylotheca,* 1 sp.; *Dendrophthoe,* 4 sp., 2 vars.; *Benthamina,* 1 sp.

In depicting the various species, two characters impressed me as being valuable aids to classification, namely, the inflorescence and the buds. Both are singularly constant, and form a ready means of discrimination. The venation of the leaves is also valuable for the same purpose, as the species with parallel venation in *Loranthus,* with one exception, belong to the section *Amyema,* as also do nearly all the terete-leaved species, while those with penninerved leaves, with one exception, are absorbed in the closely allied sections.

I have also paid some attention to the embryonic cotyledons and their manner of growth, with a view to ascertaining whether certain characters were sufficiently constant for taxonomic purposes. I find that in the various sections of *Loranthus* there is, in some species, a corresponding similarity in the structure of the embryo and its mode of growth and differential development, which, taken in conjunction with other characters, is to some extent helpful in their separation and classification.

Other characters discussed are parasitism, adventitious roots, union or attachment, mimicry, dispersal and distribution, and agents of dissemination.

A Brief Botanical History.

The first purely Australian member of the family Loranthaceae, *Loranthus floribundus* Labill. (*Nuytsia floribunda* R. Br.,) was described by Labillardière (Novae Hollandiae Plantarum, i., 1804, p. 87, fig. 113). Twenty-three years after, Sieber (Sprengel Cur. Foster, 1827, p. 139) described *Loranthus pendulus,* and two years later (in Roemer et Schultz, System Vegetabilium, vii., 163) he described *L. celastroides* and *L. eucalyptifolius.*

In 1830 A. P. De Candolle, in his classification of the *Loranthaceae* (Prodromus Syst. Veg., iv., 259) redescribed *L. pendulus* Sieb. under section Stylosi and published for the first time a description of *L. congener* Sieber. On page 316 he quotes Labillardière's description of *L. floribundus* (*Nuytsia floribunda* R. Br.), placing it in section *Taguanae* DC, along with some Chilian species, and on page 318, under Vix noti numero nempe floris ignoto, refers to Sieber's *L. celastroides* and *L. eucalyptifolius.* In the same year he gave a description and figure of *L. pendulus* Sieb. and *L. congener* Sieb. in his Mémoire sur la Famille des Loranthacées.

Robert Brown (Journ. Geogr. Soc., 1, 1831, 17) removed *Loranthus floribundus* Labill. from the genus *Loranthus,* mainly on the winged fruits, and proposed the genus *Nuytsia.* In his Botanical works (vol. i., 1832, 308) he refers again to *Nuytsia floribunda* in "A general view of the botany of the vicinity of Swan River."

In 1834, G. Don (General History of the Dichlamydeous Plants, iii., 419) reproduced the descriptions of *L. pendulus* Sieber, *L. congener* Sieber, and *L. Gaudichaudi* DC. under the generic name of *Dendrophthoe,* and on page 431 quotes *L. eucalyptoides* DC. (*L. eucalyptifolius* Sieber), while on page 432 appears a description of *Nuytsia floribunda* R. Br. The latter is also redescribed by Endlicher (Genera Plantarum, 1836-40, p. 803), and a reference to it will be found in Meisner (Plantarum Vascularium Genera, ii., 1836-43, p. 110). In 1837 Fenzl described *Loranthus linophyllus* (Hugel Enumeratio Plantarum Novae Hollandiae, p. 56), and *Nuytsia floribunda* R. Br. is redescribed by Hugel.

In the following year Hooker (Icones Plantarum, p. 13, t. 73) described *Viscum incanum* (*Notothixos incanus* Oliv.), and Lindley (Mitchell's Three Expeditions, ii., 1838, 69) described *L. Quandang.* A year later (Appendix to Bot. Mag., 4) he figured *Nuytsia floribunda* R. Br. and refers to its habit, etc., on page xxxix.

Walpers appears to be the next writer, for in his *Repertorum Botanices Systematicae*, ii., 1843, 438) he gives a description of *Viscum incanum* Hook. (*Notothixos incanus* Oliv.) and *V. distichum* Endl. from Norfolk Island. On page 443, he reproduces a description of *L. linophyllus* Fenzl, and *Nuytsia floribunda* R. Br. is mentioned on p. 446, while *L. Quandang* Lindl., is redescribed on p. 940.

In 1844 Miquel (Plantae Preissianae, i., 281-2) contributed the following species: *L. miraculosus* Miq., *L. Casuarinae* Miq., *L. scoparia* Miq., *L. Miquelii* Lehm., *L. Melaleuca* Lehm., and *L. Preissii* Lehm. The following year these species and *Nuytsia floribunda* R. Br. were redescribed by Walpers (Rep. Bot. Syst., v., 938, 940).

Three years later Dr. Behr (Sch. Linnaea, xx., 624) described *L. Exocarpi;* Lindley (Vegetable Kingdom, 1847, p. 791) mentions *Nuytsia ligustrina* A. Cunn. (*Gaiadendron ligustrina* Cunn. Engl.), his remarks being really a repetition of those in Botanical Mag., 1839.

In 1848 Hooker (Mitchell's Tropical Australia) described the following species:—*L. aurantiacus* A. Cunn. MS. (p. 101), *L. linearifolius* Hook (p. 102), *L. nutans* A.C. (*L. Quandang* Lindley) (p. 158), *L. subfalcatus* Hook. (*L. Exocarpi* Behr.) (p. 224). These species are also described by Walpers (Annal. Bot. Syst., ii., 1851-52). Hooker (Icon. Pl., 1852, Plate 880) also described and figured *Loranthus longifolius* Hook. (*L. pendulus* Sieb.).

To A. Gray (Botany of the American Exploring Expedition, 1854, 739-41) we are indebted for a full description and a figure of *L. celastroides* Sieb. (*Phrygilanthus celastroides* Eichl.), together with a reference to *L. eucalyptifolius* Sieb. (*L. eucalyptoides* DC., *P. eucalyptifolius*), *L. pendulus* Sieb., *L. nutans* Gray *non* Cunn., *L. Cunninghamii* A. Gray, *L. congener* Sieber, and a description and figure of *L. maytenifolius* A. Gray, a doubtful Australian species.

In 1856 Miquel (Ned. Kruidk. Arch., iv., 105) contributed a short paper, probably on behalf of Baron von Mueller, in which appears a description of *L. Exocarpi* Behr. var. (a) *flavescens* F. v. M. and var. (b) *coccineus* F. v. M. He also refers to *L. miraculosus* Miq., *L. Melaleucae* Lehm., *L. pendulus* Sieb. and *L. aurantiacus* A. Cunn.

Mueller (Report Burdekin Expedition, 1860) gave a short account of the Australian species known to him at the time and furnished a description of *L. vitellinus* F. v. M.; *L. signatus* F. v. M. under *L. insularum* A. Gray. *L. alyxifolius* F. v. M. is also described under *L. maytenifolius* Gray, while *L. dictyophlebus* F. v. M. and *L. grandibracteus* F. v. M. are described for the first time.

In 1860-61 Mueller (Fragmenta, ii., 130) described *Nuytsia ligustrina* A. Cunn. (*Gaiadendron ligustrina* A. Cunn. Eichl.). Perhaps the most important revision of the Australian Loranthaceae is "Notes on the Loranthaceae, etc.," by Daniel Oliver (Journ. Linn. Soc., vii., 1864, 90), which afterwards formed the basis of Bentham's classification of the Family in his Flora Australiensis, iii., 1866, 386. Oliver did not deal exclusively with the Australian genera, but with a classification of the family generally, incidentally embracing the Australian members of the family. His most notable contribution affecting the Australian section is the segregation of *Notothixos* from *Viscum*.

In 1864-5 Mueller (Plants indigenous to the colony of Victoria, t. 30) figured *L. celastroides* Sieber and *L. eucalyptoides* DC. (*L. eucalyptifolius* Sieber). With the advent of Bentham's Flora Australiensis, Vol. iii., 1866, appeared the first sequential classification of the Australian *Loranthaceae*, which comprised five genera and twenty-seven species, namely *Nuytsia* (1 species), *Atkinsonia* (1) *Loranthus* (19), *Viscum* (3), and *Notothixos* (3). Since then various Australian botanists, when dealing with the family, very largely followed Bentham's classification. Eichler (Martius' Flora Brazil, 1868, p. 21) included *Nuytsia*, *Gaiadendron* and *Phrygilanthus* in his classification of the *Loranthaceae*, which has since been accepted by Engler. In 1880, Hooker (Icones Plantarum, p. 13, Plate 1319) described *Loranthus Atkinsoniae* (*Atkinsonia ligustrina* F. v. M.).

In their classification of the *Loranthaceae* (Genera Plantarum, 1880) Bentham and Hooker partly accepted Eichler's basis of classification pertaining to *Gaiadendron* and *Phrygilanthus* which were noted by them as distinct sections of *Loranthus*. Bentham (Hooker's Icones, 1880-82, p. 13, Plate 1319) described and figured *Loranthus Atkinsoniae* (*Gaiadendron ligustrina*).

F. M. Bailey (Synop. Queensland Fl., 1883, p. 449) briefly redescribed the species recorded for that State. In the same year, Professor Tate and Baron von Mueller (Trans. Roy. Soc. S.A., vi., 109) described *L. Murrayi*. Professor Tate (Trans. Roy. Soc. S.A., viii., 1885, 71) added *L. gibberulus* to the list of species.

Mueller (Key to the System of Victorian Plants, ii., 1885, plate 66) figured *L. celastroides* Sieb. and *L. eucalyptifolius* Sieb. The upper figure on the plate is the former and the lower figure is that of the latter.

In 1889 Engler and Prantl (Pflanzenfamilien, iii., 177) followed Eichler's classification and recognized *Gaiadendron* G. Don, and *Phrygilanthus* Eichler; they also recognized Bentham and Hooker's decisions in regard to *Loranthus*, *Notothixos* and *Viscum*. Moore and Betche (Handbook of the Flora of New South Wales, 1893, pp. 226-8) briefly described the eastern species as defined by Bentham (B. Fl., iii.). The following year R. T. Baker (These Proceedings, (2), ix., 1894, 158) illustrated the genus *Notothixos*, and drew attention to what appeared to him intermediate forms of *N. subaureus*.

In 1894-5 Van Tieghem (Bulletin de la Société Botanique de France, vol. xlii.) published a new classification which included all the Australian genera and species, and in addition, the names of eight species were published, but apparently without description. The author appears to have used the names only in connection with his classification, which is most regrettable as no doubt some of them formed the basis of the new genera and sections he established.

H. P. C. Ashworth (Victorian Naturalist, 12, 1895, p. 51) contributed a most interesting article on the dispersal of the mistletoe, claiming that the Swallow Dicaeum is the exclusive agent in Victoria in the dispersal of the mistletoe.

F. Turner (These Proceedings, (2), ix., 1895, 559) recorded 27 species of exotic trees and shrubs growing in New South Wales, the host plants of three species, namely *L. celastroides* Sieber, *L. pendulus* Sieber and *Viscum articulatum* Burm.

In 1897 Engler (Pflanzenfamilien, ii.-iv., p. 127) published a revised classification of the *Loranthaceae,* and accepted Van Tieghem's classification in regard to *Elytranthe* and other sections of *Loranthus,* but in some cases he reduced several of Van Tieghem's genera to Sections and Series. Spencer Moore (Journ. Bot., xxxv., 1897, pp. 161-72) described *L. Nestor* and *L. miniatus* as additions to the flora of Western Australia.

Professor Tate (Austr. Assoc. Adv. Sci., vii., 1898, 553) rendered a similar service to that of Turner in systematically recording all the known host plants of the various species.

The next work of importance is that of F. M. Bailey in his Queensland Flora, v., 1902, pp. 1376-83, wherein he redescribed for Queensland, 16 species of *Loranthus,* 3 species of *Viscum,* and 3 species of *Notothixos,* besides depicting *L. Bidwillii* Bth., *L. myrtifolia* A. Cunn. and *L. grandibracteus.*

Mr. J. H. Maiden in a lengthy article in the "Sydney Morning Herald" dated 20.9.1902 drew attention to the destruction caused by the *Loranthus,* and mentioned that favourable reports had been received as to its fodder value.

Johncock (Proc. Roy. Soc. S. Aust., xxvi., 1902, p. 7, and xxvii., 1903, p. 253) contributed two interesting papers on the *Loranthaceae* of the Willochra Valley, in which are some useful notes on the distribution of *Loranthus.* Dr. A. Morrison in the Western Australian Year Book (1903, p. 204) enumerates the following species for that State: *L. Murrayi* F. v. M. et Tate, *L. Exocarpi* Behr., *L. acacioides* A. Cunn., *L. linophyllus* Fenzl, *L. gibberulus* Tate, *L. pendulus* Sieber, *L. Quandang* Lindl., *L. grandibracteus* F. v. M., and *L. Nestor* S. Moore, also *Nuytsia floribunda* R. Br.

Mr. A. G. Hamilton (Proc. Linn. Soc. N.S.W., xxx., 1905) recorded the host plants of the *Loranthaceae* found at Mt. Kembla. In the same Journal Mr. J. J. Fletcher recorded 54 host plants for three species, namely, *L. longifolius* Desr. (*L. vitellinus* F. v. M.), *L. celastroides* Sieb. and *L. miraculosus* Miq. He also drew attention to the double parasitism of these three species. James Britten (Botany of Cook's First Voyage, Part iii., 1905, p. 86, Figs. 274-6) rendered a special service in describing and depicting three species of *Loranthus* collected by Banks and Solander during Captain Cook's voyage in the "Endeavour" in 1778. Dr. Diels (Die Pflanzenwelt von West Australien, 1906) discusses the doubtful parasitism, etc., of *Nuytsia floribunda* R. Br., and on p. 109 an excellent figure of the plant is given, together with a photograph of the tree (Taf. vi.). A photograph of *L. Quandang* Lindley parasitic on *Acacia acuminata* also appears on page 302 (Taf. xxvii.). *L. linifolius* (*L. linophyllus* is probably intended) is also mentioned.

In 1908 (These Proceedings, xxxiii., pp. 344-376) Mr. J. J. Fletcher contributed an interesting paper on the cotyledons of *Atkinsonia ligustrina* and *Nuytsia floribunda.* Mr. C. C. Brittlebank in the same journal (p. 650) published the "Life History of *Loranthus Exocarpi,*" illustrated by a number of valuable photographs.

M. Em de Wildeman (Plantae Norti Thenensis, 1909, Pl. lxxvi., p. 61) figures and describes *L. linophyllus* Fenzl (*L. Preissii* Miq.).

F. M. Bailey (Queensland Agric. Journ., xxvii., 1911, p. 198) described and figured *L. conspicuus* Bail. He also placed on record a new species of *Viscum, V. australe* Bail. In the same year Professor Ewart (Proc. Roy. Soc.

Vic., xxiv., (N.S.), 1911, p. 69) described *L. signatus* F. v. M. var. *pulchea* Ewart from Western Australia.

In 1912 F. M. Bailey (Queensland Ag. Journ., xxix., p. 190) described and figured *L. Quandang* var. *Bancrofti* Bail. In his 'Comprehensive Catalogue of Queensland Plants" he enumerated 17 species of *Loranthus*, and also figured *L. Quandang* var. *Bancrofti* Bail., *L. conspicuus* Bail., *L.* (*Beauverdiana*) *dictyophlebus* F. v. M., *Viscum angulatum* Hey., *V. orientale*, *V. australe* Bail. and *V. articulatum.* Three species of *Notothixos* were also recorded by him.

W. V. Fitzgerald (Journ. Proc. Roy. Soc. W.A., iii., 1916-17, 35) described two new species, *L. ferruginiflorus* and *L. biangulatus.* He also recorded *L. signatus* F. v. M., *L. longiflorus* Desr., *L. acacioides* A. Cunn. and *Viscum articulatum* Burm.

C. H. Ostenfeld in a "Contribution to West Australian Botany," (Dansk Botanisk Arkiv., Bd. 2, No. 8, Pt. 11, 1908, p. 14) published several species under Engler's revised classification.

Professor Ewart (Flora Northern Territory, 1917, p. 88) recorded 14 species for the Territory.

Mr. D. A. Herbert recently contributed a noteworthy paper on *Nuytsia floribunda* R. Br. (Journ. Proc. Roy. Soc. W.A., v., 1918-19, p. 72) in which he definitely settles the question of parasitism of *Nuytsia.*

Range and Origin.

If we take into consideration the range of the Family *Loranthaceae,* we are impressed with the fact that it is very largely represented in the warmer parts of the globe and readily draw deductions that it had its origin in the tropics and gradually extended to the cooler temperatures north and south of the equator. What its origin was, it is difficult to explain. Perhaps the most feasible explanation is that intimated by Meyen when discussing tropical vegetation (Geography of Plants, p. 164): "But not only do the trunks of trees serve as the support of so luxuriant a vegetation, but high amongst the foliage are seen the scarlet flowers of *Loranthus,* shining *Tillandsiae, Pitcarniae,* and a whole host of climbing plants, which, taking root in the ground, at first twine up the trunks and branches, but afterwards forsake their parent soil, and continue to grow as parasites. Von Martius, during his long abode in Brazil, has traced with extraordinary acuteness the manner in which these singular plants grow, and his description will give the best idea of it." (Reise, etc., iii., 32).

Keeble (Trans. Linn. Soc., 2nd Ser., v., 1896, 101) describing the adventitious roots of a seedling plant of *Loranthus loniceroides,* says, "I cannot but think that this early putting out of the aerial root is a phenomenon of heredity and throws light on the course by which the *Loranthaceae* become parasites; the seeds, originally sticky, often lodged on the trees, and, as in many species of *Ficus,* these seeds, germinating, threw out roots which rapidly reached the ground or the earth which collects in the forks of trees."

Synopsis of the Family.

The family *Loranthaceae,* according to Engler's classification, comprises 25 genera and 811 species. It is reasonable to suppose that since the publication of Engler's classification the number has greatly increased, and it is highly probable there are now upward of about 30 genera and 1,000 species. Further additions are evident when the tropical and sub-tropical floras are systematically worked, and also when a more intimate knowledge is attained of the already known genera and species.

Of the 25 genera represented under Engler's classification, only seven are represented in Australia, namely:—*Nuytsia* R. Br., *Gaiadendron* G. Don, *Phrygilanthus* Eichl., *Loranthus* L., *Notothixos* Oliver, *Viscum* L. and *Korthalsella* van Tiegh.

Nuytsia is the only genus strictly Australian.

Gaiadendron and *Phrygilanthus* are found in Brazil and Chili; the latter is also endemic to the Philippines. *Notothixos* is indigenous to Ceylon, Philippine Islands and New Guinea, while *Loranthus* and *Viscum* are very widely distributed over the temperate and tropical zones. *Korthalsella* appears to be limited to India, Japan, Java, New Zealand, Lord Howe and Norfolk Islands, and also to some of the larger islands of the Pacific.

Nuytsia is confined to Western Australia; *Gaiadendron* to New South Wales; 4 species of *Phrygilanthus* are endemic to New South Wales and Queensland, and two species extend to Victoria. *Loranthus* is dispersed as follows:—Victoria 9 species, South Australia 9, Northern Territory 15, New South Wales 20, Western Australia 23, and Queensland 28 species. *L. Exocarpi, L. Miquelii, L. Preissii* and *L. Quandang* are the only species disseminated over the whole of Australia. *Korthalsella* is represented by 2 species each in Queensland and Norfolk Island respectively, and 1 species each in New South Wales and Lord Howe Island. *Notothixos* has 3 representatives in New South Wales and 4 in Queensland. Three species of *Viscum* are also endemic to the latter State, while New South Wales and Western Australia have each a single species.

The genus *Elytranthe* Blume, a native of Java and India, according to Engler, embraces some of the Australian species of the sub-genus *Dendrophthoe.* In this respect I cannot follow Engler, as they appear to me to have more of the characters of *Dendrophthoe* than *Elytranthe,* consequently the latter genus is excluded.

There has been much confusion in the genus owing to the lack of knowledge on the part of collectors. Many collectors have committed the error of mixing what they probably thought were forms of the same species, but in reality they were different. Many so-called types are unreliable, owing to mixed material.

We have examples of this on the type sheet of *L. Quandang* Lindl., and in many of Dr. Leichhardt's specimens. Mistakes have also arisen through imperfect material, as in the case quoted by Bentham when referring to a specimen from the Howick Group, thought by him to be referable to *L. odontocalyx*, which afterwards proved to be quite a different species, No. 18. The ordinary layman is apt to regard all the *Loranthus* he sees under more favourable circumstances than those which surrounded the early collectors, as belonging to the same species. When experienced persons make mistakes concerning them, there is little wonder that others are sometimes in error, and their information should on all occasions, unless backed up by actual specimens, be interpreted with the greatest caution.

It so happens that, with a large quantity of material which appears to be all the same, there is often a mixture of other species. The distribution of this material has, in some instances, been left to unqualified persons, consequently what is sent out as purporting to be a specimen of the type is something totally different.

Seeds and Germination.

The seeds of all the Australian *Loranthus* are surrounded by viscin, enclosed in a thin membranous sac, strengthened by 4 to 6 longitudinal flaccid appendages, rising from the somewhat spongy base, and extending 2 to 4 mm. beyond the seed. The viscin sac varies in length according to the size of the fruit. The spongy base is also very variable; in some species it is a mere speck, in others it is 5 mm. long, and about as broad. When the viscin is exposed to the air it hardens somewhat, and changes in appearance, until it appears like gum or resin. In *Phrygilanthus celastroides* and *P. eucalyptifolius,* it becomes quite gummy. If soaked in formalin mixture it turns white, like hard mutton fat, and can be separated from the seed without difficulty, but if placed in the same mixture fresh from the epicarp, it remains soft and gelatinous.

James Drummond (Hooker's Jour. Bot., v., 1853, p. 406) contributed the following interesting notes on the seeds of a Western Australian *Loranthus*:—"Some months ago, when I was dissolving some *Acacia* gum, which had been for three-quarters of a year in my possession, I noticed that it contained seeds of the beautiful *Loranthus* which grows on our *Acacia.* They seemed so fresh that I placed them on the bark of a tree in the neighbourhood, where they quickly germinated."

The seeds of the *Loranthus* appear to need a fair amount of moisture to ensure successful germination, and consequently the humid conditions prevailing during portion of the summer are more favourable than the hot dry periods for the successful development of the young seedlings.

I have repeatedly noticed that on germination the hypocotyl does not favour a strong light, particularly the light from the side. In all the experiments carried out by me on the various species, the hypocotyl turned away from the light; even when the hypocotyl was so placed that if it grew forward it would come in contact with the host, instead it turned away. Experiments conducted against a window subjected to strong sunlight are not altogether favourable for the successful development of the young plants, for they rarely grow beyond the attachment stage. In the natural surroundings the light is often more uniform and the humidity more favourable than that of a closed room, hence the young seedlings possess greater vitality, and readily adapt themselves with vigour to the host, if it be a favourable one.

On examining some ripe fruits of *L. miraculosus* var. (*b*), I noticed that the seed had already germinated, but the suctoral disc was unable to penetrate the thick epicarp, and therefore was compelled to turn down towards the base of the seed in some, while in others, the hypocotyl was spirally twisted and, when released, was too far gone to recover, having exhausted the supply of food from the endosperm.

In nearly all cases when germination takes place the hypocotyl and embryonic cotyledons show strong traces of chlorophyll, either a green or purple pigment. In some seeds that contain but little albumen the embryo is quite green before the fruit is fully ripe and, therefore, the irritability set up by germination cannot altogether be a factor in the assimilation of chlorophyll within the embryo.

The first pair of leaves that make their appearance in the germinating seed of most species are not truly the cotyledons but the primary leaves. They are sometimes rudimentary, acicular, linear, spathulate, oblong, lanceolate and elliptic in form, besides developing to a considerable thickness; they remain for a period of a few months to four years on the young plants before they fall off. In such species as *P. celastroides* and *P. eucalyptifolius* they are markedly large for the small hypocotyl, and appear to carry out the function of photosynthesis for the young plant to a considerable extent.

The Embryonic Cotyledons.

The term embryonic cotyledons applies to the cotyledons when enclosed in the endosperm, or when withdrawn from it. In many species they are not withdrawn, but remain imbedded within it, apparently absorbing, for the benefit of the hypocotyl and suctoral disc, the food stored therein. In some species the cementing of the viscin acts as a deterrent to the withdrawal of the cotyledons, and in such cases an early penetration or attachment of the disc takes place, thus reducing the need for the withdrawal of the cotyledons from the endosperm. The enclosed cotyledons appear to generate viscin, for they are saturated with it in a growing seedling, and almost free from it in a dormant seed. This appears to confirm the suggestion that the cotyledons act as suckers to absorb food from the endosperm until the radicle has established itself.

In all the species that I have investigated, the embryonic cotyledons are not withdrawn from the endosperm when germination takes place: they are *L. congener*, *L. Gaudichaudi*, *L. miraculosus* var. (*b*), *L.* No. 15, n.sp., *P. celastroides*, *P. eucalyptifolius*, *L. Miquelii*, and *L. bifurcatus*. Griffith, studying the development of the ovules of *Loranthus* and *Viscum* (Trans. Linn. Soc., xviii., part i., p. 78) observed that, "The cotyledons in all the species I have examined remain inclosed in the albumen, which substance begins to disappear as soon as the plumula commences to be developed."

Brittlebank, in the "Life History of *L. Exocarpi*" (These Proc., xxxiii., 1908, 650), distinctly depicts (Plate xx., figs. 2-4) the embryonic cotyledons withdrawn from the endosperm. Fig. 2 shows the hypocotyl in its early stages, and two opposite obovate cotyledons, followed by a pair of elongated lanceolate sessile leaves, and the first internodes with two small broad lanceolate leaves. Fig. 3 shows a young seedling slightly more advanced, without the cotyledons, but with the first pair of leaves, also two internodes, and above them four somewhat closely imbricate leaves.

I have not seen the seedling of this species beyond the germinating stage.

In *L. biangulatus* W. V. Fitz. the cotyledons are withdrawn. A young seedling on the type specimen shows a terete and slightly tuberculate hypocotyl, 6 mm. long; cotyledons linear-lanceolate, 5 mm. long; suctoral disc broad, smooth, 4 mm. in diameter.

There is a photograph of this species in the "Western Mail," Perth, W.A., 9th June, 1906, showing a much larger seedling.

Double Embryos.

The irregularity of the cotyledons of various species of *Loranthus* is accounted for by the fact that some seeds possess a double embryo which, on germination, gives rise to four cotyledons (or primary leaves) instead of two. It sometimes happens that one or more are suppressed by the cementing or hardening of the viscin and appear beneath the resinous mass in amorphous chlorophyll forms. The appearance of the double embryo opens up the question as to whether they are the result of the seed being two-celled. The evidence seems to point in that direction, as I have found two indistinct cells in some fruits of *L. congener* Sieb. and *L. miraculosus* var. (*b*). Bower (Origin of a Land Flora, 1908, p. 127) draws attention to "the decrease in the number of sporangia, by *fusion of sporangia* which previously in the race were separate. This has been assumed as an explanation of synangial states by various writers, but it can only rarely be proved on grounds of comparison that fusion of sporangia has actually taken place, and the best evidence of it comes from the *Angiosperms*. Thus the fusion of the ovules, leading indeed to obliteration of their identity, occurs in certain species of *Loranthus,* and comparison leaves little doubt that the sunken embryo-sacs represent the individual ovules, the identity of which is lost as regards external forms."

On this same subject Worsdell (Principles of Plant Teratology, i., p. 93) quotes Treube, who "describes a case in which *Loranthus sphaerocarpus,* the fertilized ovum divides by a vertical wall, but the sister-cells develop together into a single proembryo, consisting of a double row of cells. The case of imperfect twins, in which the lower part of the structure is undivided while the upper is separated into two similar parts, represents at once the simplest case of fasciation in existence and also the phenomenon which most easily and clearly explains it, illustrating as it so well does the result of the compromise between the two tendencies towards unification and separation respectively. It is a by no means uncommon phenomenon for two embryos or young seedlings to appear more or less intimately fused together."

Griffith (Trans. Linn. Soc., xviii., i., p. 82) refers to the plurality of embryos in some Indian species of *Viscum.* Also J. D. Hooker (Fl. British India, v., 223) says, "Embryo in fleshy album, solitary or 2 in each seed."

Double embryos have also been found in *Viscum album* L., the well known European mistletoe, and attention has been recently drawn to it by Dom Ethelbert Horne (Journ. Bot., liv., 1916, p. 292) who says, "There appear to be two kinds of mistletoe seeds—those that produce but one radicle and those that produce two or more. The former are oblong in shape and the latter triangular. In the paper by the late Dr. Bull of Hereford on *Viscum album* (Trans. Woolhope Club, 1852-65, p. 312) he states that out of 36 seeds taken at random, 25 had a pair of radicles. I put 30 seeds, also taken haphazard, in a patch on the trunk of a plane-tree. Three of these were lost, and of the remaining 27, two radicles came from 19, which is almost exactly the same proportion as in Dr. Bull's experiment. But where he obtained only 4 seeds with single radicles out of 36, I grew 7 out of 27—a very much larger proportion. Also in the older experiment 7 seeds had 3 radicles, whereas I had only 1."

Brittlebank (These Proc., xxxiii., 1908, 650, fig. xxx.) depicts a double radicle in *L. Exocarpi.* I have also observed and depicted the same phenomenon in the following species: *L. congener* Sieb., *L. Miquelii* Lehm., *L. miraculosus* Miq. and the variety (*b*), *L.* No. 15, n.sp., *L. Gaudichaudi* DC., *L.* No. 24, n.sp., *L. vitellinus* F. v. M.

In the majority of cases the development of the double radicle is unequal, and a large percentage of them fail to develop into plants. As the two radicles appear to exhaust the store of food within the endosperm before the suctoral disc becomes established, it is evident that the double radicles are not always a beneficent factor in the reproduction of the species, but, on the contrary, they are detrimental to it. They are also subject to self-parasitism, which results in the death of the one preyed upon, and occasionally both succumb.

Parasitism.

It has been pointed out by many authorities that the Loranth does not live entirely upon the host. The presence of chlorophyll in the leaves and young branches is suggestive of the power of assimilation it possesses, and therefore it is only partly dependent upon the host for its food supply, which consists chiefly of moisture and mineral food derived from the host through its haustoria or sucking roots. Being possessed of green leaves, it is able to make the rest of its food by photosynthesis.

J. D. Campbell (Text Book of Botany, p. 506) refers to the Loranth as a semi-parasite, because it possesses chlorophyll, "and can therefore assimilate carbon-dioxide, nevertheless it penetrates the tissues of other plants and takes food from them."

It appears that *Loranthus* is capable of extracting injurious properties from its host as shown in the case of *L. namaquanus,* a South African species found parasitic on *Mèlianthus comosus,* a well-known poisonous plant. According to a record by Marloth (Flora South Africa, vol. i., p. 167) "The *Loranthus* . . . is eagerly eaten by animals, and farmers state that they have lost goats which had eaten some *Loranthus* that was growing on *Melianthus.* If the animals had not really eaten some of the *Melianthus* together with the *Loranthus,* this occurrence would indicate that the poisonous principle had passed from the host into the parasite growing on it." It is generally understood that species of *Loranthus* are detrimental to the trees and shrubs upon which they grow, but are not wholly injurious, except in extreme cases, where vegetation is impoverished. They have the tendency of disfiguring forest trees, rather than destroying them altogether, as it would be unnatural for them to destroy the source of their food supply; the greatest danger is when they become attached to young trees in the sapling stage; it is then that the greatest amount of damage is done, as the young tree is quickly deformed and rendered useless for all purposes. On the other hand, when large or mature trees are infected by these parasites it is only the branches that are affected, and, in the majority of cases, it is quite a long time before any injury is noticed, the usual result being the loss of the upper portion of the branch, the parasite taking its place; in the course of time, it entirely surrounds the end of the branch and appears to preserve it from further decay by excluding the air and rain by its growth. In the majority of cases it is the small branches that suffer most; the larger ones appear to be more capable of resisting the growth of the parasite, perhaps on account of the diminution of the cambium layer. The young branches are more sappy and afford better facilities for the spread of the haustoria, which sometimes encircle the young branch, and hence, the flow of the sap is cut off from the terminal portion which dies, and in a number of cases falls off.

Anyone who has given attention to this group of plants must be impressed with the fact that all parasitism of this family is purely accidental; moreover, owing to the sticky nature of the seeds, and the simple manner in which they are dislodged from the ripe fruits, every inducement is offered to accidental parasitism in every case. When the fruit is ripe it is easily dislodged, and many are displaced by strong winds, which act as a distributing agent, as well as birds and other animals that feed upon the ripe fruits or come in contact with them, so that the assortment of host plants of any particular species depends largely upon circumstances.

The seeds have been found adhering to many objects. The seed of the European mistletoe, *Viscum album* L., has been noted by many observers suspended from telegraph and telephone wires, and we have a similar example, in the case brought under my notice by Mr. A. Cox, of Mudgee, who found seeds of *L. miraculosus* Miq. hanging from a wire fence; surrounding an orchard. Three seeds were suspended by a thread of viscin, the seeds being half an inch apart.

It was thought at one time that the Loranth would only grow on certain hosts, but such is not the case. There are, however, some instances when the parasite is more prevalent on some host than others. For example, *L. Gaudichaudi* is invariably parasitic on *Melaleuca parviflora* Lindl. while *L.* No. 23, n.sp. appears to prefer *Brachychiton Gregorii* F. v. M. If these species were thoroughly investigated in the field, they would, in all probability, be found on other plants as well, and probably good reasons for their apparently preferential choice of hosts would be found. For a long time I had been puzzled by the frequency of *L. vitellinus* upon the Bloodwood, *Eucalyptus corymbosa* Sm., in the Hornsby (Sydney) district, and, after careful observations, I have attributed it to the Harmonious Thrush, *Colluricincla harmonica,* and the Blue Jay, *Coracina robusta.* These birds feed upon the fruits of the Loranth and also upon the beetles and other insects which visit the blossoms of the Bloodwood. In this case the food assortment of these birds is the accidental factor which accounts for association of the Loranth with the Bloodwood, as the parasite is usually in ripe fruit when the Bloodwood is in full blossom.

Besides the foregoing there are other examples of what might be termed preferential parasitism, for which it is most difficult to find a satisfactory reason, as in the following cases:

On the Pennant Hills Road, Normanhurst, Sydney, *Phrygilanthus celastroides, P. eucalyptifolius* and *Loranthus vitellinus* smothered five plants of *Photinia serrulata.* Other plants in the vicinity, though older and more sappy than the *Photinia,* were quite free from the parasites. It is interesting to note that none of the plants that were free from the mistletoe were berry-bearing species. They were *Tristania conferta, Eucalyptus resinifera, Jacaranda ovalifolia* and *Erythrina indica.*

In the Botanic Gardens, Sydney, the Planes, *Platanus orientalis,* are infested with *Phrygilanthus celastroides,* and a few plants of *P. eucalyptifolius* and *Loranthus congener,* while on either side of the Planes the Willows, *Salix babylonica,* are quite free from the parasites, notwithstanding the fact that the branches of the Planes almost touch those of the Willows.

Another case in point, is that of *Loranthus congener* Sieb. In the vicinity of Bobbin Head, near Sydney, *Casuarina suberosa* is the common host of that species, while plants of *Casuarina glauca* Sieb., which fringe the salt waters of Cowan Creek, and in many places are only a few feet away from the infested trees of *C. suberosa,* are entirely free from the parasite. Yet, in other localities, *L. congener* has been found parasitic on *Casuarina glauca.*

The same phenomenon also applies, in the same locality and extending along the water front as far as Windybank's boat sheds, to *Phrygilanthus celastroides,* which is fairly common on *Casuarina suberosa* and only occasionally parasitic on *C. torulosa,* but I have never yet found it on *C. glauca,* although I have been constantly on the lookout for it for three years. On several occasions I have seen the branches of *C. torulosa* and *C. suberosa* mingled with those of *C. glauca,* and the former laden with the parasite, but not a trace of it could be found on the latter. Those who are acquainted with the two trees would readily admit that *C. glauca,* with its thinner bark, which is also less corky, would appear to offer more inducement to the parasite than either of its congeners. I have also noticed that *Phrygilanthus celastroides* appears to have a decided dislike to the *Eucalyptus,* or is incapable of effecting a union with it in the majority of cases. On the other hand, its congener *P. eucalyptifolius* is just the reverse. The fruits of the former are smaller than those of the latter, as also are the seeds, while the viscin does not appear to be as durable and the radicle is not quite as strong; therefore, it is probably less adapted for effecting an infection in certain hosts. Apparently the *Eucalyptus* is one of these, although I have never attempted the germination of its seeds upon the *Eucalyptus*.

Certain hosts, because of their thick deciduous bark, are very largely immune from the attack of the parasites, and, unless the young radicle has made good during the season before the host commences to shed its bark, and had penetrated well beyond the deciduous cortical layer, it stands a chance of being carried away with it.

Such host plants as *Eucalyptus punctata* have the class of bark alluded to, but the species does not appear to be capable of warding off all attacks; nevertheless, the percentage of *Loranthus* found parasitic upon it is exceedingly small. *Phrygilanthus eucalyptifolius* is occasionally successful in effecting a union with it, but I look upon that species as the most tenacious and aggressive of all the Australian *Loranthaceae*, as it is capable of adapting itself to almost any host under trying conditions. Next to it in vitality is *Loranthus vitellinus*, which has rather large fruits, and whose seeds are amply supplied with viscin and albumen, which enable it to establish itself upon many kinds of host. On some of the Ironbarks, *Eucalyptus paniculata* for instance, large clumps of *Phrygilanthus eucalyptifolius* are often seen, indicating that they were attacked at an early age, as it is quite a difficult matter for the young radicle to penetrate the hard, composite, kino-like bark, which affords little or no nutriment to it, and 99 per cent. of the seeds that fall upon the hard bark fail to obtain an adhesion. It is upon the young tender branches, or in the furrows of the semi-hard bark that the young plants are best able to thrive. Besides the ordinary or single adhesion we have what is called "double or secondary" parasitism, which is a very common form, and many interesting examples can be seen in the field in places where the parasites are plentiful. The most notable on record is that recorded by Mr. J. J. Fletcher (These Proc., xxx., 1905 (1906), p. 489) as follows: "Mr. Fletcher exhibited eleven branches or parts of stems—being portion of eight individual plants of *Loranthus celastroides*, parasitic upon four Eucalypts, two Angophoras, a Quince tree, and a *Pinus insignis*. These eight Loranths had been victimised in their turn by seventeen Loranths (shown *in situ* upon the host-Loranths) referable to three species."

I have noticed that with plants of *Phrygilanthus eucalyptifolius* in the Botanic Gardens, Sydney, both on *Eucalyptus tereticornis* Sm. and *E. melanophloia* F. v. M., secondary or self parasitism results in a much shorter and more erect growth instead of the long pendulous branches so common to this species. *Loranthus* was proclaimed a noxious plant in Victoria in 1904, which accounts for its absence in some districts. Mr. D. W. Shiress, after a recent visit to Victoria, informed me that the Loranth is almost stamped out, and that during his two week's stay in the Bendigo district he saw but two plants.

Adventitious Roots.

Adventitious roots occur on all the species of *Phrygilanthus* found in Australia, and also upon some species of *Loranthus*. The ramifications of the root structure are similar in both genera. The union with the host in some species gives rise to numerous red-brown adventitious roots which, in nearly all cases, take a downward course. The chief purpose of these roots appears to be to give greater support and stability to the plant, for, by becoming attached to the cambium of the host, they draw from it, through their haustoria, most of the essential food that the parent plant requires.

The mode of attachment of the adventitious roots depends largely upon the host. They occur more frequently, and are more vigorous, upon hosts with a persistent bark. The swelling or ball-like growth is commonly associated with hosts having a deciduous bark. On one occasion I came across a plant of *Phrygilanthus eucalyptifolius* growing on the trunk of *Angophora lanceolata* Cav., which had no swelling where the union took place, but, instead, a deep depression around the base of the parasite, as if it were growing from a hole in the trunk of the host from which two strong adventitious roots descended for about six feet; one was almost dead, and entirely free from the host, the other, in a fairly healthy condition, had, at regular intervals of about six inches, sent out haustoria from the lower surface, which had penetrated the host in the same manner as a seedling plant. These had become elongated, and no less than seven layers of the dead bark of the host were counted on two of them, and five layers on three others. In two places I was able to pass my fingers between the host and the main root. The largest rootlets were about an inch long and conspicuously ringed. The old bark of the host had partly crumbled away, and could be turned round and round like so many washers. The point of attachment of the rootlets was much smaller and extremely weak. The struggle for existence of this particular plant was noticeable in the sparseness of its foliage. The annual shedding of the host bark was to all appearances detrimental to it, as it loosened the feeders annually, thus depriving them of the necessary support.

When adventitious roots are formed upon plants with a persistent bark, as in the case of *Angophora intermedia, Exocarpus cupressiformis, Syncarpia laurifolia* and many others, they are very firmly attached to the host. On old plants they form a matted mass encircling the host for some distance on either side of the attachment, but usually they are more numerous on the side facing the South. Occasional examples will be seen when the main root develops to a considerable size of varying thickness. This applies more particularly to the adventitious roots of *P. celastroides* when living upon *Syncarpia laurifolia*. Sometimes the adventitious roots are free, and sway about in the wind, like those formed on the branches of some species of *Ficus*, and continue to grow until a suitable object is reached for them to prey upon. It happens that they sometimes reach the ground but do not penetrate it, as in the case with the roots of the *Ficus*, but become dry and withered at the end.

I had under investigation at Turramurra, near Sydney, a plant of *Phrygilanthus eucalyptifolius* growing on the trunk of *Acacia decurrens* var. *mollis*, with two adventitious roots touching the ground. I heaped some soil around them to ascertain whether they would root in the soil, but in the course of two months I found that the portion of the roots I had placed in the soil were dead, and above the dead part new roots had formed which were well beyond the level of the ground. This matter is worthy of further investigation in other species. It, however, proves one point,—that the adventitious roots of *Phrygilanthus* differ entirely from the so-called adventitious roots of other genera.

The adventitious roots of this Family are capable of feeding upon each other. It is a common occurrence to see conglomerate masses of roots fused together by their own haustoria, thus suggesting the idea that the parasite actually lives upon itself. When the roots are broken they produce new roots from the side near the end of the broken part, and continue to grow as in the first instance.

Many of the roots are seen to produce young plants along them, but in some cases the plants are the result of seed germinating upon the roots, having fallen from the parent plant or been deposited by birds or other agencies. If a large plant be examined in the fruiting season when the fruits are ripe, a number of young seedling parasites will be seen adhering to the branches, roots, and even leaves of the parent plant. So that many of the sucker-like growths observed on the roots are due to reproduction from its own seed, and in this manner large clumps are often formed upon the roots and branches of the host, thus illustrating another form of parasitism—"self or secondary."

It is interesting to note that when this form of parasitism takes place the union of the two parasites is scarcely distinguishable, and would be passed over in a great many cases as ordinary branches.* There are occasional exceptions when the union gives rise to a ball-like swelling, and when this is the case, the plants are much larger and more vigorous than when no union is perceptible. Another point of interest is the deterioration in the size of the parasite when living upon its parent. The result is a diminution chiefly in the shortness of its branches and leaves, or in other words, smaller plants are produced, after a year or two. Adventitious roots act in the assimilation of moisture for the plant. As will be noticed when attached to a dead branch, their haustoria push their way beneath the dead bark in quest of food or moisture; they do not enter very far into the dead cambium, but adhere firmly to it. When by chance or accident they become attached to the dead wood, the haustoria or root suckers are more numerous, and are sometimes closely followed by each other in a continual line beneath the main runner, and resemble a number of grubs in outline. During favourable weather, that is, when the weather is warm and there is a bounteous rainfall, the growth of these roots upon the dead branches is very marked, and is indicative of the part played by them in providing moisture for the plant. It may also be surmised that when the haustoria feed upon dead wood or bark, a fair amount of liquid food is absorbed by them which must naturally benefit the plant. It is well known that decaying vegetable matter contains plant food, and it is quite reasonable to assume that in carrying out their functions these adventitious roots, with the aid of their haustoria, convey a considerable amount of nutriment to the plant, and are therefore of much value to it, not only as a means of assisting the plant to adhere firmly to the host, but also as an agent of assimilation.

The following species possess adventitious roots:—*Phrygilanthus Bidwillii, P. myrtifolia, P. eucalyptifolius, P. celastroides, Loranthus vitellinus, L. dictyophlebus, L. odontocalyx, L. alyxifolius, L. biangulatus.*

The Union or Attachment.

In the Australian *Loranthaceae* there are two distinct forms of union or attachment with the host, namely, ball-like and fusiform.

The first is brought about in two ways: (1) When the wood of the parasite expands into a ball-like excrescence over the wood of the host, and (2) When the penetration of the radicle causes the wood of the host to form a ball-like growth around the point of attachment of the parasite. Both no doubt are the result of a straight or single puncture of the radicle. To the first, I have

* I find that Mr. J. J. Fletcher has made the same discovery in reference to this form of parasitism, and has placed it on record in these Proceedings (xxx., 1905 (1906), 489).

applied the name "aggressive," and to the second "defensive" attachment, or union.

It is not my intention to go into details, as the subject needs careful and critical investigation; all I propose to do is to draw attention to it.

Loranthus Gaudichaudi provides a good example for the ball-like union. The fusiform swelling is the result of the division and creeping nature of the radicle as it penetrates the host, causing it to swell into a cylindrical body, as seen in *P. Bidwillii.* This form is invariably followed by adventitious roots which soon make their appearance, relieve the radicle by effecting an early union with the host, and thus lessen the growth at the point of attachment, rarely if ever reaching the dimension of the ball-like union. Sometimes the adventitious roots form a conspicuous swelling at the union, and increase in size, ultimately forming the main stem, as seen in some plants of *P. celastroides.*

Under "Origin" (p. 6) I drew attention to the adventitious roots of *Loranthus,* which appear to have impressed some observers with the idea that it was at one time a climbing plant, and through evolutionary changes had dispensed with the soil as a means of existence, and instead acquired the habit of appropriating the bark and sap of various plants to perfect itself, just as its hosts utilise the soil in the process of their development and reproduction.

It will be admitted that those species possessing adventitious roots appear to throw some light upon their origin, as suggested by Meyer and Keeble, and therefore, are singularly interesting on that account.

It might be assumed that the ball-like growth, or union free from aerial roots, belongs to the oldest species, as it demonstrates that the parasites, through evolution, have thrown off what is usually accepted as one of their primary characters, and have to depend upon a single attachment. If that is so, they therefore make the fullest use of the sun's rays in the assimilation and retention of essential foods: much of their food no doubt consists of atmospheric moisture and inorganic compounds, and they are to a great extent self supporting. This single adhesion is also more suggestive of xerophytic nature than support by adventitious roots; it is not nearly as destructive to vegetation, and is easily eradicated.

None of the Australian *Loranthaceae* throw out runners beneath the cortex of the host like the European mistletoe, *Viscum album* L., and they are, on that account, much easier to eradicate without doing any serious damage to the host.

The following species develop a ball-like union:—*L. pendulus, L. congener, L. Miquelii, L. Gaudichaudi, L. miraculosus* and *varieties, L.* No. 15, n.sp., *L. linophyllus, L. grandibracteus, L. Exocarpi* and *varieties* (aggressive), *L. Quandang* and *var. Bancrofti, L.* No. 24, n.sp., *L.* No. 21, n.sp., *L. ferruginiflorus, L. gibberulus, L. Murrayi, L.* No. 32, n.sp., *L. Nestor.*

Species with a fusiform union or not definitely ball-like:—*P. myrtifolius, P. Bidwillii, P. celastroides* [Sometimes ball-like (defensive) type when parasite on *Platanus orientalis*], *P. eucalyptifolius, L. vitellinus* [Sometimes ball-like (aggressive) when on smooth-barked trees like *Angophora lanceolata.* This species in many cases throws out one or two adventitious roots which soon develop haustoria, causing the wood of the host of rough-barked trees to expand around them in raised globular excrescences, which, as they grow, remove the adventitious root further away from the host, which does not increase in size, and is soon surpassed in thickness by the main branches of the parasite], *L.* No. 23, n.sp., *L. alyxifolius, L. dictyophlebus* [Growth similar to that of *L. vitellinus*], *L. biangulatus.*

Mimicry or Imitative Powers of Loranthus.

I cannot say that I am greatly impressed with *Loranthus* as having any marked power of mimicry. To my mind, based upon field observations, the great controlling factor in the variability of a species is ecological. The Loranth is what environment makes it, not a desire of the plant to conceal its identity by imitative means, but one solely to derive as much nutriment as it can from its host.

I have arrived at this conclusion after a careful examination and study of various species, extending over four years, noting the condition of the host, favourable or unfavourable, attachment of the parasite in relation to the host, and the climatic conditions prevailing. Shade and exposure have a great influence on the development of the size, shape, colour, thickness or texture of the leaves, and also on the colour of the flowers. Likewise a sound attachment and a vigorous food plant play a most important part in the life of the parasite. There is, however, a gradual development of different forms of some species which, though difficult to describe, manifest themselves irrespective of host differentiation, and which may be termed species in the making, or in the evolutionary stage, without easily definable characters.

One of the commonest species in the Port Jackson district is *Phrygilanthus eucalyptifolius*, which is beyond doubt the most polyphagus of our mistletoes; notwithstanding its large assortment of food plants, it does not show any particular or marked signs of mimicry of any of them. Its leaves show the same uniformity when growing on *Acacia Baileyana* as on *A. melanoxylon, A. implexa,* or when parasite on *Angophora cordifolia,* and on the long jointed terete branchlets of *Casuarina.* In fact I have seen specimens from the latter with leaves remarkably broad and long, which might be said to be ridiculously out of all proportion to those of the host, and are contrary to all attempts at mimicry. This also applies equally to *P. celastroides, Loranthus congener, L. pendulus, L. Miquelii, L. vitellinus* and others that I have noted in the field.

W. P. Hemsley (Jour. Linn. Soc., xxxi., 308) draws attention to the remarkable similarity of the leaves of *L. pendulus* to those of *Eucalyptus amygdalina (radiata)*. The close analogy of the leaves of some of our Loranths and Eucalypts and other hosts is readily admissible. But is it not attributable to homoplasy, rather than to sensitiveness or instinct on the part of the plant to conceal its identity? On this subject Spencer Moore writes (Jour. Linn. Soc., xxxiv., 1898-1900, p. 259) "The frequent close resemblance between certain species of *Loranthus* and their hosts was noticed by me. Nor was it without interest that I learnt, on my return home, how the same fact had been alluded to by that sagacious observer, James Drummond. [See below]. The two species showing this resemblance best are *Loranthus pendulus,* Sieb., var. *parviflora,* which is difficult to descry when growing upon the Quandong, and *L. Quandang,* Ldl., of which the leaves are strikingly similar to those of its host, an *Acacia.* But it may be doubted whether mere homoplasy is in point here, seeing that the parasites are greedily eaten by camels, † and so are, in all probability, equally attractive to vegetivorous marsupials. In these cases, therefore, the resemblance may possibly be protective, and may have been perfected by means of natural selection. The attraction probably lies in the flowers, which contain much nectar and are very sweet in consequence." † "Camels will browse upon the parasites and leave the hosts quite untouched, although the latter are themselves excellent food. There would be stronger support for the suggested mimicry were the host distasteful; but the parasites have, it must be remembered, only a small range of selection, if any."

James Drummond (Hooker's Jour. Bot., ii., p. 347 and 360, 1840) also refers to the close resemblance between the *Loranthus* and certain hosts. Miss C. M. Le Plastrier (Australian Naturalist, iv., 1920, 139) also refers to the same phenomenon, and wonders if it is a "case of protective adaptation." By giving a little thought to this subject I find quite a number of plants with leaves similar to those of *Loranthus.* For example, the terete leaves or phyllodes of *Acacia calamifolia, A. Havilandi, A. neura* (the terete form) and many other terete phyllode species resemble the terete leaves of *L. Preissii* more closely than those of the *Casuarinae.* Other plants which are also homoplastic with it or its congeners *L. linophyllus* and *L.* No. 15, n.sp., are *Hakea lorea, H. Cunninghami* and *H. Fraseri.* Amongst the Eucalypts corresponding examples are also numerous, both in the lanceolate and the cordate leaves of that genus. In the case of *Loranthus eucalyptifolius* H.B. et K. from Venezuela, which the authors undoubtedly thought resembled *Eucalyptus*—hence the name, although *Eucalyptus* is not indigenous to Venezuela—it cannot be accused of imitating a host which is not even indigenous to its native country. Many other examples can be cited. In fact, nearly every family of the Vegetable Kingdom, especially among the Cryptogams and Phanerogams, has many counterparts in some other totally different family, and therefore homoplasy is much more common than at first appears, and it is not confined to the parasites any more than to other groups of plants. No doubt the parasite habit of *Loranthus* led to the belief that it imitated the plant from which it derived its nourishment.

In reference to the suggested "protective adaptation," it is evidently, in the case of *L. pendulus* and *L. vitellinus* and other species with showy flowers, the reverse, and, instead of being "protective," is strikingly "attractive." Whether it is with the object of perpetuating the species, by attracting the birds and insects to assist in the pollination of the flowers (if it be necessary), is an open question. I have seen the "honey-eaters" fly with the greatest precision from plant to plant of *L. vitellinus* when in full blossom in quest of nectar. If these plants had inconspicuous flowers the birds would not be able to detect them so readily; as it is, they are discernible at a great distance, especially *L. vitellinus.*

Fertilization of the Loranthus.

I am of opinion that all the Australian species of *Loranthus* that have come under my observation are self-pollinated, as the anthers are fully developed and the pollen released from them simultaneously with the opening or bursting of the petals. The close proximity of the stigma to the anthers, and the powdery nature of the pollen facilitate the work of self-pollination.

It has been suggested by Keeble (Trans. Linn. Soc., 2nd Ser., iv. (3), 1896, p. 94) that nectar-eating birds assist in the fertilization of the flowers, in which I concur, as it is quite possible that some of the flowers occasionally "miss," and these may accidentally be fertilized by visiting birds, as their bill is bound to be saturated with pollen as they forage amongst the flowers in quest of food. It must be admitted that the percentage of flowers pollinated by birds in some districts is remarkably small, seeing that there are no examples of hybridism, though the opportunity for such is very often favourable.

During the flowering season in the Port Jackson district the following species flower about the same time:—*P. celastroides, P. eucalyptifolius* and

Loranthus vitellinus. In fact they are so closely associated that all three are sometimes found upon the same host, and occasionally parasitic on each other, yet I have not seen any forms suggesting or exhibiting any signs of hybridism.

Many species are without doubt pollinated by insects and many of the buds show punctures made by small grubs.

The Curvature of the Style.

In some species the style is distinctly curved in bud. This appears to be the result of two causes:—(1) the thickening of the top of the petals, and (2) the closely packed anthers around the top of the style. In all the Australian species, the style, when fully developed, exceeds the anthers by 2-5 mm. The development or extension of the style is sometimes the result of the elongation of the ovary. As the top of the petals in some species is considerably thicker than the median portion, and a concavity is formed on the inner surface by the combined thickness of the stigma and the closely packed anthers, it is evident that both characters act conjointly in the curvature of the style.

The style of *L. sanguineus* F. v. M. var. *pulcher* Ewart is distinctly curved in bud, and it appears that the greatest pressure is apically. The tops of the petals are remarkably thick and coriaceous and considerably broader than in the middle, consequently the latter part is the weakest and therefore apt to offer the least resistance. The style, which appears to grow fastest, meets with opposition at the apex, and is forced to bend in the middle; in so doing it presses against the diminished portion of the corolla and forces the segments apart along the commissural line, the bent portion protruding 3 or 4 mm. above the surface of the segments. At first, only two of the segments are cleft (one opposite the other) by the curving of the style, the others gradually splitting afterwards as the flower ages, from which it appears that the style has some influence on the opening of the flower. The anthers play a prominent part also in the curvature of the style of this variety, as their tips are somewhat firmly pressed into the slight depressions around the base of the large stigma. They remain in that position after the petals separate, and when released have the tendency to keep in an erect position around the style, instead of curling back with the petals away from it, as is the case with nearly all the allied species.

In dried specimens the style is distinctly bowed by the adhering anthers, which are so firmly pressed to the base of the stigma that their apices are broken by the style in its effort to release itself or to gain an erect position. When fully developed it is longer than the petals, and it continues to grow after the flower opens. I have not had the opportunity of carrying out field observations with this form to ascertain the exact position of the stamens in the expanded flower; but in the dried state they coincide with the above description.

Another point to be considered is whether the adhering apices of the anthers that are saturated with pollen grains impregnate the stigma before the style succeeds in releasing itself from the anthers. In the case of *L. Exocarpi* Behr. var. (a), the style, when in bud, is bent from one side of the corolla to the other, and is actually shorter than the anthers when in that position. When the flower expands it exceeds the anthers by 3-4 mm. This indicates that the style to some extent assists in the opening of the flower (Keeble, *l.c.*). In one specimen of *L. dictyophlebus* F. v. M. the style was distinctly curved, and it had protruded through one of the clefts of the petals. *L. vitellinus, L. acacioides,* and *L. alyxifolius* are species which show the bent character of the style when in bud.

Dispersal and Distribution.

The dispersal and distribution of *Loranthus* has been the subject of much discussion. An examination of the seedling parasites in the field discloses the fact that birds are the chief agents of distribution, as many young seedlings will be found adhering to the branches of trees and other objects, and in some instances small clumps of 3 to 6 seedlings, sometimes of different species, will be seen growing together, the seeds having been deposited by birds.

Loranthus is a light-loving plant, and is found in the most exposed situations, along the mountain spurs and ridges, usually with a northerly, easterly or westerly aspect, in open forest country, along the main roads in the vicinity of cultivation, also around orchards and large gardens. The scrub land affords but few species, and they are more often found on the fringe, rarely in the dense scrubs. Some species prefer the coastal area, others the dry interior, while a few keep to the sub-tropical regions. Thus *Loranthus* in common with other plants, has its barriers to migration. This may be accounted for by the fact that some species are less hardy than others, and cannot live beyond certain latitudes, and consequently become confined to limited areas, while the dissemination of the hardier species may be controlled by the limitations of their migratory agents of dissemination.

The distribution of *Loranthus* is most marked along open water courses, both on the coast and in the interior. In well-watered country the parasite is widespread. In the drier interior it is less common, although in some places in the desert country it is apparently abundant.

In the desert, the absence of large or suitable host plants is probably the compensating factor, as *Loranthus* makes the most of its host and sometimes, through the favourable position of the first attachment, it increases by the seeds falling on to the lower branches of the host, developing into strong plants, which almost take possession of the host.

The habit of the birds that feed upon the flowers or fruits of *Loranthus* is also to be reckoned with. They are peculiarly regular in their habits when feeding upon the parasites, for they fly from Loranth to Loranth with the greatest precision, methodically searching for newly-opened flowers or ripe fruits. It was thought at one time that the "Mistletoe Bird," *Dicaeum hirundinaceum,* which feeds upon the ripe fruits of the *Loranthaceae,* was the sole agent of distribution of these parasites, but quite a number of birds feed upon the flowers and fruits of *Loranthus,* as the following records will show: Writing of the Mistletoe Bird, Dr. E. P. Ramsay (These Proc., 2nd Ser., i., 1886, p. 1093) says, "This species is universally dispersed over the whole of Australia; feeds on berries and fruits of various kinds, but seems to prefer those of the *Loranthus,* of which we have in Australia so many varieties if not species, and of a *Viscum* (*V. aureum*), which is only found as a parasite on the *Loranthus*; this plainly accounts for the distribution of the *Loranthus* and *Viscum* all over the districts frequented by the *Dicaeum,* and in which it is locally known as the Mistletoe Bird."

Professor R. Tate (Rept. Horn Sci. Exped., iii. (Geol. and Bot.), p. 129) writes, "The little *Dicaeum hirundinaceum* lives chiefly on the berries of *Loranthus* spp., and in consequence the distribution of the bird is coterminous with that of its food plants . . . Tasmania and Kangaroo Island, where the bird is absent, do not produce a single species of *Loranthus.*"

H. P. C. Ashworth (Vict. Nat., xii., 1895, p. 51) intimates that the swallow Dicaeum seems to be the exclusive agent in Australia in the dispersal of the Mistletoe.

In a letter to the "Sydney Morning Herald" dated September 26th, 1902, Mr. Edward Stack attributes the dissemination of the mistletoe to the Silver-eye, *Zosterops coerulescens,* and the common house-sparrow, *Passer domestica.*

Mr. C. F. Johncock (Trans. Roy. Soc. S. Aust., xxvi., 1902, 7, et xxvii., 1903, p. 253) records the following birds observed by him on *Loranthus*: *Acanthiza,* Yellow-rumped Tit (Does not eat the fruits but nests in the Loranth); *Ptilotis sonora,* Singing Honey-eater: *Acanthochaera carunculata,* Wattle Bird; *Zosterops coerulescens,* Silver-eye, "A great distributing agent. To this bird is attributed the spread of the Loranth to the fruit trees. *Coracina robusta,* Black-faced Cuckoo Shrike."

Mr. A. J. North (British Ass. Ad. Sc., 1914, N.S.W. Handbook, p. 299) states that "the Family *Dicaeidae,* with a single representative in Australia, has an important action on its flora. The Mistletoe-bird (*Dicaeum hirundinaceum*), generally distributed over New South Wales, feeds largely on the viscid berries of the *Loranthus,* which it passes entire, and thus assists in the distribution of this parasite."

C. C. Brittlebank in his "Life History of *Loranthus Exocarpi,*" had noted the Swallow Dicaeum and the Bell Magpie, *Strepera versicolor,* feeding on the fruits of *L. Exocarpi.* The latter he says "feeds upon the fruits which it swallows whole, casting the seeds."

In the vicinity of Warrawee, near Sydney, I watched the *Dicaeum* strip a plant of *Phrygilanthus celastroides* of its ripe fruits; the ingenious way in which it performed the task was not without humour. First the bird bit the fruit to ascertain whether it was ripe, and if so, gave it a sharp twist dislocating it, then, turning the fruit endways in its bill, it sucked the seed from the epicarp, letting the latter fall to the ground, and then proceeded with another in the same manner. The whole process was similar to a person drinking out of a bottle—the pear-shaped fruits resembling little bottles.

During the month of May, 1920, I observed the Starlings feeding upon the fruits of *Phrygilanthus eucalyptifolius* in the Botanic Gardens, Sydney.

The following birds were observed by me eating the fruits of various species of *Loranthus* in the Hornsby district. I determined the birds from Dr. J. A. Leach's "Australian Bird Book." The numbers following the names are those used in the book. Mistletoe Bird, *Dicaeum hirundinaceum,* No. 336; Yellow Rumped Thornbill, *Acanthiza chrysorrhoa,* No. 293; Red-browed Finch, *Aegintha temporalis,* No. 382; White-eye, *Zosterops coerulescens,* No. 334; Rufus-breasted Whistler, *Pachycephala rufiventris,* No. 323; White-eared Honey-eater, *Ptilotis leucotis,* No. 358; Leatherhead, *Tropidorhynchus corniculatus,* No. 374; Black-faced Cuckoo-Shrike, *Coracina robusta,* No. 262; Grey Bell Magpie, *Strepera versicolor,* No. 394; Harmonious Thrush, *Colluricincla harmonica,* No. 315; Little Cuckoo-Shrike, *Coracina mentalis,* No. 263.

The last four swallow the fruit whole, and it passes through them in a mass mixed with the wings of beetles, etc. The smaller birds usually swallow the seed only; sometimes they sip at the sweet watery substance surrounding the viscin before and after the seed is dislodged from the epicarp. Mr. Froggatt, the Government Entomologist, informed me that he saw the Galah, *Cacatua roseicapilla,* feeding upon the fruits of *Loranthus linophyllus* Fenzl at Warrah, N.S.W.

At Bowan Park, along Oakey Creek, 20 miles S.W. of Orange, N.S.W., I noticed the following birds feeding upon the fruits of *L.* No. 15,—Mistletoe bird, *Dicaeum hirundinaceum*; Golden-rumped Diamond-bird, *Pardalotus xanthopygius*; Silver eye, *Zosterops coerulescens*; Soldier-bird, *Myzantha garrula*; Leatherhead, *Tropidorhynchus corniculatus*; Rosella, *Platycercus eximius*; Galah, *Cacatua roseicapilla*; Cockatoo-Parrot, *Calopsittacus novae-hollandiae.*

The small birds are the greatest disseminators of *Loranthus,* as in a large number of cases when they feed upon the fruits, they do not swallow the seed, but as before stated, sip the sweet fluid surrounding it, and in many cases the seed sticks to the bird's bill, and is displaced by wiping it on the most convenient object. Sometimes the seed is not easily dislodged. I have seen the Mistletoe-bird and the Silver-eye make many attempts before they succeeded; thus the seed is occasionally carried long distances before it is disposed of. With the large birds, the fruits being swallowed whole, the seeds and epicarps are passed in a hard mass, consequently the only chance the seeds have of germinating is when they happen to fall in the fork of a tree,—a rare occurrence.

The percentage of seeds sticking to the bill of the large birds is exceedingly small. An example of seed distribution of this family was noted by me in the case of specimens of *Loranthus Miquelii,* collected at Brooklyn, Hawkesbury River, which contained seeds of *L. vitellinus* and *Phrygilanthus eucalyptifolius.* The former was plentiful on *Angophora lanceolata* about fifty yards away, while adult plants of the latter were half a mile away. On another occasion. while examining a large clump of *P. eucalyptifolius* near Asquith, Hornsby district, I noticed a little clump of seeds of *Phrygilanthus* and *Notothixos* that had been deposited by a bird, one seed of *Phrygilanthus* and two seeds of *Notothixos subaureus* were just commencing to germinate. After a diligent search extending over two hours I failed to find any plants of *Notothixos* in the vicinity. The nearest plant known to me was more than a mile away.

The Flying Fox, *Pteropus rubicollis,* is another agent of distribution of these parasites. Towards the end of April of 1920, a large number of these animals paid several visits to the Botanic Gardens, Sydney, and I noticed that beneath a large tree of *Eucalyptus melanophloia* which was frequented by them, and which was infested with *Phrygilanthus eucalyptifolius* the ground was strewn with the castings of small clumps of seeds and epicarps of the parasite. In some cases the fruits appeared as if they were partly chewed, and the seed sucked off the sweet coating. It is reasonable to assume that a number of seeds adhere to these animals when feeding upon the fruits of the parasites, and, presumably, the result is an accidental distribution of the parasites by them.

List of Bird Disseminators.

Acanthiza chrysorrhoa, Yellow-rumped Thornbill.
Acanthochaera carunculata, Wattle Bird.
Aegintha temporalis, Red-browed Finch.
Cacatua roseicapilla, Galah.
Calopsittacus novae-hollandiae, Cockatoo-Parrot.
Colluricincla harmonica, Harmonious Thrush.
Coracina mentalis, Little Cuckoo Shrike.
Coracina robusta, Black-faced Cuckoo Shrike.
Dicaeum hirundinaceum, Mistletoe Bird.
Gliciphila melanops, Tawny-crowned Honey-eater.
Myzantha garrula, Soldier Bird.

Pachycephalus rufiventris, Rufus-breasted Whistler.
Pardalotus xanthopygius, Golden-rumped Diamond Bird.
Passer domestica, Common Sparrow.
Platycercus eximius, Rosella.
Ptilotis leucotis, White-eared Honey-eater.
Ptilotis sonora, Singing Honey-Eater.
Strepera versicolor, Grey Bell Magpie.
Sturnus vulgaris, Starling.
Tropidorhynchus corniculatus, Leather-head.
Zosterops coerulescens, White-eye.

Birds Observed Feeding on the Nectar.

Nearly all the flowers of the Australian species of *Loranthus* and *Phrygilanthus* contain much nectar, and therefore are sought after by many honey-eating birds. On examination, many of the flowers in the field will be found with small punctures at the base and sometimes in the swollen part near the attachment of the filaments. The flower tube of *Loranthus vitellinus*, *Phrygilanthus eucalyptifolius*, and *P. celastroides* is sometimes filled for more than half its length with nectar.

I watched the Spinebill, *Acanthorhyncha tenuirostris*, No. 348 (Leach, *op. cit.*) and the Tawny-crowned Honey-eater *Gliciphila melanops* (*fulvifrons*), No. 349, and the Yellow-Rumped Pardalote, *Pardalotus xanthopygius*, No. 341, piercing the base of the flowers with their sharp bill, or thrusting it between the clefts of the ripe buds, or down the centre of the flower. Other birds noted by me feeding upon the flowers between Hornsby and Pymble, near Sydney, were the Sanguineus Honey-eater, *Myzomela sanguinelentas*, No. 346; Singing Honey-Eater, *Ptilotis sonora*, No. 356; and the White-bearded Honey-eater, *Meliornis novae-hollandiae*. These birds also feed upon small insects at the same time, thus demonstrating that they do not depend upon the parasites for their food supply.

Mr. O. H. Sargent (Ann. Bot., xxxii., 1918, 216) states that he saw *Zosterops Gouldi* and other honey-eaters sipping nectar from the flowers of *Loranthus linophyllus* Fenzl in the York district, Western Australia.

Fungi Found Upon the Mistletoes.

The *Loranthaceae*, like other groups of plants, are not immune from the ravages of microscopic fungi which attack the leaves and fruits, and also the wood of some species. In the Port Jackson district a number of *Loranthus*, *Notothixos* and *Phrygilanthus* are infested with Fungi, which in many cases appear on the viscin surrounding the seed.

As far as I am aware, Mr. D. McAlpine was the first to draw attention to the Fungi upon *Loranthus* in Australia. In These Proceedings (xxviii., 1903, 96) he recorded *Cerospora Loranthi* D. McAlp. on the living leaves of *Loranthus pendulus* Sieb. at Dandenong Creek, Victoria. Mr. W. Pearse, of Jerry's Plains, writing to the "Sydney Morning Herald," 19th September, 1905, intimated that a disease killed out all the mistletoes attacking the Kurrajongs. Mr. R. T. Keys, of Muswellbrook, in a letter to the same paper dated 10th October, 1905, also stated that "a disease had spread over hundreds of miles of country killing out the mistletoes." It appears that no investigations were carried out to ascertain the cause of the Mistletoes dying out in these localities, nor to ascertain the nature of the disease.

Insects Attacking the Mistletoe.

Quite a number of different kinds of insect gall are found upon some species, both on the leaves, young shoots, buds and fruits. These galls vary considerably in shape and size. So far few of the insects which cause them have been determined. Mr. G. A. Waterhouse (These Proceedings, xxxi., 1906, pp. 424, 425) exhibited specimens of all the known Australian species of *Ogyris* (Lepidoptera, *Lycaenidae*), which feed mainly upon the *Loranthus*. "Commenting on the habits of their larvae, he remarked that so far all had been found to feed on various species of *Loranthus*, feeding by night only and hiding during daylight under pieces of bark, in holes in the trees, under stones on the ground, or even in ants' nests. Most of the species are attended by ants, which seem to be very useful to them. About 7 o'clock one evening he watched larvae of *O. ianthis* making their way from a piece of *Loranthus* to their hiding place. These larvae did not seem to have any idea of direction, for they frequently attempted to go quite away from their hiding place, but were prevented by the ants blocking their further progress in that direction."

Mr. J. J. Fletcher (These Proc., xxxiv., 1909, 419) exhibited a number of *Diptera* pronounced by Mr. W. W. Froggatt, Government Entomologist, to be probably an undescribed species of *Ceratitis*, bred from fruits of *Loranthus pendulus* (*L. Miquelii* Lehm.), forwarded from Perth, Western Australia, by Dr. J. B. Cleland. "The majority of the fruits sent were infested with larvae—one in each infested fruit—which had eaten out the seeds more or less completely by the time they were ready to pupate." The following year in the same journal (pp. 862-3) Mr. W. W. Froggatt pronounced the insect to be *Ceratitis Loranthi* Froggatt.

Mr. J. A. Kershaw (Vict. Nat., xxv., 1908-09, 131) recorded a search for the "Larvae and pupae of the rare blue butter-fly, *Ogyris olane*. The larvae feed on the Mistletoe, *Loranthus pendulus*, and when fully grown, travel down the tree-trunk (often a considerable distance) to near the base, pupating under the loose bark." Several pupae were found.

Messrs. A. A. Hamilton and G. A. Waterhouse (Aust. Naturalist, iii., 1915, p. 90) recorded having found the larvae of the butterfly *Ogyris amaryllis amaryllis* on the branches of *L. linophyllus* var. (*b*) Benth. at Tuggerah Lakes.

T. S. Hart (Vict. Nat., xxxiv., 1917, 33) drew attention to the larvae of the "Mistletoe Butterfly," *Delias harpaleyense* Don on *Loranthus celastroides* (*Phrygilanthus celastroides*).

Some fruits of *Loranthus* No. 24, which I had received from Mr. A. Morris, Broken Hill, contained larvae; when hatched out, they proved to be a species of moth, which Mr. W. W. Froggatt determined as one of the *Microlepidoptera*.

Many plants, particularly old ones, are infested with scale insects in the Hornsby district, which have a bad effect upon the parasites. The Indian Wax Scale, *Ceroplastes cerciferus* Andr., and the two Red Scales, *C. rubens* Marsk., and *Aspidiotus aurantii* Marsk., were noted on the following species by me: *Phrygilanthus celastroides*, *P. eucalyptifolius*, *Loranthus congener*, *L. pendulus*, *L. Gaudichaudi*, *L. vitellinus*, and *Notothixos subaureus*. Mr. T. Steel also drew my attention to the Indian Wax Scale on *P. eucalyptifolius* near Kuring-gai station, near Sydney.

Economic Uses.

So far *Loranthus* and allied genera have not been put to any extensive economic uses. All the species produce edible fruits which are eagerly sought after by birds, and they are also used as an article of food by the blacks in the remote parts of the continent.

E. Palmer (Proc. Roy. Soc., N.S.W., xvii., 1883, p. 100) says that the fruits of *L. longiflorus* Desr. (*L. odontocalyx* F. v. M.), *L. Exocarpi* and *L. Quandang* Lindl. are used for food by the natives of the Flinders and Mitchell Rivers. They also bruise the leaves of *L. Exocarpi* in water and then drink the concoction in cases of fever. Mr. F. M. Rothery in the "Sydney Mail," 17th February, 1904, drew attention to the possibilities of the growth of the mistletoe being turned into ornamental articles.

Nuytsia is said to exude a large quantity of transparent gum which makes a good adhesive mucilage. It also appears to be suitable for paper pulp.

Phrygilanthus eucalyptifolius and *Loranthus vitellinus* fruit profusely, the fruits containing copious viscin which is suitable for making bird lime.

Professor Ewart (Flora Northern Territory, p. 88) states that "*L. longiflorus* Desr. (*L. odontocalyx* F. v. M.) is said to contain 10 per cent. of Tannin."

Seeman (Flora Vitiensis, p. 429) states that "the leaves of *L. insularum* A. Gray are used by the natives for dyeing their cloth and cordage black."

Stock Food.

From time to time reports are received from stock owners and others directing attention to various species of mistletoes being relished by stock. Sheep and cattle are said to be particularly fond of *Loranthus* and *Korthalsella*.

Spencer Moore (Journ. Linn. Soc., xxxiv., 1898-1900, 259) mentions that the parasites are greedily eaten by camels, and in some cases they prefer the parasite to the hosts, although the latter are excellent food. W. Bauerlen has observed the same with *L. miraculosus* var. (*b*). Stock Inspector A. W. Mellen states that in the Bourke district "stock are fond of the Mistletoe, *L. linearifolius* but in many cases they will not eat the tree it grows upon." Between Wahroonga and Normanhurst on the Pennant Hills road, Sydney, there is a large plant of *Magnolia grandiflora* laden with *Phrygilanthus celastroides*; the lower branches of the Mistletoe are eaten off by cattle as high as they can reach, showing that they will eat the parasite when it is within their reach. Mr. Max Koch (Trans. Roy. Soc. S. Aust., xxii., 1898, p. 101) writing from Mt. Lyndhurst states that the mistletoes are eaten by stock.

In reference to *Korthalsella breviarticulata,* Stock Inspector M. H. Simon reports that "in the Gunnedah district, cattle and sheep are passionately fond of this plant."

Spencer Moore, on Poisoning of Camels (Jour. Bot., xxxv., 1897, 172) writes, "I never saw camels browsing on vegetation known or reasonably supposed to be harmful; my early fears in respect of some, such as the Loranthi, and *Alyxia buxifolia,* having proved quite groundless."

A MONOGRAPH OF THE FRESHWATER ENTOMOSTRACA OF NEW SOUTH WALES. Part i. Cladocera.

By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

(Plates iv.-viii.; and four Text-figures.)

[Read 29th March, 1922.]

Introduction.

The pioneer of the study of the Cladocera in New South Wales was the Rev. R. L. King who, in 1852, published two papers in which he very briefly described nineteen species belonging to seven genera, one genus, *Dunhevedia*, being new. His specimens were almost exclusively collected in the near neighbourhood of Sydney. In 1853 Dana, with the United States Exploring Expedition, added one more species which he collected from "pools near Sydney." No further reference to Cladocera in New South Wales was made for twenty-four years, until, in 1889, Prof. G. O. Sars of Christiania published some brief notes on some of King's species, the specimens having been collected for him in the Waterloo Swamps. In 1896 he published a longer paper containing the descriptions of eight new species and also more detailed descriptions of some of King's species; his material for this paper was raised from dried mud, collected in swamps and pools near Sydney. In 1919 the present writer received some small collections of Crustacea from eight country districts and published a paper in which twenty-five species were described, seven of them being new. The material for the present paper was obtained from as many localities as possible and fifty species belonging to seventeen genera are dealt with; five species are described as new and others are recorded for the first time, some in Australia, some in New South Wales. A short description of each genus and species is given, as well as keys to all the New South Wales species.

In the other States there must be many unrecorded forms. In Queensland, Sars, in 1885 and 1888, described 16 species, eight of which were new, collected in the neighbourhood of Rockhampton. No additional species have been recorded since that date.

In 1903, Haase mentioned the occurrence of five species in Victoria. In 1904, 1912 and 1914, Sars published three papers, each dealing extensively with one species, for one of which he proposed a new genus, *Saycia*. Searle published two papers in 1917 and 1918, in which the presence of several more species is recorded, and also a table is given showing their relative numbers for every month in one year, in a certain pond. This raised the number of Victorian species to sixteen.

No reference has previously been made to the occurrence of Cladocera in South Australia; eight species are here recorded, all of which were collected in the Botanic Gardens, Adelaide.

Only one species has been recorded for Western Australia, *Moina flexuosa*, a species described as new by Sars in 1896.

In Tasmania, G. W. Smith in 1909 recorded eleven species, eight of which were described as new.

Preserving and Mounting.—The best preservative for Cladocera is 10% glycerine in alcohol. This does not distort or render them brittle as do so many preservatives; they can be mounted directly from the glycerine alcohol in glycerine jelly, but an excellent mounting medium can be made by a mixture of gum arabic, cocaine, chloral hydrate and water. If a stain is required, borax carmine is fairly satisfactory; after staining, the specimens are cleared in the usual way and mounted in Canada balsam.

The writer's thanks are due to Acting-Professor L. Harrison for his interest and valuable advice in the preparation of this paper, and also to many friends, who have so kindly collected material.

The following lists give the species of Cladocera recorded from the various States:

New South Wales.

DAPHNIDAE.—*Daphnia carinata* King, and vars. *intermedia* Sars, *gravis* King. *magniceps* Sars, *cephalata* King, *Scapholeberis kingi* Sars, *Simocephalus australiensis* (Dana), *S. elizabethae* (King), *S. gibbosus* Sars, *S. acutirostratus* (King), *S. iheringi* (?) Richard, *Ceriodaphnia cornuta* Sars, *C. spinata* Henry, *C. honorata* (King), *Moinodaphnia macleayii* (King), *Moina australiensis* Sars, *M. tenuicornis* Sars, *M. propinqua* Sars.

MACROTHRICIDAE (*Lyncodaphnidae*).—*Pseudomoina lemnae* (King), *Macrothrix spinosa* (King), and var. *dentata* Playfair, *M. triserialis* Brady, *Ilyocryptus spinifer* Herrick, *I. sordidus* (Liévin).

CHYDORIDAE (*Lynceidae*).—*Camptocercus australis* Sars, *Acroperus avirostris* Henry, *A. sinuatus* Henry, *Alona affinis* Leydig, *A. cambouii* Richard, *A. clathrata* Sars, *A. laevissima* Sars, *A. pulchella* King, *A. whiteleggii* Sars, *A. wallaciana* Henry, *A. kendallensis* Henry, *A. longirostris* Henry, *A. abbreviata* Sars, *A. microtata*, n.sp., *Graptoleberis testudinaria* (Fischer), *Dunhevedia crassa* King, *D. podagra* King, *Pleuroxus inermis* Sars, *P. reticulatus* Henry, *P. australis*, n.sp., *Chydorus globosus* Baird, *C. ovalis* Kurz, *C. leonardi* King, *C. denticulatus* Henry, *C. jugosus*, n.sp., *C. unispinus*, n.sp., *Alonella karua* (King), *A. diaphana* (King), *A. clathratula* Sars, *A. excisa* Fischer, *A. duoodonta*. n.sp.

Victoria.

DAPHNIDAE.—*Daphnia carinata* King, and vars. *intermedia* Sars, *gravis* King, *eurycephala* Sars, *expansa* Sars, *cephalata* King, *lamellata* Sars, *Scapholeberis kingi* Sars, *Simocephalus acutirostratus* (King), *S. elizabethae* (King), *S. gibbosus* Sars, *Ceriodaphnia rotunda* Sars, *Moina australiensis* Sars, *M. tenuicornis* Sars.

MACROTHRICIDAE.—*Pseudomoina lemnae* (King), *Ilyocryptus sordidus* (Liévin).

BOSMINIDAE.—*Bosmina longirostris* Muller.

CHYDORIDAE.—*Camptocercus australis* Sars, *Alona pulchella* King, *Pleuroxus inermis* Sars, *Chydorus globosus* Baird, *Saycia orbicularis* Sars.

Queensland.

SIDIDAE.—*Diaphanosoma excisum* Sars, *Latonopsis australis* Sars.

DAPHNIDAE.—*Daphnia lumholtzii* Sars, *Simocephalus australiensis* (Dana), *S. elizabethae* (King), *Ceriodaphnia cornuta* Sars, *Moina propinqua* Sars.

MACROTHRICIDAE.—*Macrothrix spinosa* King, *Ilyocryptus spinifer* Herrick.

CHYDORIDAE.—*Leydigia australis* Sars, *Dunhevedia crassa* King, *Alona archeri* Sars, *A. laevissima* Sars, *A. clathrata* Sars, *Alonella diaphana* (King), *A. karua* (King).

South Australia.

DAPHNIDAE.—*Simocephalus australiensis* (Dana), *S. elizabethae* (King), *Ceriodaphnia rotunda* Sars.

BOSMINIDAE.—*Bosmina longirostris* Muller.

CHYDORIDAE.—*Leydigia quadrangularis* Leydig, *Chydorus globosus* Baird, *C. unispinus* Henry.

Western Australia.

DAPHNIDAE.—*Moina flexuosa* Sars.

Tasmania.

DAPHNIDAE.—*Daphnia carinata* King, *Simocephalus australiensis* (Dana), *S. dulvertonensis* Smith, *Ceriodaphnia hakea* Smith, *C. planifrons* Smith.

BOSMINIDAE.—*Bosmina geoffreyi* Smith, *B. tasmanica* Smith, *B. sorelli* Smith.

MACROTHRICIDAE.—*Macrothrix burstalis* Smith.

CHYDORIDAE.—*Alonella nasuta* Smith, *A. propinqua* Smith.

Key to the families of Cladocera.

A. Antennae with dorsal rami four-jointed, ventral three-jointed.
  B. Antennules short, intestine with two hepatic caeca .. .. *Daphnidae.*
  BB. Antennules long, intestine without hepatic caeca.
    C. Antennules fixed, ocellus absent .. .. *Bosminidae.*
    CC. Antennules freely movable, ocellus present .. .. *Macrothricidae.*
AA. Rami of antennae both three-jointed .. .. *Chydoridae.*

Family DAPHNIDAE Straus.

Antennules small, one-jointed. Antennae with three- and four-jointed rami. Eye large; ocellus small, sometimes absent. Five pairs of feet. Intestine not convoluted. Ephippium well formed, containing one or two eggs.

Key to genera of Daphnidae.

A. Rostrum present.
  B. Head crested .. .. *Daphnia.*
  BB. Head not crested.
    C. Posterior margin of the carapace with two ventral spines *Scapholeberis.*
    CC. Carapace ending posteriorly in a short spine or angle *Simocephalus.*
AA. Rostrum absent.
  B. Ocellus present, carapace completely covering the body.
    C. Head small, depressed .. .. *Ceriodaphnia.*
    CC. Head large, extended .. .. *Moinodaphnia.*
  BB. Ocellus absent, carapace not completely covering the body. .. .. *Moina.*

Genus Daphnia Muller, 1785.

Female. Body laterally compressed, with a median spine on the posterior margin of the carapace. Head crested; not separated from the thorax by a cervical sinus, rostrum present. Carapace marked with a rhomboidal pattern. Antennules immovable. Ephippium containing two eggs.

Male. Smaller than the female. Head without a rostrum. Antennules large and movable. First foot with a hook and long flagellum.

This genus comprises over seventy species from different parts of the world, all of which are subject to considerable variations. Only one species has thus far been recorded from New South Wales.

Key to varieties of Daphnia carinata

A. Carina very greatly developed, forming a large expansion .. .. var. *cephalata.*
AA. Carina of ordinary size.
B. Spine straight .. .. var. *intermedia.*
BB. Spine upturned.
C. Rostrum recurved .. .. var. *gravis.*
CC. Rostrum straight .. .. var. *magniceps.*

DAPHNIA CARINATA King (*Syn.* D. similis Claus.).

First described by King (1852, p. 246) and later redescribed by Sars (1896), both writers noting varieties. In 1914 Sars published a more detailed description to show the extraordinary variableness of the species.

Female. Outline of carapace very variable, mainly due to the degree of development of the carina surrounding the anterior portion; the posterior spine may be very long, medium sized or greatly reduced. Head carinated, fornix terminating on each side in an angular corner. Eye of moderate size, ocellus small. Antennules very small. Post-abdomen with a straight dorsal edge, 10-14 marginal denticles, end-claws curved, short, bearing a row of fine spinules.

Male. Smaller than female. Head without a distinct carina, carapace spine long and slender. Antennules with a well developed flagellum.

Distribution.—This species occurs in New South Wales, Victoria, Tasmania and in New Zealand; also in Palestine and Syria.

Typical form (Plate iv., fig. 1).

Carapace somewhat oval in shape, narrowing posteriorly towards the base of the spine. Head with a very acute rostrum, carina not very largely developed. Posterior spine exceeds half the length of the carapace. Length up to 4 mm.

Distribution.—N.S.W.: "Swamps near Sydney," Clyde, Parramatta, Corowa.

Var. INTERMEDIA Sars.

Carapace shorter and broader. Posterior spine coarser. Length not exceeding 3 mm.

Distribution.—N.S.W.: Waterloo Swamps, Hay; Victoria.

Var. GRAVIS King.

Carapace broadly oval, rostrum recurved, posterior spine slender, upturned. Length 5 mm.

Distribution.—Sydney, Melbourne.

Var. MAGNICEPS Sars.

Carapace quadrangular, posterior spine very upturned. Head large. Length 3.5 mm. This variety has only been collected from swamps in the neighbourhood of Sydney.

Var. CEPHALATA King (Plate iv., fig. 2).

Carina very greatly developed forming a large expansion which is sharply defined from the straight dorsal margin of the carapace. Posterior spine long, only slightly upturned. Length 4.2 mm.

Distribution.—N.S.W.: Swamps near Sydney, Denham Court, Campbelltown, Clyde; Victoria; New Zealand.

Genus SCAPHOLEBERIS Schoedler, 1858.

Female. Carapace with the posterior and ventral margins straight, the latter produced into two backwardly-directed spines. Body not compressed. Head small, marked off from the thorax by a deep cervical sinus. Carapace reticulated. One egg in the ephippium.

Male. Very similar to the female. First foot provided with a hook.

Thirteen species have been described, one of which is represented in New South Wales.

SCAPHOLEBERIS KINGI Sars (Plate iv., fig. 3).

Recorded by King (1852, p. 255) as *Daphnia mucronata*; recognised as a new species and described by Sars in 1903.

Female. Carapace, seen laterally, somewhat quadrangular in outline; dorsal edge arched, ventral edges almost straight, each produced posteriorly into a pointed projection. Head comparatively small. Surface of the carapace marked by an irregular reticulation, the transverse ridges being prominent and running parallel to the posterior edges. Eye large, with conspicuous lenses, ocellus small, situated near the top of the rostrum. Post-abdomen short, bearing only four pairs of anal denticles; end-claws of moderate length, smooth. Colour dark grey, sometimes nearly black. Length, female .8 mm., male .45 mm.

This species swims close to the surface of the water, usually upon its back. Its movements are very active.

Distribution.—N.S.W.: Moore Park, Manly, Parramatta, Kendall; Victoria; Sumatra; Siam; India; South Africa.

Genus SIMOCEPHALUS Schoedler, 1858.

Female. Carapace large and broad with rounded angles. Head small, rostrum blunt. Eye of moderate size, ocellus present, sometimes elongated. Antennules short. Carapace marked by transverse striations, the striae anastomosing irregularly. Post-abdomen large. Ephippium triangular, containing one egg.

Male. Smaller than the female. Antennules with two lateral sense hairs. First pair of feet without a flagellum and with a small claw.

The members of this genus are not very active and will remain fixed to the same spot for a long time. They swim on their backs making short trips through the water at a uniform speed. Twenty species have been described, and five of these are included in the New South Wales fauna.

Key to species of Simocephalus.

A. Ocellus punctiform.
  B. Posterior prominence obtuse.
    C. Forehead rounded .. .. *australiensis.*
    CC. Forehead with a pointed projection .. .. *acutirostratus.*
  BB. Posterior prominence pointed .. .. *iheringi.*
AA. Ocellus elongated.
  B. Body symmetrical .. .. *elizabethae.*
  BB. Body asymmetrically produced .. .. *gibbosus.*

SIMOCEPHALUS AUSTRALIENSIS (Dana). (Plate v., figs. 1-1*c*.).

Very briefly described by Dana (1853, p. 1271); detailed description published by Sars in 1888.

Female. Carapace, seen laterally, rhomboidal in outline, with the length greater than the height; dorsal edge slightly arched, ventral edges bulging anteriorly; posterior prominence broad and obtuse. Head small, ventral edge nearly straight. Carapace obliquely striated. Eye of moderate size, ocellus very small, punctiform. Post-abdomen broad, armed with nine anal denticles which increase in size distally; end-claws long, slightly curved and armed with a series of spinules. Colour yellowish-brown. Length 2 mm.

This species has a wide distribution in New South Wales, and usually occurs in large numbers.

Distribution.—N.S.W.: Clyde, Parramatta, Five Dock, University Pond, Botany, Maroubra, Manly, Holbrook, Moss Vale, Kendall, Bangalow. Dana found it in "fresh water ponds near Sydney." It also occurs in Queensland, South Australia, and South Africa.

SIMOCEPHALUS ELIZABETHAE (King). (Plate v., figs. 2-2*a*.).

Described by King (1852) as *Daphnia elizabethae* and more fully described by Sars in 1888.

Female. Carapace, seen laterally, irregularly oval, broadening posteriorly and terminating in an obtuse median prominence which is more distinct than in the preceding species. Head somewhat triangular, with the ventral edge concave. Eye of moderate size, ocellus in the form of a black stripe running obliquely towards the rostrum. Carapace obliquely striated, posterior part of the dorsal edge denticulate, the denticles continuing round the posterior prominence. Post-abdomen with the supra-anal angle projecting and denticulate; end-claws smooth; about six anal denticles present. Colour pale brown. Length 1.5 mm.

King gives the following localities in New South Wales:—Newtown, Parramatta, Stroud and Port Stephens, but it is possible that some of these may refer to the preceding species which he did not recognise as distinct. This species is, however, widely distributed throughout the State, having been collected at Centennial Park, University Pond, Botany, Moss Vale, Holbrook, and Mudgee. It has also been recorded from Victoria, Queensland, South Australia, Sumatra, Java, Siam, India, and Ceylon.

SIMOCEPHALUS ACUTIROSTRATUS (King). (Plate v., figs. 4-4*a*.).

First mentioned by King (1852, p. 254) as a variety of the preceding species, *Daphnia elizabethae* var. *acutirostrata*. In 1877 Schoedler pointed out that it was specifically distinct and it was described by Sars in 1896.

Female. Carapace, seen laterally, oval in outline; dorsal and ventral margins evenly curved, the latter bulging somewhat anteriorly; posterior prominence obtuse, produced, situated above the longitudinal axis of the body. Head small, with the front produced into an acute projection, ventral edge straight. Carapace marked by oblique striations, posterior prominence bearing a few denticles. Eye comparatively small, ocellus small, punctiform. Post-abdomen very broad; the posterior edge forming an expansion in front of the anal sinus; twelve anal denticles present; end-claws bearing a series of spinules. Colour pale brown.

This is by far the largest species of *Simocephalus* found in Australia; the average length is about 3.3 mm. but specimens have been examined which were 4 mm., the very largest attaining the length of 4.2 mm.

Distribution.—N.S.W.: Denham Court, "water holes off Bourke St.," Holbrook, Casino; also occurs in Victoria. It has not been recorded outside Australia.

SIMOCEPHALUS GIBBOSUS Sars. (Plate v., figs. 3-3*a.*).

First described by Sars in 1896 from specimens collected at Centennial Park.

Female. Carapace, seen laterally, like a rounded triangle; dorsal margin fairly straight, abruptly curved posteriorly, forming an asymmetrical expansion. Posterior prominence distinct, obtuse. Head of moderate size, dorsal margin evenly curved, ventral slightly convex. Eye of moderate size, ocellus prolonged into a stripe. Carapace obliquely striated, both the expansion and the posterior prominence denticulate. Post-abdomen not very broad, armed with twelve anal denticles which increase in size distally. Length 2 mm.

Distribution.—This species has only been found at Centennial Park and Botany in N.S.W.; Searle records its presence in Victoria.

SIMOCEPHALUS sp.

A single specimen of *Simocephalus* was present in a collection of Entomostraca taken at Byron Bay. Unfortunately this specimen is imperfect and therefore cannot be exactly identified; it is, however, obviously distinct from the four preceding species, and bears a decided resemblance to the South American form *Simocephalus iheringi* Richard (1897, p. 279). The chief feature of resemblance is the acutely-pointed posterior prominence.

Genus CERIODAPHNIA Dana, 1853.

Valves of the carapace ending in a posterior angle or a short spine. Head small and depressed, separated from the thorax by a deep cervical groove. Carapace marked by a polygonal pattern. Antennules in the female not freely movable. Ocellus always present. Ephippium triangular, containing one egg. About thirty-eight species have been described from different parts of the world; three of these are found in New South Wales.

Key to species of Ceriodaphnia.

A. Head bearing one or two pointed projections .. .. *cornuta.*
AA. Head without projections.
  B. Posterior spine long .. .. *spinata.*
    BB. Posterior spine short .. .. *honorata.*

CERIODAPHNIA CORNUTA Sars. (Plate iv., fig. 4).

Described by Sars (1885) from a single specimen reared from dried mud which had been collected from the Gracemere Lagoon, near Rockhampton.

Female. Carapace, seen laterally, oval in outline, upper and lower margins of the valves slightly arched, posterior part produced as a short spiny process. Head depressed, with the frontal part jutting out into two acute prominences, the upper as a prolongation of the front, the lower taking the place of a rostrum. Sculpture of the whole carapace a conspicuous network; free edges of the valves devoid of hairs or spines. Eye of moderate size, ocellus very small, punctiform. Antennules small, with a seta situated in the middle of the posterior margin. Post-abdomen with two dorsal processes, armed with 6-8 anal denticles; end-claws smooth. Length .6 mm.

Distribution.—This species has not hitherto been recorded from N.S.W. It was obtained from the Lane Cove River near Gordon, from Kendall and Corowa. It also occurs in Queensland, Ceylon, New Guinea and Java.

There has been a controversy as to whether the forms *Ceriodaphnia rigaudi* Richard and *C. cornuta* Sars are specifically distinct. Daday (1898) united them on the grounds that he had found an intermediate series of forms. Stingelin (1904) maintained that they were distinct species. Daday in 1910 reasserted his view and again mentioned finding intermediate forms. Delachaux (1917, p. 81) examined specimens collected in the neighbourhood of Lake Victoria Nyanza, and noted that all those which had two spines on the head had also a double posterior spine. He also pointed out differences in the structure of the ventral edges of the carapace and in its sculpture.—"Tandis que chez les premiers (*C. cornuta*) ces bords sont munis d'écailles ou de dents découpées en scies, chez les seconds (*C. rigaudi*) ces écailles présentent un bord à peu près droit. Chez la forme cornue du reste, toute la structure des téguments parait plus fortement développée, le réseau hexagonal de la carapace est mieux marqué et fortement en relief." Sars (1901) mentioned this difference in sculpture and also the fact that a form of *C. rigaudi* did exist with two spines on the head. This species was never very plentiful in the collections. About a dozen specimens were found that were normal for *C. cornuta*, but there were some in which the spine taking the place of the rostrum was present alone, but in which there were two distinct points at the posterior end of the carapace; about ten specimens were typical of *C. rigaudi*; there were none which bore two head spines and a single posterior spine. In regard to the markings of the carapace edges as observed by Delachaux, the majority of the typical *C. cornuta* forms had the saw-like markings, but some had not, and these forms had a weaker reticulate sculpturing. It is noteworthy that the two forms were always taken together. It would appear from these examples that the species are not distinct but that *C. cornuta* is very variable. Delachaux points out that the characters by which he distinguishes them are subject to variation. In two of the specimens examined a short spine was present immediately in front of the cervical sinus.

Ceriodaphnia spinata Henry. (Plate iv., fig. 5.).

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 466.

Distribution.—N.S.W.: Holbrook, Corowa.

Ceriodaphnia honorata (King).

King (1852, p. 249) described and figured this form under the name of *Daphnia honorata*. It is undoubtedly not a member of the genus *Daphnia* but belongs to *Ceriodaphnia*. As I have not been able to obtain a specimen I quote King's original description.

"Carapace oblong, dorsal margin often concave, the surface reticulated in an irregular pentagonal manner. The spine at the extremity is very short. Antennules large. Antennae also large, basilar joint having a crenation carrying two setae. The first joint of the posterior branch is as long as the remaining two and as long also as the first three of the anterior branch. Setae not plumose."

Locality.—Varroville near Campbelltown.

Both King and Sars pointed out that this species is most nearly related to *Ceriodaphnia reticulata* (Jurine) though distinct. It is also distinct from the two preceding species.

Genus MOINODAPHNIA Herrick, 1887. (*Syn.* Paramoina Sars.).

Body compressed, valves elliptical, crested dorsally; cervical sinus distinct, dorsal and ventral margins forming a sharp angle posteriorly. Carapace marked by oblique striae. Antennules attached on the ventral surface of the head, with a sense hair situated about the middle of each. Ocellus present. One large abdominal process. Post-abdomen slender, resembling the genus *Moina.* Only two certain species are known, one of which is represented in N.S.W.

MOINODAPHNIA MACLEAYII (King). (Plate iv., fig. 6.).

Syn. Moinodaphnia macquerysi Richard; Moina submucronata Brady.

First described by King (1852, p. 251) as *Moina macleayii*; fully described by Sars in 1901.

Female. Carapace, seen laterally, rounded oval, dorsal margin strongly curved posteriorly, ventral evenly curved, the junction forming a sharp angle. Sculpture of the carapace consisting of very fine oblique striae, free edges armed with tiny denticles. Dorsal margin of the head arched, ventral almost straight, with a small prominence as a rudiment of the rostrum. Eye of moderate size, ocellus small, situated close behind. Post-abdomen slender, bearing ten laterally situated anal denticles; end-claws of moderate size. Length 1 mm.

Distribution.—This is a rare species in N.S.W.; it has only been obtained from Elizabeth Bay and Byron Bay. It occurs in New Guinea, Sumatra, Siam, Ceylon, Congo, North and South America.

Genus MOINA Baird, 1856.

Body thick and heavy. Carapace without a spine, not completely covering the body, cervical sinus present. Rostrum absent. Antennules long and mobile, modified in the male to form clasping organs. Carapace valves obscurely reticulated. Abdominal process represented by a horseshoe-shaped fold. Post-abdomen bearing ciliated spines and a bident. Ephippium oval, containing one or two eggs. Over twenty different species have been described; some of these resemble one another closely and are often difficult to determine unless males and ephippial females are present. Three species occur in N.S.W.

Key to species of Moina.

A. Head with a sinus above the eye.
  B. Ephippium with two eggs .. .. *australiensis.*
  BB. Ephippium with one egg .. .. *propinqua.*
AA. Head without a sinus above the eye .. .. *tenuicornis.*

MOINA AUSTRALIENSIS Sars.

Described by Sars in 1896 and fully figured (Plate 3, figs. 1-2).

Female. Carapace rounded, varying in shape according to the condition of the matrix. Head of moderate size, slightly depressed, with a distinct sinus above the eye, ventral edge slightly convex at the insertion of the antennules. Eye of moderate size. Antennules short. Post-abdomen tapering distally, 10-12 anal spines which are ciliated on both edges, last spine two-pronged; end-claws smooth. Two eggs in the ephippium. Length up to 1.4 mm.

Male. Head comparatively larger and less strongly arched above, ventral edge straight, antennules armed at the tip with claws. First pair of legs provided with a claw as well as a curved spine and a long seta. Length up to .85 mm.

Distribution.—In N.S.W., this species has only been found in the neighbourhood of Sydney, Kensington, the Waterloo swamps and ponds near Bourke St. and Botany Rd. It also occurs in Victoria.

MOINA TENUICORNIS Sars.

Described by Sars in the same paper as the preceding species (1896, Plate 4, figs. 1-8).

Female. The general shape of the carapace is very like that of *M. australiensis.* The head differs in that it lacks the sinus above the eye and has a rounded prominence at the insertion of the antennules. Eye larger than in *M. australiensis,* antennules longer and narrower. Post-abdomen as in *M. australiensis* except that the end-claws are armed with a series of secondary teeth. Two eggs are found in the ephippium. Length 1.2 mm.

Male. Very like *M. australiensis,* the antennules much longer, exceeding half the length of the body. Length .7 mm.

Distribution.—N.S.W.: Bourke St., Botany, University Pond, Corowa. It has also been recorded from Victoria and South Africa.

MOINA PROPINQUA Sars.

Described by Sars (1885) from specimens raised from dried mud from the Gracemere Lagoon, near Rockhampton.

Female. Carapace rounded, sometimes very greatly expanded dorsally. Head with the dorsal margin slightly concave above the eye, front rounded, ventral margin straight. Eye of moderate size. Antennules short, fusiform, with a long tentacular seta situated above the middle. Post-abdomen with nine lateral denticles, the last as usual bidentate; end-claws smooth. Ephippium with a single egg. Length about 1 mm.

Male. Antennules very long, about the length of the head, each bearing 3 incurved hooks. Length .6 mm.

Distribution.—N.S.W.: Bourke St., Botany; Queensland: Rockhampton; Java, Algeria.

Family MACROTHRICIDAE (*Lyncodaphniidae*).

Antennules in the female long and freely movable. Ocellus present. Four to six pairs of feet. Intestine simple or convoluted.

Key to genera of Macrothricidae.

A. Six pairs of feet . . . . *Ilyocryptus.*
AA. Five pairs of feet.
  B. Anal denticles present . . . . *Macrothrix.*
  BB. Anal denticles absent . . . . *Pseudomoina.*

Genus MACROTHRIX Baird, 1843.

Female. Shape oval, compressed, with a dorsal crest. Head large, rostrum short. Eye large, ocellus present. Antennules flattened and curved, antennae with four setae on the dorsal ramus, five on the ventral. Post-abdomen large, no abdominal process. Five pairs of feet. Intestine simple, no caeca.

Male. Antennules large, first foot bearing a hook. About thirty species of this genus have been described; two occur in New South Wales.

Key to species of Macrothrix.

A. Lip-plate lobed .. .. *triserialis.*
AA. Lip-plate not lobed.
B. Head finely serrate .. .. *spinosa.*
BB. Head bearing teeth .. .. var. *dentata.*

MACROTHRIX SPINOSA King.

First described by King (1852, p. 256). Redescribed and figured in detail by Sars (1888, Plate 3, figs. 1-6).

Female. Carapace, seen laterally, oval in outline; dorsal margin arched, especially posteriorly, ventral curved, ascending to form with the dorsal a slight obtuse prominence. Head large, fairly erect, rostral prominence slight. Carapace marked by a faint reticulation, dorsal margin quite smooth, ventral edges serrate, armed with slender spines. Eye large, ocellus small, quadrangular. Antennules curved, with notches along the anterior edges. Post-abdomen comparatively small, bilobed, armed with a row of small but strong anal denticles; end-claws very small. Length .6 mm.

Male. Smaller than the female. Antennules larger and not so curved. First pair of legs as usual armed with a curved hook.

Playfair (1914, p. 140) notes that in specimens collected at Lismore the dorsal edge of the carapace is minutely serrate, and points out that this is the main character by which Sars distinguishes this species from *Macrothrix laticornis* (Jurine). An important difference between the two species, however, is that *M. spinosa* has a bilobed post-abdomen, and *M. laticornis* has not.

Distribution.—This species has a wide distribution in New South Wales (Centennial Park, Five Dock, Liverpool, Casino, Lismore, Holbrook and Corowa). It also occurs in Queensland, Hawaii, Sumatra, Java, Siam, Singapore, South America and South Africa.

Var. DENTATA Playfair, 1914 (p. 141, Plate 8, fig. 2).

Head without hairs but minutely serrate; furnished on the front and dorsally with teeth not spines.

Locality.—Lismore.

MACROTHRIX TRISERIALIS Brady.

Brady first described this species (1886, p. 295) from specimens collected in Ceylon. A more detailed description was published by Daday in 1898 (p. 51, fig. 24).

Female. Carapace, seen laterally, somewhat oval in shape, broader anteriorly than posteriorly; dorsal margin slightly arched, ventral more strongly arched and protuberant in the middle, forming a sharp angle and a produced point posteriorly. Head moderately arched, produced below into a small triangular rostrum. Eye large, with conspicuous crystalline lenses; ocellus very small, square, situated near the end of the rostrum. Antennules slightly curved, their anterior margins serrate. Lip-plate large, bearing four sets of small bristles, the ventral edge produced and bilobed. Surface of the carapace marked by an irregular reticulation and also by tiny pits; dorsal margin serrate, ventral bearing a series of small teeth arranged in groups of three, between which are slender bristles. Post-abdomen moderately broad, bilobed, the first lobe bearing eight denticles, the second with about twenty denticles, which increase in size posteriorly; end-claws short, curved; fine lateral spinules also present. Length 1 mm. Colour pale yellow.

Distribution.—This species is here recorded in Australia for the first time; it has only been obtained from Casino, N.S.W. It also occurs in Ceylon and South America.

Genus PSEUDOMOINA Sars, 1912.

Carapace of irregular oval form with the valves well developed and completely enclosing the body. Head defined by a well marked cervical sinus. Labrum bearing a slender digitiform process. Ocellus present. Antennules slender, straight. Each ramus of the antennae bears five setae. Five pairs of legs. Post-abdomen devoid of anal denticles; end-claws strong. Intestine straight, caeca absent. Only one species known.

PSEUDOMOINA LEMNAE (King).

First described by King (1852, p. 250) as *Moina lemnae*. Sars redescribed it and proposed a new genus in 1912 (Plate 10, figs. 1-16).

Female. Carapace, seen laterally, somewhat oval; dorsal margin almost straight, ventral edges curved, thickly clothed with long setae, posterior edges narrowly rounded, partly clothed with setae, the last six or seven of which are long and spreading. Head rounded in front, rostrum very slight. Eye large, ocellus very small. Antennules narrow, elongated, bearing short bristles throughout their length. Upper ramus of the antennae composed of four segments, the first of which is very small. Process of the labrum slender, recurved, bearing bristles on the anterior edge. Surface of the carapace perfectly smooth. Post-abdomen bearing slender spines on the supra-anal margin; end-claws strong, curved, a secondary denticle at the base of each. Length 1.2 mm.

Male. Smaller than the female. Antennules comparatively longer; first pair of legs armed with a claw.

Distribution.—N.S.W.: Cook's River, Holbrook, Kendall; Victoria.

Genus ILYOCRYPTUS Sars, 1861.

General form oval-triangular, dorsal crest of valves absent or small. Antennules long, 2-jointed, freely movable. Antennae short, with powerful setae. Eye small but larger than the ocellus. Six pairs of feet. Post-abdomen very large, with long spines; end-claws with two basal spines.

Male. Larger antennules than the female, no hook present on the first foot.

Unlike the other members of the Cladocera the old shells of most species are not cast off in moulting but persist, one overlying the other. The members of this genus are not strong swimmers, and are usually found in the bottom mud, their shells covered with debris and vegetable growth. Seven species are known, two of which are present in New South Wales.

Key to species of Ilyocryptus.

A. Antennae large and powerful .. .. *spinifer.*
AA. Antennae small .. .. *sordidus.*

ILYOCRYPTUS SPINIFER Herrick. (Plate vi., figs. 1-1*a*.).

(*Syn.* I. halyi Brady; I. longiremus Sars.).

This species was first described by Herrick in 1884.

Female. Carapace, seen laterally, triangular, much wider posteriorly; ventral and posterior edges of the valves passing into each other with an even curve, dorsal and posterior edges forming an obtuse angle. In old specimens the carapace is marked by numerous concentric lines of growth caused by imperfect moulting. Free edges of the valves fringed with long ciliated setae. Head small, terminating in a sharp corner anteriorly. Eye distant from the front, ocellus much smaller than the eye, situated close to it. Antennules long and narrow. Antennae very powerful, more elongated than is usual for the genus, setae very long and not ciliated. Post-abdomen large, plate-like, dorsal edge sinuated above the middle, bearing small marginal denticles, pre-anal portion also bearing 5-8 lateral spines and the post-anal 4-8 spines; end-claws long, with two small hair-like denticles at the base. Colour orange. Length up to 1.5 mm.

Male. Eye comparatively larger than in the female. Antennules dilated in the middle, bearing a slender bristle. This species can swim, but usually drags itself along the mud.

Distribution.—N.S.W.: Centennial Park, University Pond, Lane Cove, Kendall, Casino; Queensland, Sumatra, Celebes, India, Ceylon, East Africa, North and South America.

ILYOCRYPTUS SORDIDUS (Liévin).

First described by Liévin (1848, p. 34) as *Acanthocercus sordidus.* Sars recorded its presence in New South Wales in 1896 (Plate 5, figs. 1-3).

Female. Carapace, seen laterally, like a rounded triangle expanding posteriorly; posterior and ventral margins of equal length, passing into each other by a very strong curvature, margins fringed with ciliated setae; dorsal margin very slightly arched. Head comparatively small, seen laterally, triangular in form, fornix prominent. Eye distant from the front, ocellus smaller than the eye and situated near the base of the antennule. Antennules with the proximal joint very small, distal long and slender. Antennae short and thick, not nearly as powerful as in the preceding species. Post-abdomen large, conically produced at the tip, bearing a marginal row of small denticles, 10-14 pre-anal spines, 8-10 post-anal; end-claws long and slender, each with two secondary denticles. Colour red. Length 1 mm.

Male. Much smaller than the female, only attaining a length of .4 mm. This species appears to be devoid of swimming powers.

Distribution.—N.S.W.: Ponds off Botany Rd. and Bourke St., Maroubra. It occurs in Victoria, Sumatra, China, South Africa, North and South America, Europe. Of world-wide occurrence, it is much rarer in New South Wales than *I. spinifer.*

Family CHYDORIDAE (*Lynceidae*).

Fornices extended, uniting with the rostrum to form a beak. Antennae with both rami three segmented. Five to six equidistant pairs of feet. One or two summer eggs. Intestine convoluted.

Key to genera of Chydoridae.

A. Head crested
- B. Post-abdomen bearing marginal denticles .. .. *Camptocercus.*
- BB. Marginal denticles absent .. .. *Acroperus.*

AA. Head not crested.
- B. End-claws of post-abdomen with one basal spine.
  - C. Carapace compressed.
    - D. Rostrum pointed.
      - E. Anal denticles minute .. .. *Alonella* (most species).
      - EE. ,, ,, stout .. .. *Alona.*

DD. Rostrum broad semicircular .. .. *Graptoleberis.*
CC. Carapace valves thick, gaping below .. .. *Dunhevedia.*
BB. End-claws with two basal spines.
C. Infero-posteal corner rounded off, usually unarmed .. .. *Chydorus.*
CC. Infero-posteal corner distinct, usually armed.
D. Posterior margin entire .. .. *Pleuroxus.*
DD. „ excised .. .. *Alonella* (some species).

Genus Camptocercus Baird, 1843.

Body laterally compressed, head and valves carinate. Infero-posteal angle often toothed. Eye distant from the anterior cephalic margin. Antennae with seven swimming hairs. Carapace longitudinally striated. Post-abdomen more than half as long as the carapace, bearing marginal denticles only; end-claws with one basal spine and bearing a series of secondary denticles ending in a spine half way along the claw. Twelve species are known, one of which occurs in New South Wales.

Camptocercus australis Sars. (Plate vi., figs. 3-3*a*.).

Described by Sars in 1896 from a single specimen taken at Centennial Park.

Female. Carapace, seen laterally, of oval form, greatest height in front of the middle; dorsal and ventral edges evenly arched, posterior edges rounded. Head large, crested, ending in a blunt rostrum. Eye of moderate size, ocellus smaller, slightly closer to the eye than to the rostral tip. Surface of the carapace longitudinally striated. Infero-posteal corners unarmed. Post-abdomen slender, long; about twenty marginal denticles present; end-claws long and straight, a basal spine present and another spine half way along the claw. Length .7 mm.

Distribution.—N.S.W.: Centennial Park, Kendall, Port Stephens. It is also recorded from Victoria, Sumatra, India, South America.

Genus Acroperus Baird, 1843.

Body compressed, head and valves carinate. Infero-posteal angle rounded or acute, usually with teeth. Antennae with eight swimming hairs. Carapace obliquely striated. Post-abdomen without marginal denticles; end-claws as in *Camptocercus*. Large intestinal caecum. Nine species known, two among the New South Wales fauna.

Key to species of Acroperus.

A. Infero-posteal corner unarmed .. .. *sinuatus.*
AA. Infero-posteal corner bearing two teeth .. .. *avirostris.*

Acroperus avirostris Henry. (Plate vi., figs. 2-2*a*.).

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 469.

Distribution.—N.S.W.: Port Stephens, Kendall, Cumbalum.

Acroperus sinuatus Henry.

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 471, Pl. xl., figs. 5, 6.

Distribution.—N.S.W.: Kendall, Lorne.

Genus ALONA Baird, 1850.

Body more or less compressed, in lateral view oval-triangular or oval-rectangular with rounded posterior angles. Head not carinate. Process of the upper lip often large, rounded. Antennules short and thick. Antennae short, the inner ramus with 4 or 5 swimming bristles. Five to six pairs of legs, the sixth, if present, rudimentary. Post-abdomen compressed, armature varied, usually both marginal denticles and lateral combs present; end-claws with one basal spine. Over seventy species have been described from all parts of the World, eleven of which are included in the fauna of New South Wales.

Key to species of Alona.

A. Length exceeding .6 mm.
  B. Carapace smooth .. .. *longirostris.*
  BB. Carapace longitudinally striated.
    C. Twelve anal denticles .. .. *kendallensis.*
    CC. Fifteen anal denticles.
      D. Post-abdomen of uniform width .. .. *affinis.*
      DD. Post-abdomen widening distally .. .. *whiteleggii.*
AA. Length not attaining .6 mm.
  B. Lateral fascicles absent.
    C. Ocellus equal in size to the eye .. .. *clathrata.*
    CC. Ocellus much smaller than the eye.
      D. Supra-anal angle very distinct .. .. *abbreviata.*
      DD. Supra-anal angle not distinct .. .. *microtata.*
  BB. Lateral fascicles present.
    C. Fascicles long, extending beyond the dorsal margin .. .. *cambouii.*
    CC. Fascicles short.
      D. Post-abdomen long and slender .. .. *wallaciana.*
      DD. Post-abdomen short and stout.
        E. Carapace striated .. .. *pulchella.*
        EE. Carapace smooth .. .. *laevissima.*

ALONA AFFINIS (Leydig). (Plate viii., figs. 2-2*a*.).

(*Syn.* Lynceus quadrangularis Fischer, *not* Muller; Alona oblonga P. E. Muller.)

Described by Leydig in 1860 (p. 223) as *Lynceus affinis.*

Female. Carapace, seen laterally, oval in outline, dorsal margin arched, curving abruptly downwards posteriorly so that the greatest height is about the middle. Ventral edges slightly curved, posterior edges obliquely truncated. Head slightly depressed, rostral end pointing obliquely forwards. Eye large, ocellus smaller, situated about twice as far from the rostral tip as from the eye. Surface of the carapace marked by longitudinal striations which are not very conspicuous, sometimes a faint reticulation. Post-abdomen strongly built, of uniform breadth throughout; 13-15 serrated anal denticles; lateral combs present; end-claws strong, each armed with a secondary denticle at the base; both end-claws and denticles bearing spinules. Colour yellowish-brown, sometimes with a greenish tinge. Length 1 mm.

Distribution.—This is a very cosmopolitan species. N.S.W.: Centennial Park, Lett River, Kendall, Byron Bay; Europe, Asia, North and South America, Africa, Greenland, Siberia.

ALONA WHITELEGGII Sars. (Plate viii., figs. 1-1*a*.).

Described by Sars (1896) from a single specimen obtained at Centennial Park, Sydney.

Female. Carapace, seen laterally, oval triangular, slightly widening posteriorly; dorsal margin evenly arched, ventral almost straight, posterior angles rounded off. Head bent forward, rostrum acute. Sculpture of the carapace consists of longitudinal striae, ventral edges bearing a thick row of setae. Eye of moderate size, ocellus very slightly smaller and situated closer to the eye than to the tip of the rostrum. Post-abdomen strongly built, slightly widening distally, supra-anal angle not prominent, 15 denticles present on the infra-anal margin, also 15 lateral combs. End-claws long, each with a strong secondary denticle at the base. Length .63 mm.

Distribution.—Centennial Park, Kendall. This species has not as yet been recorded outside N.S.W.

Alona kendallensis Henry. (Plate viii., fig. 7.).

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 474.

Distribution.—N.S.W.: Kendall.

Alona longirostris Henry.

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 475, Pl. xli., figs. 11-12.

Distribution.—N.S.W.: Byron Bay, Centennial Park.

Alona clathrata Sars.

Described by Sars (1888, Plate 6, figs. 7-10) from specimens raised from dried mud collected at the Gracemere Lagoon, near Rockhampton.

Female. Carapace, seen laterally, short, rounded, quadrangular; dorsal margin strongly arched in the middle, ventral fairly straight, ascending anteriorly, posterior edge truncated, with the upper angle distinct, the lower rounded. Rostrum elongated, acute. Ocellus about the same size as the eye and situated closer to it than to the tip of the rostrum. Antennules long, slender, the terminal papillae reaching beyond the rostral tip. Surface of the carapace marked by a regular reticulation. Post-abdomen short and broad, truncated, bearing small strong anal denticles; lateral combs absent; end-claws short, secondary spines very minute. Colour pale yellow. Length .38 mm.

Distribution.—N.S.W.: Lismore, Byron Bay; Queensland.

Alona microtata, n.sp. (Plate viii., figs. 4-4*a*.).

Female. Carapace, seen laterally, truncated oval in shape; dorsal margin boldly arched, ventral arched anteriorly, then curving upwards to join the comparatively short posterior edges which are almost straight. Head broad, terminating in an elongated rostrum which reaches below the ventral edges of the valves. Eye large, ocellus very much smaller and situated closer to the eye than to the tip of the rostrum. Antennules long and slender, not reaching the tip of the rostrum. Antennae short, bearing comparatively long swimming bristles. Lip-plate large, margin smooth. Surface of the carapace marked by a distinct reticulation in the anterior portion, posteriorly very weak or completely absent. Post-abdomen strongly built, broadening distally, the corner opposite the end-claws projecting, supra-anal angle not very distinct; nine marginal denticles present, rapidly increasing in size distally, lateral fascicles absent; end-claws very long, with a small secondary spine at the base of each. Colour very pale yellow. Length .28 mm.

Distribution.—Orange.

This very minute form somewhat resembles *Alona abbreviata* in its general appearance, but it differs greatly in the form and armature of the post-abdomen and the sculpture of the carapace.

ALONA CAMBOUII Guerne & Richard. (Plate viii., fig. 5).

Described by Guerne and Richard in 1893 from specimens collected in Madagascar.

Female. Carapace, seen laterally, oval in outline; dorsal margin evenly arched, ventral edges almost straight, infero-posteal angle rounded. Head of moderate size, terminating in an obtuse rostrum. Eye of medium size, ocellus much smaller, situated closer to the eye than to the tip of the rostrum. Antennules almost reaching the rostral tip, two of the olfactory setae longer than the rest. Lip-plate rounded. Carapace marked by a reticulation or simply punctate. Post-abdomen short and broad, of uniform breadth throughout, supra-anal angle very distinct; 8-10 anal denticles, each with a minute accessory spinule, 5-8 lateral fascicles, the longest spine in each passing the dorsal margin; end-claws long, smooth, each provided with a basal spine. Colour yellow. Length .48 mm.

Distribution.—N.S.W.: Port Stephens; New Zealand, South America, India, Madagascar, Palestine.

ALONA WALLACIANA Henry.

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 472, Pl. xli., figs. 7-8.

Distribution.—N.S.W.: Kendall.

ALONA ABBREVIATA Sars. (Plate viii., fig. 8).

Described by Sars in 1896.

Female. Carapace short and stout, somewhat quadrangular in lateral view, the greatest height in front of the middle; dorsal margin curved rather abruptly anteriorly, ventral slightly curved, posterior edges transversely truncated. Head fairly erect, terminating in an acute rostrum. Eye of moderate size, ocellus smaller, situated closer to the eye than to the rostral tip. Carapace marked by a reticulation in the posterior portion, anteriorly by a series of transverse curved lines. Post-abdomen short and very stout, supra-anal angle prominent; 10 distinct anal denticles, lateral fascicles absent; end-claws moderately strong, each armed with a small basal spine. Length .37 mm.

Distribution.—N.S.W.: Orange, Bathurst, Pond near Bourke St., Sydney.

ALONA PULCHELLA King. (Plate viii., fig. 6).

First described by King (1852, p. 260). Fully described by Sars in 1896.

Carapace, seen laterally, somewhat oval in outline, not widening posteriorly, dorsal margin evenly curved, ventral almost straight, posterior edges oblique. Head fairly erect, rostrum acute. Carapace striated longitudinally, striations faint. Eye of moderate size, ocellus smaller and situated very slightly closer to the eye than to the tip of the rostrum. Antennules not reaching the rostral tip. Post-abdomen rather short, transversely truncated at the tip, of uniform breadth, end-claws long, each armed with a secondary denticle at the base. About 12 infra-anal denticles and the same number of lateral fascicles. Length .59 mm.

Distribution.—N.S.W.: Waterloo Swamps, Varroville, St. Leonards, Holbrook, Mudgee, Byron Bay; Victoria; South Africa.

ALONA LAEVISSIMA Sars. (Plate viii., figs. 3-3*a*.).

Described by Sars in 1888.

Carapace, seen laterally, oval in outline, dorsal margin evenly curved, ventral edges straight, posterior edges truncated, upper angle obtuse, lower rounded off. Surface of the valves smooth, no sculpturing present. Eye of moderate size, ocellus very slightly smaller. Antennules narrow, not quite reaching the rostral tip. Post-abdomen very similar to the preceding species, marginal denticles somewhat smaller and lateral combs usually fewer in number. Colour yellow. Length .48 mm.

This species is very closely related to the preceding species, *A. pulchella* King, the chief differences being the entire lack of markings on the carapace and the slightly different armature of the post-abdomen. It has a wide distribution in the country districts of N.S.W., having been collected at Byron Bay, Kendall, Bathurst, Moss Vale, and Lismore. Sars' specimens came from Rockhampton, Queensland.

Genus GRAPTOLEBERIS Sars, 1863.

Female. Head not carinate, rostrum broad, carapace conspicuously reticulated, two strong teeth on infero-posteal corner of the valves. Eye much larger than the ocellus. Post-abdomen nearly triangular, marginal spines small; end-claws with one accessory spine, sometimes wanting. Five pairs of feet.

Male. Smaller than the female, first pair of feet with hooks. Post-abdomen narrow, with a crenulated but unarmed posterior edge. End-claws small, disc-like.

Only one species is known.

GRAPTOLEBERIS TESTUDINARIA (Fischer). (Plate vi., figs. 5-5*a*.).

Lynceus testudinarius Fischer (1848, p. 191); *Alona testudinarius* Schoedeler (1863); *Lynceus reticulatus* Fric (1872).

Female. Carapace, seen laterally, somewhat oval, dorsal margin evenly arched, ventral fairly straight, posterior margins narrow, truncated. Infero-posteal corner armed with two strong teeth. Head large, fornix very broad, forming a semi-circular rostrum covering the antennules and extending down as far as the ventral margins of the valves. Reticulation of the carapace very distinct. Ocellus smaller than the eye, and closer to it than to the tip of the rostrum. Post-abdomen bent at the sharp pre-anal angle, somewhat triangular in shape. Marginal spines small, end-claws with one small basal spine.

Distribution.—This species has only been obtained from two localities in New South Wales, a pond in the University grounds and Moss Vale and in both cases, very few specimens were found. The Moss Vale specimens are distinguished by a much more erect head than is typical; the rostrum pointing forwards instead of downwards and not nearly reaching the ventral margins of the valves. The species occurs in Europe, North and South America, Asia, Iceland, Azores.

Genus DUNHEVEDIA King, 1853.

General shape rounded. Valves obscurely reticulated. Rostrum short. Infero-posteal angle rounded with one or two teeth. Post-abdomen with many fine denticles, end-claws short and curved, with one basal spine. Post-abdomen in male armed with fine hairs only. Seven species have been described, two of which are found in New South Wales.

Key to species of Dunhevedia.

A. Seen from above the outline is obovate .. .. *crassa.*
AA. „ „ „ „ „ .. concave in the middle .. .. *podagra.*

DUNHEVEDIA CRASSA King. (Plate vi., figs. 4-4*a*.).

First described by King (1852, p. 261); redescribed by Sars in 1888.

Female. Carapace, seen laterally, almost semicircular, dorsal edge boldly arched, ventral almost straight, posterior edge truncated. A denticle present on the infero-posteal corner. Seen from above the carapace appears obovate, not constricted in the middle, posterior part tapering. Head bent down, rostrum acute, curved. Eye large, ocellus much smaller, of irregular shape, situated closer to the eye than to the rostral tip. Post-abdomen with a row of small denticles; end-claws small, curved, with a single denticle at the base of each.

Male. Smaller than the female, with hairs instead of denticles on the post-abdomen.

Distribution.—This species has a wide distribution in New South Wales, having been collected at Dunheved, Varroville, Moss Vale, Bathurst, Cumbalum, Mudgee, the University pond. It is recorded from Queensland, South Australia, Java, Siam, Hawaii, India, Ceylon and South Africa.

DUNHEVEDIA PODAGRA King.

Described by King in 1852. I have not been able to obtain this form, so quote King's original description. It is apparently specifically distinct from the preceding species.

"Antennae with the tubercle near the base very prominent. When seen from the back the outline at the middle is concave. This species is much smaller than *Dunhevedia crassa*. When a number of them are placed together in a glass of water, they congregate near the surface. The intestine is much convoluted, having in reality two whole turns, although they are not in the same or parallel planes.

Locality.—Parramatta.

Genus PLEUROXUS Baird, 1843.

Lateral outline of the carapace may be long and comparatively low, or short and highly arched; the posterior margins are short. Infero-posteal corner sharp, usually toothed. Head not carinate, rostrum long and pointed, sometimes bent forward. Lip-plate large. Antennules short, antennae with 8 swimming bristles. Five pairs of legs present. Post-abdomen armed with marginal denticles only; end-claws with two accessory teeth.

About 27 species have been described from all parts of the World; three of them are found in New South Wales.

Key to species of Pleuroxus.

A. Infero-posteal corner unarmed . . . . *inermis.*
AA. Infero-posteal corner armed.
  B. Form short and high . . . . *reticulatus.*
  BB. Form long and narrow . . . . *australis.*

PLEUROXUS INERMIS Sars.

Described in 1896 (Plate 5, fig. 8).

Female. Carapace, seen laterally, somewhat rounded, dorsal margin strongly arched, ventral straight posteriorly, bulging anteriorly. Infero-posteal corner rounded off, quite unarmed. Head bent forward, rostrum long and pointed. Sculpturing of the carapace lacking, except in the anterior portion, where about ten conspicuous curved striae are present. Ocellus very much smaller than the eye and situated closer to it than to the tip of the rostrum. Post-abdomen comparatively slender, bearing numerous hair-like marginal denticles; end-claws strong, each with two secondary denticles at the base. Length .6 mm. Colour brown.

Distribution.—N.S.W.: Only thus far from localities near Sydney, Ponds near Lachlan and Bourke Sts., Waterloo Swamps, Botany. Victoria, South Africa, South America, Hungary.

PLEUROXUS RETICULATUS Henry. (Plate vii., figs. 2-2*a*.).

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 478.

Distribution.—N.S.W.: Port Stephens, Kendall.

PLEUROXUS AUSTRALIS, n.sp. (Plate vii., fig. 3).

Female. Carapace, seen laterally, comparatively long and low; dorsal margin evenly curved for the greater part of its length, but sloping abruptly down to the posterior margin; ventral edges of the valves slightly convex; posterior edges very short and truncated. The head is small and depressed, terminating in a long acutely-pointed rostrum which projects slightly beyond the ventral margins of the carapace. The eye is large, the ocellus smaller, and situated more than twice as far from the tip of the rostrum as from the eye. The surface of the carapace appears quite smooth, without any reticulation. The ventral edges are fringed with a row of bristles which are finely ciliated. The infero-posteal angle is an obtuse angle and is armed with 3 or 4 strong teeth. The antennules are short and thick and do not extend to the middle of the rostrum. The post-abdomen is moderately strong, tapering slightly distally, with the corner opposite the end-claws produced forward, although not to the same extent as in the preceding species, supra-anal angle obtuse, 14-16 anal denticles; end-claws long and moderately strong, each bearing two denticles at the base. Colour pale yellow, length .5 mm.

The most nearly related species to this is perhaps the American form *Pleuroxus denticulatus* Birge, but this species is very distinct from it in the general shape, absence of reticulation and in the armature of the post-abdomen.

Distribution.—N.S.W.: Bangalow, Cumbalum.

Genus CHYDORUS Leach, 1843.

Female. Body small and spheroidal. Head depressed, rostrum long and acute. Lip-plate moderately large, narrowed posteriorly. Infero-posteal corner usually unarmed. Antennules short and thick. Antennae provided with 7-8 swimming bristles. Post-abdomen short, supra-anal angle prominent; end-claws with two basal spines.

Male. Smaller, rostrum short, antennules thick, first foot with a hook.

Between thirty and forty species have been described from all parts of the World, six of them occurring in New South Wales.

Key to species of Chydorus.

A. Infero-posteal corner with a spine .. .. *unispinus.*
AA. Infero-posteal corner unarmed.
  B. Post-abdomen long and slender .. .. *globosus.*
  BB. Post-abdomen short and broad.
    C. Carapace strongly marked with oblique ridges .. .. *jugosus.*
    CC. Carapace smooth or weakly reticulated.
      D. Olfactory setae all terminal.
        E. 15 anal denticles .. .. *denticulatus.*
        EE. Less than 12 anal denticles .. .. *leonardi.*
      DD. One olfactory seta lateral .. .. *ovalis.*

CHYDORUS UNISPINUS, n.sp. (Plate vii., figs. 4-4*a*.).

Female. Carapace, seen laterally, broadly oval; dorsal margin strongly arched, ventral also curved, bulging somewhat anteriorly, posterior edges short, slightly curved. Infero-posteal corner armed with a short backwardly-directed spine. Head of moderate size, terminating in a produced, acutely-pointed rostrum. Eye of moderate size, ocellus smaller, situated slightly closer to the eye than to the tip of the rostrum. Antennules short, not nearly reaching the tip of the rostrum. Lip-plate long, the margin smooth. Post-abdomen strongly built, anal sinus very distinct; end-claws long, curved, each armed with two unequal-sized basal spines, 12-15 groups of anal denticles. Colour pale yellow.

This species resembles the *barroisi* group in that it has a spine on the infero-posteal corner; it differs from all the other members of the group, however, by the lip-plate having a perfectly smooth margin and in the curious armature of the post-abdomen.

Distribution.—N.S.W.: Botany.

CHYDORUS GLOBOSUS Baird. (Plate vii., figs. 6-6*a*.).

(*Syn.* Chydorus augustus King).

First described by Baird in 1850 (p. 127).

Female. Form almost spherical, without carapace angles. Dorsal and ventral margins strongly arched, posterior edges short. Carapace smooth or reticulated. Head comparatively large, rostrum produced, acute. Eye large, ocellus much smaller than the eye and situated slightly nearer to it than to the tip of the rostrum. Antennules very short and thick. Post-abdomen long and slender, of uniform breadth throughout, supra-anal angle very small; numerous anal denticles present; end-claws armed with a series of secondary spinules which become hair-like towards the tip, two basal spines of unequal length. Colour varying from yellow to dark brown. Length .8-.9 mm.

Distribution.—This large form is very widely distributed in New South Wales: Centennial Park, Botany, Sydney University, Five Dock, Corowa, Bangalow, Lett River. It also occurs in Victoria, India, Europe and North America.

CHYDORUS JUGOSUS, n.sp. (Plate vii., figs. 5-5*a*.).

Female. Carapace, seen laterally, rounded in outline, dorsal margin very strongly arched, ventral evenly curved, posterior edges very short and almost straight; infero-posteal corner unarmed. Head of moderate size, rostrum produced, acutely-pointed. Eye large; ocellus very slightly smaller, irregular in shape and situated much closer to the eye than to the tip of the rostrum. Antennules tapering at the ends, olfactory setae comparatively long, reaching more than half the length of the rostrum. Lip-plate large, the backwardly-directed portion narrowly produced. Ventral margins thickly fringed with long feathered bristles. Surface of the carapace very conspicuously marked with an oblique, rarely branching series of ridges which give the appearance of alternating light and dark bands. Post-abdomen very strongly built; end-claws long, slightly curved, each with two basal spines which are both comparatively long though unequal; 14-16 anal denticles with small spinules between them. Colour brown. Length .74 mm.

Distribution.—N.S.W.: Holbrook.

CHYDORUS DENTICULATUS Henry.

Proc. Roy. Soc. N.S.W., lii., 1918 (1919), p. 480, Pl. xlii., figs. 15, 16.

Distribution.—N.S.W.: Centennial Park, Sydney University Pond.

CHYDORUS LEONARDI King.

(*Syn.* C. minor Lilljeborg, C. clelandi Henry).

First described by King in 1852 (p. 258). Figured by Sars in 1896 (Plate v., figs. 4-5).

Female. Carapace rounded, dorsal and ventral margins strongly arched, posterior very short. Head somewhat depressed, rostrum long and pointed. Eye of moderate size, ocellus slightly smaller, situated nearer the eye than the rostral tip. Carapace devoid of sculpturing, ventral margin fringed with bristles. Antennules short, olfactory setae terminal. Post-abdomen comparatively wide, supra-anal angle prominent, 8-10 anal denticles, end-claws each with two basal spines. Length .25 mm.

This species is regarded by some authors as identical with *C. sphaericus* Muller. It is undoubtedly nearly related to this species and should perhaps be classed as a variety. A larger form described as *C. clelandi* attains a length of over .3 mm., has a pitted carapace, and 12 anal denticles, but in other respects is identical with *C. leonardi.*

Distribution.—Widely distributed in N.S.W.: St. Leonards, Denham Court, Waterloo Swamps, Botany, Kendall, Lett River, Holbrook, Cumbalum. It also occurs in Europe, Africa, Ceylon, Singapore and South America.

CHYDORUS OVALIS Kurz.

Described in 1874 (p. 79, Plate iii., fig. 2).

Female. Carapace, seen laterally, evenly rounded, posterior part depressed, posterior edges very short. Head not depressed, terminating in a long pointed rostrum. Eye larger than the ocellus, which is nearer to it than to the tip of the rostrum. Antennules short and thick, scarcely reaching the middle of the rostrum, one olfactory seta situated laterally, the others terminal. Post-abdomen short and broad, supra-anal angle projecting, pointed. Twelve to fifteen anal denticles; end-claws moderately large, with two unequal basal spines. Colour yellowish brown. Length .6 mm.

Distribution.—N.S.W.: Centennial Park. Europe, North America.

Genus ALONELLA Sars, 1862.

Head not carinate. Valves of the carapace reticulate or striated. Rostrum variable. Infero-posteal angle toothed or smooth. Antennae with 8 swimming hairs. 5 pairs of legs. Post-abdomen large, pre-anal angle usually not prominent, lateral spines usually absent, end-claws with one or two basal spines.

This is a somewhat unsatisfactory genus, consisting of forms that are not easily separable and yet differ widely in many points. Some of the species approach the genus *Alona* and others *Pleuroxus.* About twenty different species have been described, four of which occur in New South Wales.

Key to species of Alonella.

A. Claws with one basal spine.
  B. Post-abdomen armed with marginal and lateral denticles.
    C. Valves striated .. .. *karua.*
    CC. Valves reticulated.
      D. Margin of lip-plate notched .. .. *duoodonta.*
      DD. Margin of lip-plate entire .. .. *clathratula.*
  BB. Post-abdomen with marginal denticles only .. .. *diaphana.*
AA. Claws with two basal spines .. .. *excisa.*

ALONELLA KARUA (King).

First described by King as *Alona karua* (1852, p. 260). Described by Sars in 1888 (Plate 5, figs. 8-9).

Female. Carapace, seen laterally, somewhat quadrangular, broader anteriorly, posterior edges abruptly truncated. Head depressed, terminating in a sharp rostrum. Ocellus smaller than the eye and situated closer to it than to the tip of the rostrum. Carapace marked with distinct striations. Infero-posteal corner armed with 1-4 small teeth. Antennules slender, conical, not reaching the tip of the rostrum. Post-abdomen dilated distally, apex broadly truncate, anal denticles very small, about 8 lateral fascicles present; end-claws of moderate length, with one minute basal spine. Length .4 mm.

Distribution.—N.S.W.: Stroud, Port Stephens. North and South America, South Africa, Sumatra, Java, Singapore, Siam, Cochin China, Ceylon.

ALONELLA DIAPHANA (King). (Plate vii., figs. 1-1*a*.).

First described by King (1852, p. 260) as *Alona diaphana*.

Female. Carapace, seen laterally, rounded oval, tapering posteriorly, angles all rounded off. Head rather depressed, rostrum obtuse. Carapace striated, striae rather close together, curved. Infero-posteal corner unarmed. Eye of moderate size, ocellus smaller than the eye and situated midway between it and the tip of the rostrum. Post-abdomen large, oblong in form, tapering slightly distally, edge armed with small hair-like denticles, supra-anal angle slight; end-claws each with one small basal spine. Length .49 mm.

Distribution.—N.S.W.: Sydney, Moss Vale. Queensland, South America.

ALONELLA EXCISA (Fischer).

First described by Fischer as *Lynceus excisus* (1854, p. 428).

Female. Carapace, seen laterally, roughly oval in outline, dorsal margin evenly arched; ventral straight for the greater part of its length, ascending anteriorly; posterior narrowly truncated, with the upper and lower corners angular. Head slightly bent down, rostrum of moderate size, sometimes long. Surface of the carapace marked by a conspicuous network crossed with longitudinal striae, anterior part marked with curved transverse striae. Infero-posteal corner sometimes produced into a point with the posterior margin above it excised, sometimes crenulated. Ocellus much smaller than the eye and situated nearer to it than to the tip of the rostrum. Post-abdomen long, of almost uniform breadth throughout; supra-anal angle prominent, marginal denticles small. End-claws small, each with two unequal denticles at the base. Length up to .5 mm.

Male. Much smaller than the female, the largest found measuring only .25 mm.

Distribution.—Typical specimens were found at Lett River and Kendall in N.S.W. It has not hitherto been recorded in this State. This species is known from Europe, Siberia, Greenland, Iceland, North and South America and South Africa.

ALONELLA CLATHRATULA Sars. (Plate vi., figs. 6-6*a*.).

Described by Sars in 1896.

Female. Carapace, seen laterally, oblong oval, with the greatest height in front of the middle; dorsal margin evenly arched, posterior edges truncated. Head depressed, terminating in an acute rostrum. Infero-posteal angle distinct, not excised or crenulated as in the preceding species. Surface of the carapace reticulated in the posterior portion and marked by curved striae anteriorly. Post-abdomen truncated at the tip, marginal denticles very small and hair-like; end-claws each with a very minute basal spine. Length .35 mm.

This species is regarded by some authors as identical with *Alonella excisa* (Fischer), and Delachaux (1918) classed it as *A. excisa* var. *clathratula* on the grounds that the only difference was the presence or absence of the posterior excision. There are, however, other differences, the carapace of *clathratula* is longer in proportion to its breadth, and the markings of the carapace differ in the two species; in *clathratula* there is only one minute basal spine, while in *excisa* there are two spines of unequal length.

Distribution.—N.S.W.: Maroubra, Kendall, Lett River. South America, South Africa.

ALONELLA DUOODONTA, n.sp. (Text-figs. 1-4).

Female. Carapace, seen laterally, truncated oval in outline; dorsal margin evenly arched, ventral slightly curved, posterior edges straight. Infero-posteal corner armed with two strong teeth. Head somewhat depressed, ending in an obtuse rostrum. Eye of moderate size, ocellus slightly smaller, situated closer to

Text-fig. 1. *Alonella duoodonta.* (x 111). Text-fig. 2. Lip-plate. (x 300).
Text-fig. 3. Infero-posteal corner. (x 300). Text-fig. 4. Post-abdomen. (x 395).

the eye than to the tip of the rostrum. Antennules not nearly reaching the tip of the rostrum. Lip-plate large, its anterior and posterior edges almost parallel, its ventral margin with one deep notch followed by irregular crenulations. Surface of the carapace marked by a conspicuous reticulation; ventral edges fringed with bristles. Post-abdomen strongly built, supra-anal angle distinct; anal denticles arranged in an irregular manner, about six stout marginal denticles above which are scattered 5-7 lateral denticles and also some fine spines; end-claws long, bearing a series of spinules and one basal spine. Colour pale yellow. Length .35 mm.

Distribution.—N.S.W.: Manly.

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EXPLANATION OF PLATES IV.—VIII.

Plate iv.

Fig. 1.—*Daphnia carinata*. (x 15).
Fig. 2.— ,, ,, var. *cephalata*. (x 15).
Fig. 3.—*Scapholeberis kingi*. (x 50).
Fig. 4.—*Ceriodaphnia cornuta*. (x 75).
Fig. 5.— ,, *spinata*. (x 45).
Fig. 6.—*Moinodaphnia macleayii*. (x 45).

Plate v.

Fig. 1.—*Simocephalus australiensis*. (x 28). 1*a*. Post-abdomen. (x 56.); 1*b*. Ephippium (x 23); 1*c*. Antenna (x 65).
Fig. 2.—*Simocephalus elizabethae*. (x 39). 2*a*. Post-abdomen. (x 72).
Fig. 3.—*Simocephalus gibbosus*. (x 30). 3*a*. Post-abdomen. (x 72).
Fig. 4.—*Simocephalus acutirostratus*. (x 15). 4*a*. Post-abdomen. (x 34).

Plate vi.

Fig. 1.—*Ilyocryptus spinifer*. (x 32). 1*a*. Post-abdomen. (x 67).
Fig. 2.—*Acroperus avirostris*. (x 78). 2*a*. Post-abdomen. (x 170).
Fig. 3.—*Camptocercus australis*. (x 70). 3*a*. Post-abdomen. (x 84).
Fig. 4.—*Dunhevedia crassa*. (x 116). 4*a*. Post-abdomen. (x 116).
Fig. 5.—*Graptoleberis testudinaria*. (x 70). 5*a*. Post-abdomen. (x 253).
Fig. 6.—*Alonella clathratula*. (x 130). 6*a*. Post-abdomen. (290).

Plate vii.

Fig. 1.—*Alonella diaphana*. (x 95). 1*a*. Post-abdomen. (x 186).
Fig. 2.—*Pleuroxus reticulatus*. (x 148). 2*a*. Post-abdomen. (x 270).
Fig. 3.—*Pleuroxus australis*. (x 90).
Fig. 4.—*Chydorus unispinus*. (x 82). 4*a*. Post-abdomen. (x 160).
Fig. 5.—*Chydorus jugosus*. (x 70). 5*a*. Post-abdomen. (x 130).
Fig. 6.—*Chydorus globosus*. (x 58). 6*a*. Post-abdomen. (x 130).

Plate viii.

Fig. 1.—*Alona whiteleggii*. (x 77). 1*a*. Post-abdomen. (x 204).
Fig. 2.—*Alona affinis*. (x 46). 2*a*. Post-abdomen. (x 166).
Fig. 3.—*Alona laevissima*. (x 77). 3*a*. Post-abdomen. (x 245).
Fig. 4.—*Alona microtata*. (x 140). 4*a*. Post-abdomen. (x 380).
Fig. 5.—Post-abdomen *Alona cambouei*. (x 270).
Fig. 6.—Post-abdomen *Alona pulchella*. (x 205).
Fig. 7.—Post-abdomen *Alona kendallensis*. (x 320).
Fig. 8.—Post-abdomen *Alona abbreviata*. (x 270).

NOTES ON NEMATODES OF THE GENUS *PHYSALOPTERA*, WITH SPECIAL REFERENCE TO THOSE PARASITIC IN REPTILES.

Part ii.—A Review of the Physaloptera of Lizards.

By Vera A. Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

[Read 29th March, 1922.]

Seurat is the only author who has made any general study of the members of this group, and his work is confined to the representatives of it in Northern Africa, his two papers (1914, 1917) dealing with four species only. Descriptions of the other species are scattered among isolated papers, often difficult to obtain; and in most cases very unsatisfactory. The writers usually devote their attention to characters which are common to all the species, and, therefore, of no specific value. As Seurat points out, the reptilian *Physaloptera* form a very homogeneous group; and he has done a useful service in giving a general account of the Northern African forms. Most of the features which he describes are common to the whole group. Briefly summarised, they are as follows:—

Thick cuticle, transversely striated; a cephalic collarette; narrow lateral wings, bearing a pair of post-cervical papillae; excretory pore, ventrally situated, not far from these papillae; two asymmetrical papillae further back, in the intestinal region; a strong tooth (external labial tooth) on the summit of each lateral lip, several smaller teeth on its inner face, and a row of minute spines, or denticles, on its lower border; a pair of lateral papillae on the buccal pad external to each lip, and a median cephalic gland between them; a pair of lateral caudal pores on the mid region of the tail, and a caudal gland at its tip; large nerve ring surrounding the muscular oesophagus; vulva in front of middle of body; uterus with two or four branches; caudal bursa on male tail, bearing four pairs of external pedunculated papillae, surrounding cloaca, and about thirteen internal papillae, usually sessile, of which three are pre-anal, and the rest, in pairs, post-anal; spicules unequal, the right short and broad, the left long and slender.

With so much uniformity in the group, the determination of characters on which to base specific distinctions is a difficult one. Seurat considers that such characters are to be found only in careful measurements of the relative proportions, and in the conformation of the internal organs. But considerable variations are found in the dimensions given of the same species by different writers, even when all the required measurements are given, which is rarely the case. And, where a long series of what is undoubtedly the one species is carefully examined, similar variations are found to occur, both in the proportions and conformation of organs.

So that it is not advisable to rely on this character alone, although a very necessary one, for a specific determination. Another objection to it is that it usually requires the dissection of the specimens, a delicate and tedious operation in the smaller species.

A useful and more easily observed character is found in the structure of the male caudal bursa. Seurat is of the opinion that the number and disposition of the genital papillae are too constant to make this feature of specific value. But a careful study of the male tails of all the species shows well marked differences, not only in the papillae, but in the general shape and proportions of the bursa, form of margin (whether lobed or straight), shape of cloaca and character and arrangement of the area of cuticular granulations which usually surrounds it. Such distinctions are well seen, for example, in a comparison of the caudal bursas of *Physaloptera antarctica*, *P. sonsinoi*, and *P. dentata*, shown in the text figures.

It appears, too, that a more thorough examination than is usually given to the formation of the labial teeth would supply characters of specific value. In the existing descriptions of the species, there are indications of marked differences in the shape and size of the teeth, and in the denticular formations.

In the following specific diagnoses, I have been careful to note, from the authors, all those points in the descriptions which appeared to me to be of some specific value, omitting features which have been described as common to all. The measurements are grouped all together, in a table, as they are essential for specific determinations, and of most use when they are most readily available for comparison. The figures of the male tails are also grouped together, for the same reason; and, as they supply all the necessary information in regard to the number and arrangement of papillae, this is omitted from the diagnoses, except in cases where no figure of the bursa has been given by the author. The figures given in this paper represent traced copies of the originals.

It will be noticed that in several of the species the uterus is divided into four branches, instead of the usual two.

Seurat has separated the Physaloptera of reptiles into two groups, those which have a female genital apparatus formed of four uteri and four ovaries, viz.—Formes tetrahystériennes, and those in which it consists of two uteri and two ovaries, Formes didelphes.

This grouping has been adopted here. But the more typical arrangement of the genital apparatus has been assumed for species when no mention of it is made in the descriptions relative to them; and it is possible that, with more careful study, more species will be found to have the four-branched uterus.

Though *P. abbreviata* is one of Rudolphi's original species, the type of the genus is *P. clausa*, and Diesing's revised diagnosis of the genus *Physaloptera* includes the definite statement "uterus bicornis." It may be questioned, therefore, whether species with four uteri are properly assignable to the genus; though it would seem undesirable to establish a new genus entirely on a character which can be determined only by dissection.

Of the fifteen species which have been recorded from lizards, several have already been proved to be synonyms, and there are reasonable grounds for the supposition that other names will fall as synonyms. The total number of valid species, known from lizards, may be taken to be not more than nine, or, at most, ten. But, as this assumption is based only on a comparison of the descriptions given by the authors, and specimens are not available here for study, it has seemed better to retain the present status of the different species, pending further investigation. Therefore I have merely indicated the probable synonymy, in a discussion under the diagnosis of each doubtful species.

A list of the hosts in which the species are found is given in the first paper of this series (Irwin-Smith, 1921).

The Physaloptera of lizards.

A. Species with uterus divided into four branches.

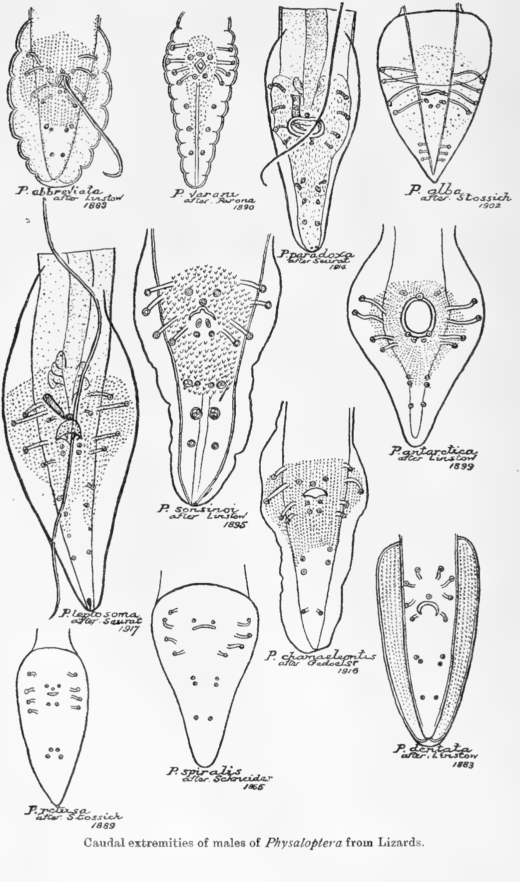
PHYSALOPTERA PALLARYI Seurat, 1917.

External labial tooth triangular, sharply pointed, erect; about 20 sharp denticles forming a very plain internal denticular border to the lip. Buccal frame slightly trilobed, bearing a pair of very small papillae. Muscular oesophagus slender, narrower than the glandular oesophagus. Body of female much attenuated anteriorly, thick and robust posteriorly. Vulva not salient; opening in front of termination of oesophagus; ovijector and reservoir long (1.55 mm.); unpaired trunk of uterus fairly long (650 μ), dichotomously divided into four branches. Caudal pores opening at posterior fifth of tail. Male tail (not figured) very short, provided with two narrow wings which do not reach the extremity. Three pre-anal papillae close to anterior border of cloacal ring, first pair of post-anal papillae right on posterior margin of the ring, fourth pair only a short distance from caudal point. Spicules very short, only slightly unequal. Wart-like cuticular protuberances surrounding cloaca big and salient. Measurements as given in table.

PHYSALOPTERA ABBREVIATA Rudolphi, 1819.

Body robust. The two lips very big, each bearing a large wedge-shaped external labial tooth, truncated at the extremity, and, on the inner face, a number of small teeth. The usual pair of external labial papillae. Muscular oesophagus massive, as wide as glandular oesophagus. Body of female attenuated at both extremities. Vulva not, or only slightly, salient; its position variable, opening either before or behind termination of the oesophagus: vestibule very long (3.5 mm.), unpaired trunk of uterus fairly long, dichotomously divided into four branches; seminal receptacles 150 μ x 120 μ, clearly marked off from both uterus and oviducts by narrow constrictions. Caudal pores just beyond middle of tail. Male tail elongated, inflected ventrally; caudal wings wide, cloacal lips not salient, cuticular projections arranged in longitudinal rows. Spicules very unequal. For number and arrangement of papillae see figure.

Reference is usually made to Linstow's description of this species, but a good deal of additional information has been contributed by Seurat, who examined the female genital system. Details supplied by Seurat have been incorporated in the above diagnosis, and the measurements given by him have been used in the table. Linstow's measurements differ considerably. According to him the oesophagus is one twelfth the total length; the tail, in the male, one twenty-seventh, in the female, one forty-seventh as long as the entire body; male 9 mm. long, 600 μ thick, female 18 mm. long, 870 μ thick, the vulva dividing the body in the ratio 8: 31. Eggs 36 μ x 20 μ in diameter.



Caudal extremities of males of *Physaloptera* from Lizards.

PHYSALOPTERA VARANI Parona, 1890.

Synonyms.—Physaloptera paradoxa Linstow, 1908; Physaloptera quadrovaria Leiper, 1908.

Head without lateral cuticular expansions. External labial tooth cuneiform, truncated. Labial papillae very small. Caudal extremity of female obtuse, anus nearly apical. Vulva opening behind the termination of oesophagus; ovijector elongated (3 mm.), unpaired trunk of uterus very short, divided directly into four branches, which terminate in seminal receptacles; these marked off from oviducts by deep constrictions, but passing gradually into the uteri. Ova brown coloured. Caudal pores in female very apparent just beyond middle of tail, opening in a cuticular depression bordered by a thick ring; in male situated midway between third and fourth pairs of post-anal papillae. Cloaca bounded by two prominent lips; cuticular knobs surrounding it often ornamented with little spurs. Pre-anal unpaired papilla oval, the paired papillae round. For arrangement of papillae see figure. Measurements as given in table.

In the above diagnosis, use has been made of the accounts given by Seurat, in conjunction with Parona's original description. The details of the female genital system are taken from the description of *Physaloptera paradoxa* by Seurat (1914). He subsequently (1917) classed both this and *P. quadrovaria* as synonyms of *P. varani.* As I have not had an opportunity of seeing the original description of *P. paradoxa,* I have accepted Seurat's authority for the synonymy. But it will be seen, from the two figures given, that the caudal bursa of *P. varani,* as shown by Parona, differs both in the number and arrangement of papillae from that of *P. paradoxa* as figured by Seurat. However, this is a feature in which mistakes of observation readily occur, and Seurat himself, in his second description, amends his first statement that six pairs of post-anal papillae occur, one of the pairs proving to be caudal pores.

The only description supplied by Leiper for *P. quadrovaria* is that "the vaginal canal is formed by the fusion of four distinct ovarian tubes," and a diagram, which indicates that the mode of division is similar to that described for *P. paradoxa.*

PHYSALOPTERA ANTARCTICA Linstow, 1899.

? *Synonym.*—Physaloptera alba Stossich, 1902.

Skin very thick. Lips hemispherical, each surmounted by a conical tooth, with two small adjacent teeth on the inner side. Body stout and elongated. Tail, in male, one twenty-third, in female, one fifty-fourth as long as entire body. Female tail conical, with rounded point. Eggs with very thick shell. Large cloacal aperture, circular in outline. The four pairs of external papillae possessing long stalks. For details of caudal bursa see figure. Measurements as given in table.

Linstow's description is too brief for a good specific diagnosis, but enough to show a close agreement with the *Physaloptera alba* described by Stossich.

PHYSALOPTERA ALBA Stossich, 1902.

Lips feebly developed, each produced into two big submedian papillae. Teeth very weak. Female tail conical. Vulva opening at anterior third of body length. Eggs enclosed in a very thick hyaline shell. Male caudal bursa as shown in figure. Stalks of the four pairs of external papillae long. Measurements as given in table.

As noted above, this species is probably identical with *Physaloptera antarctica.* The few measurements given accord with those for Linstow's species, and both worms are recorded from species of the same genus of host. The figures for the male tail, given by the two authors, show a close agreement in the general shape of the bursa, and the area on it covered by the cuticular granulations. Both writers note the length of the stalks of the external papillae, a feature which is also well shown in the two figures. In the figure of *P. alba,* precaudal papillae are missing, but these papillae are easily overlooked. Physaloptera from the same host, which I have examined recently and found to agree in most particulars with the description of *P. antarctica,* have the three pairs of caudal papillae stalked, as shown by Stossich. The females examined are also found to possess a four-branched uterus. Neither Linstow nor Stossich makes any mention of the female genital system, but I have placed the species in this group (A), on the evidence afforded by the worms now in my collection, of which a full description will be published later.

B. Species with uterus divided into two branches.

PHYSALOPTERA LEPTOSOMA (Gervais) Seurat, 1917.

Synonyms.—Strongylus leptosomus Gervais, 1848; Fraipont, 1882; ? Physaloptera chamaeleontis Gedoelst, 1916.

External labial tooth cuneiform, truncated, and provided with a little rounded button at the extremity. Internal teeth very distinct, bicuspid. Internal denticular border much reduced, interrupted by indistinct elliptical spots. Postcervical papillae slightly asymmetrical, the left longer. Muscular oesophagus remarkable for its brevity. Caudal extremity of female digitiform, elongated. Vulva not salient; vestibule and reservoir very elongated (3.125 mm.), unpaired trunk of uterus fairly long (500 μ), dividing into two parallel branches, 1.6 mm. long, each of which continues as a uterus extending nearly to level of anus. Caudal pores opening at posterior third of tail, in a slightly sunken elliptical area, bounded by a thin cuticular border. Male spicules very unequal. Caudal bursa elongated. Cloaca bounded by two salient lips with smooth surface. Cuticular processes of circum-cloacal region armed with spines, and arranged in longitudinal rows. Caudal pores just beyond middle of tail. For details of caudal bursa see figure. Measurements as given in table.

PHYSALOPTERA CHAMAELEONTIS Gedoelst, 1916.

External labial tooth triangular. Internal "fourchette" absent. The two extremities of the female equally attenuated; tail conical. Vulva slightly prominent; vestibule and reservoir 3.2 mm. long, unpaired trunk of uterus 1.5 mm. long, dividing into two branches 2 mm. long, each continuous with a uterus. Maximum thickness of male body in the posterior half, gradually attenuated in front. Spicules very unequal. Caudal bursa 1.44 mm. long. Circum-cloacal region provided with a regular longitudinal series of chitinous denticles, extending nearly to the middle of the tail. For arrangement of caudal papillae see figure. Measurements as given in table.

As will be seen from the tables of measurements, this species agrees so closely in all its dimensions with *P. leptosoma* as to suggest that it is a synonym. This assumption is strengthened by a comparison of the descriptions. The structure and proportions of the female genital systems are about the same; in both there is a reduction of the denticular formation on the inner face of the lip; the male caudal bursa has an elongated form in both, and the figures show that the arrangement of papillae and chitinous processes is alike.

PHYSALOPTERA DENTATA Linstow, 1883.

? *Synonym.*—Physaloptera aloisii-sabaudiae Parona, 1907.

Lips very large, with a median papilla on each. External labial tooth big, wedge-shaped, with a small tooth attached to its internal base. Caudal extremity of female conical, with rounded point, one twenty-fifth of the length of the whole body. Eggs very numerous, thick-shelled. Male tail one eleventh of the length of the body. Conical processes arranged on wings of bursa in longitudinal rows. Of the post-anal papillae 1 and 2 close together, often merging into one big one. See figure, for general arrangement of papillae. Measurements as given in table.

PHYSALOPTERA ALOISII-SABAUDIAE Parona, 1907.

Body attenuated anteriorly for a third of the total length. Mouth with two large lips; one papilla on each lip; big teeth, with a series of spines. Head with two oval membranous lobes, with continuous margins. Intestine in male straight, in female sinuous in the posterior half. Caudal extremity of female short, with rounded point. Vulva prominent, with smooth circular outline. Eggs in immense numbers, oval, thin-shelled. Male spicules stout, long, and unequal. Anterior end of testis extending right beyond the base of the oesophagus. Caudal bursa lanceolate, margins not lobed, without spines ('senza aculei') on its surface. External papillae with long peduncles; 2 and 3 post-anal shortly pedunculate.

Parona makes a note of the similarity between this species and the descriptions of *P. dentata,* and *P. abbreviata.* It seems probable that it is identical with the former. They were found in different species of the same host genus (*Agama*); the lengths are about the same, and although the descriptions of both are very meagre, they agree in important particulars. No figure is given of the caudal bursa of *P. aloisii-sabaudiae,* but the absence of the usual cuticular granulations on the circum-cloacal region is a very distinctive feature, and, in the figure of the caudal bursa of *P. dentata,* it is seen that these formations are confined to the marginal wings, the region round the cloaca being, apparently, quite smooth. *P. dentata,* too, is figured with the straight, not lobed, edge to the bursa, which is described for *P. aloisii-sabaudiae.* And, in each case, mention is made of a single median papilla on each lip.

PHYSALOPTERA SONSINOI Linstow, 1895.

External labial tooth conical. A pair of small submedian papillae on each lip. Caudal extremity of female rounded, and curved dorsally. ♀ tail one-eighteenth of whole length. Eggs very thick shelled. Twenty three papillae on caudal bursa, unusual in size and arrangement, as shown in figure. ♂ tail 1/9.25 of the body length. See measurements in table.

PHYSALOPTERA SPIRALIS Schneider, 1866.

External labial tooth pointed, inner tooth absent. Inner side of each lip beset with spines; a pair in the median line below the base of the tooth, another pair on each side near the margin of the lip, and, dorsally and ventrally, on the base, a row of about five. Caudal extremity, in female, dorsally curved or coiled in a spiral; in male, straight. Measurements as given in the table.

TABLE OF MEASUREMENTS OF *PHYSALOPTERA* OF LIZARDS.

		P. ballaryi.	*P. abbreviata.*	*P. varani.* Syn. *paradoxa.*	*P. antarctica*	*P. alba.*	*P. leptosoma.*	*P. chamaeleontis.*	*P. dentata.*	*P. aloisii-sabaudiae.*	*P. sonsinoi.*	*P. retusa.*	*P. spiralis*
Total length	female male larva (female)	19·5–25 mm. 8·5–10·8 12·3	15 mm. 10·6 13·5	22·5 mm. 11·4—15 15	42 mm. 27	42 mm. 25—28	28·5 mm. 15·8 6·2	22 mm. 13·4	12 mm. 7	11 mm. 6	6·7 mm. 6·5	65 mm. 30 7	67 mm. 14—22 29
Maximum thickness	female male larva	490 μ 300 420	770 μ 445 770		1·18 mm. ·79		790 μ 540 170	815 μ 640	960 μ 660		480 μ 430		
Tail	female male larva	270 μ 280 250	310 μ 660 515	660 μ	.77 mm. 1·17		740 μ 984 162	770 μ 960	480 μ 636		372 μ 684		
Distance of cephalic extremity from :— middle of nerve-ring	female male larva	192 μ 210 250	370 μ 315 396	at junction of muscular and glandular oesophagus			432 μ 350 185						
,, post cervical papillae	female male larva	300 μ 318 360	624 μ 600 552	behind limit of muscular oesophagus			610—636 μ 516—564		480 μ				
,, excretory pore	female male larva	300 μ 322 385	720 μ 624 672				610 μ 588	0·8—1·0 mm.					
,, vulva	female larva	2.376 mm. 2·375	4·356 mm. 1.860	4 mm. or at anterior $\frac{1}{5}$ of body length		at $\frac{1}{3}$ body length	3·8 mm.	4·4 mm. (ant. $\frac{1}{5}$ of body length)			divides body in ratio 5 : 31	15 mm.	10 mm.
Buccal cavity	female male larva	60 μ 70 60	50 μ										
Muscular oesophagus	female male larva	240 μ 262 300	360 μ 300 360	massive			350 μ 360 180						
Entire oesophagus	female male larva	3·2 mm. 1·73 2·87	3 mm. 2 3·1	3 mm. 1·9—2·3 2·17	4·88 mm. 3·25		2·85 mm. 2·57 1·42	3.7 mm. 1.9	2·8 mm. 1·7				
Proportion of total length to that of oesophagus	female male larva	6 5 4·3	5 5·3 4·3	7·4 5—6·7 6·9	8.6 8·3		10 6 4.3		4·2 4·2	4 4	2·75 4·6		
Spicules	right left	150 μ 260 μ	180×45 μ 2 mm.	100×35 μ 1·920 mm.			156 μ 1·92 mm.	370 μ 2.1 mm.			320 μ 1·89 mm.		
[illegible]			56×38 μ	50×25 μ	54×42 μ		52×35 μ	56×40 μ	52×43 μ		57×39 μ		

Schneider's figure of the caudal bursa (*See* Text-fig.) shows no unpaired papilla and only four pairs of internal papillae; but in his description he makes the statement "6 unmittelbar hinter der unpaaren Papilla."

In comparing this species with *P. abbreviata* he says that the denticles on the lip of the latter form an uninterrupted row along the edge, and that the only difference in the arrangement of the caudal papillae is that in *P. abbreviata* they are further from the median line.

PHYSALOPTERA RETUSA Rudolphi, 1819.

External labial tooth notched, the notches not extending to the base. Inner teeth longer. Internal face of lip beset with short spike-shaped processes; a pair towards each side of the base, dorsal and ventral, a pair midway between these and the apex of the lip. The two branches of the uterus extend far towards the posterior end. Caudal papillae arranged as shown in the figure. Measurements as given in the table.

Schneider mentions that he has observed ecdysis in a larva 7 mm. long, and that ripe eggs are first found in a female 30 mm. long.

PHYSALOPTERA BRITANICA Skrjabin.

Seurat makes a brief reference to this species (1917, p. 47). He says that it resembles *P. pallaryi* in the conformation of the buccal lips, but differs from it by its much superior stature, by the relatively slighter length of the oesophagus, and by the different form of the tail in the female.

I have not been able to trace the original description of the species, nor to find any other reference to it.

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A NEW GENUS OF AUSTRALIAN *CIXIIDAE* (HOMOPTERA).

By F. Muir, Hawaiian Sugar Planters' Experiment Station, Honolulu, T. H.

(*Communicated by H. J. Carter, B.A., F.E.S.*)

[Read 26th April, 1922.]

Bathymeria, n. gen.

Closely allied to *Leptoclamys* Kirk. but the great development of the front legs distinguishes it. Vertex about twice as broad as long, with a transverse carina about middle, a transverse carina divides vertex from frons; base very shallowly emarginate, except in the middle, where there is a minute angular emargination; apex truncate, not produced beyond eyes. Length of *middle* of face equal to width, widest slightly beyond middle, sides slightly curved, apical half more so than basal, apex of face deeply and roundly concave thus making the sides longer than middle, marginal carinae distinct, median carina somewhat obscure, no median ocellus but the median carina obsolete at apex. In side view base of clypeus rounded, slightly produced, distinctly tricarinate. Antennae globose. Pronotum fairly long, hind margin deeply and angularly emarginate with a carina margining the middle half; no lateral carinae but a slight groove runs from the anterior margin behind eye in a circle nearly touching the hind margin, the area within this groove being slightly swollen. Mesonotum slightly flattened in middle, tricarinate. Front legs considerably thickened, femora slightly excavate along the ventral surface with small spines along each margin; tibiae slightly excavate along dorsal surface with spines around apex. This arrangement allows the tibiae to be laid close to the femora and the tarsi doubled back upon the tibiae, as is often found in subterraneous insects. Other legs normal; hind tibiae without spines. Ovipositor short, complete; the surface of female pygofer forming a wax-secreting surface; female abdomen fairly full but decidedly compressed horizontally. Male pygofer of the normal Cixiid type, abdomen compressed horizontally. Tegmina of the Cixiid type, subtectiform, claval veins joining about middle of clavus, entering hind margin before apex, Sc and R forking at same level as Cu slightly beyond middle of clavus; R with three apical veins; first fork of M slightly before apex of clavus, five apical veins, M_1, M_{1a}, M_2, M_3 and M_4.

Type, *B. helmsi* Muir.

Bathymeria helmsi, n.sp.

♂. Length 4.4 mm.; tegmen 5.6 mm.

Dark brown or nearly black over head and thorax, carinae lighter, also the raised area on pronotum, front and middle tibiae and tarsi and the hind legs lighter; abdomen light brown. Tegmina and wings hyaline, vitreous, veins dark brown; tubercles sparse, more numerous on apical veins, bearing small black macrotrichia; a brown stigmal mark. Ventral margin of pygofer angularly produced, lateral margins slightly curved; anal segment of moderate size, rounded at apex; genital styles Y-shaped, the inner arm being small and the outer curved.

♀. Length 6.4 mm.; tegmen 8.6 mm.

Lighter than the male. Full view of pygofer a little longer than wide, sides fairly deep, ovipositor slightly curved upward, not reaching the anal segment which is short and slightly flattened horizontally.

Described from one male from Sydney, N.S.W., and five females, one unlabelled, one from National Park (December, 1905) and three from Sydney, N.S.W. These specimens are in Dr. Helms' collection, now in the Bishop Museum, Honolulu, T.H. One Paratype in Australian Museum Collection, No. K45294.

The interest attached to this insect is that the front legs are developed abnormally for the family and indicate that the nymph is likely to be subterraneous in its habits. Information on this point would be of interest and local collectors should endeavour to settle this point.

AUSTRALIAN *COLEOPTERA*: NOTES AND NEW SPECIES. No. ii.

By H. J. Carter, B.A., F.E.S.

(Fourteen Text-figures.)

[Read 26th April, 1922.]

BUPRESTIDAE.

Buprestidae. Having lately examined long series from the South Australian Museum of many species of the Chalcophorini group of Buprestidae, I made a careful study of the *Chalcotaenia*—especially of those having 4-spotted elytra—in order to clear my own mind on the subject. Cotypes of the late Canon Blackburn's species were amongst these, including one of *C. beltanae*—the label in Blackburn's handwriting. I would note: (1) This species is a *Chalcotaenia*—as so placed by Kerremans in the Gen. Insectorum—not a *Chalcophorella* as originally described. (2) Portions of the description do not agree with the specimen—(*a*) "partibus elevatis obscure cuprascentibus," (*b*) "antennis sat brevibus haud prothoracis basin attingentibus." With regard to (*a*) the elevated parts are dark green, the depressed areas golden; the word *non* should thus be prefixed to elevatis to describe the specimen.

As to (*b*) there only remain 9 joints of one antenna; but the 9th joint exactly reaches the base of prothorax, so that the antennae of the example in question are decidedly longer than the prothorax. Further, except for parts of joints 1-3 which are metallic, the antenna is testaceous, although in his final note the author compared it with "*C. martini* Saund., and *C. cerata* Kerr., both of which, however, differ from it, *inter alia multa*, by their testaceous antennae." The dimensions of the example are 19 x 7 mm., those of the type $8\frac{3}{4}$ x 3 lines. I can only deduce, therefore, that either the specimen is wrongly named or that the above statements are inaccurate.

The other species by this author, of which I have examined cotypes are, I consider, synonyms as follows:—

C. australasiae Saund. = *C. angulipennis* Blackb.

C. quadri-impressa Waterh. = *C. sulciventris* Blackb.

I append a tabulation of the Australian species of the genus. The two extra-Australian species are *C. gratiosissima* Kerr. from Papua and *C. longicollis* Kerr. from "Isles du Sud-East."

Table of Australian species of Chalcotaenia *Deyrolle.*

1	Elytral costae entire, without impressions	*lamberti* C. and G.
2—4	Elytral costae interrupted by one impression on each	
3	Form elongate, the elytral impressions near apex	*elongata* Waterh.
4	Form ovate, the elytral impressions premedial	*bi-impressa* Cart.
5—12	Elytral costae interrupted by two impressions on each	
6—8	Sides of prothorax widely arched in front.	
7	Four impressions wide and irregular in shape; humeral truncature of elytra subangulately widened	*australasiae* Saund. *occidentalis* Waterh. *angulipennis* Blackb.
8	Four impressions subcircular (equally wide apart)—humeral truncature not angulate .. .. *quadri-impressa* Waterh.	*sulci-ventris* Blackb.
9—12	Sides of prothorax nearly straight (lightly sinuous).	
10	Four impressions subcircular, the premedial closer set than the post-medial .. .. *cuprascens* Waterh.	*australis* Fairm.
11	Form more obovate than 10, postmedial impressions forming a comma-like connection (on outside) with latero-apical sulci	*laeta* Waterh.
12	Form narrower than 10, 11, impression more vague; post-medial impressions connected (on inside) with latero-apical sulci	*beltanae* Blackb.
13—15	Costae wide and little raised, impressions elongate.	
14	Prothorax subquadrate, elytra subparallel	*violacea* Cart.
15	Prothorax trapeziform; elytra ovate	*castanea* Cart.

Buprestis aurulenta L. This beautiful North American beetle has now to be recorded from Australia, probably bred from imported Oregon pine timber. An example was taken by Dr. E. W. Ferguson at Port Macquarie, Aug. 1919, in or near his boarding house, which was so unrelated to any Australian Buprestidae known to me that I sent it to the British Museum for determination. This has now been returned by Mr. K. G. Blair, named as above, together with a note that a specimen from Hawaii was also in the British Museum. I have lately seen another example from the National Museum, Melbourne, taken at Toorak or Frankston, (Vic.). A short description of this will interest our coleopterists.

N.S.W. Example.—♂, 16 x 6 mm. Vic. Example.—♀, 20 x 8 mm.

Oval, glabrous, golden green above and below, head, pronotum (apex and sides) suffused with golden copper, suture and sides of elytra brilliant golden copper; pronotum rugose punctate; each elytron with four sharp costae, suture and margins also costate, interspaces rugose punctate.

NEO-BUBASTES FLAVO-VITTATA, n.sp. (Text-fig. 1).

Elongate, oblong, lightly attenuate behind; head and pronotum gold suffused with green, golden at sides. Elytra green with a wide yellow vitta on each, not quite touching the base and terminating some distance from apex, its inner margin near suture, its external margin parallel to the margins of elytra; the suture sometimes violaceous on apical half; underside dark golden bronze, rather thickly clothed with short white pubescence.

Head densely punctate, antennae short, 1st joint large, all after the 3rd finely serrated; eyes parallel and widely separated. *Prothorax* sub-globular, apex truncate, base lightly bisinuate, sides widely rounded; very densely punctate and varyingly rugose in parts; in two (of three examples) with a fine medial carina on basal half, anterior angles depressed—quite rounded off from above—posterior obtuse. *Scutellum* large, transversely oval, very nitid and brassy. *Elytra* lightly enlarged at shoulders and compressed at middle; apices separately rounded, posterior margins serrated, striate-punctate, the seriate punctures large and close; intervals convex and closely punctate. Underside densely punctate, the prosternum coarsely so, margins of abdominal segments smooth and nitid. Apical segment truncate between two sub-obsolete teeth in ♂, rounded in ♀. *Dimensions*: ♂, 11-12 x 4 mm., ♀, 15 x 5 mm.

Hab.—Western Australia: Kellerberrin (Mr. H. Giles), Cunderdin (Mr. R. Illidge).

Three examples (2 ♂, 1 ♀) are before me. The species is peculiar amongst Buprestidae in the contrasted metallic areas and the non-metallic vittae of the elytra. If the yellow be taken as the ground colour, then the base and suture are narrowly, and the margins and apex widely, green. The apices and suture are, in two examples, violaceous. Though presenting certain marked differences in the form of the prothorax and in the elytral sculpture from *N. aureocincta* Blackb. (Text-fig. 2)—of which I have seen the type—it is, I consider, congeneric with that species. Types in Coll. Carter.

N.B. The genus is clearly distinct from *Bubastes* by its shorter prothorax, larger scutellum and flatter elytra *inter alia,* though merged by Kerremans with *Bubastes* (Gen. Ins.).

I have lately received some valued papers (Ann. Soc. Ent. France, 1920) on Buprestidae by Dr. Jan Obenberger of Prague. Amongst his new species there is one evident synonym as follows:—

Bubastes suturalis Carter = *B. strandi* Obenb.

B. suturalis was published in 1915.

Pseudanilara roberti Théry.—I have identified this genus and species in two examples from Sydney in my collection (described as from Victoria). The genus is separated from *Anilara* by its wide head, bisinuate base of pronotum, the position of the antennary cavities and the absence of impression or carenum on the last segment of abdomen.

STIGMODERA.

Synonymy. *Stigmodera rollei* Kerr. = *S. hackeri* Carter. [*S. caudata* Cart. (nom. praeocc.)].

Stigmodera horni Kerr. = *S. unimaculata* Carter.

Kerremans' descriptions were published Jan. 1908 (Deutsche Ent. Zeit.) while my names appeared in August of the same year (These Proc.). I have only recently obtained Kerremans' descriptions. He notes, as I did, the identical colour markings of these two species, but, like myself, considers the marked differences, especially of apical structure, specific distinctions, though noting that his two examples of *rollei* were ♀♀, and those of *horni* were ♂♂.

Of six examples of *rollei* and three of *horni* now before me the same sexual association holds. This is quite strong, though not conclusive evidence that *rollei* is the ♀ and *horni* the ♂ of the same species. *S. horni* is also very close to *S. erubescens* Blackb. from the same region—a species of which I have only seen the ♂ (Three in my collection).

Stigmodera johannae Théry.—This is, evidently, one of the forms of *S. straminea* Macl. The colour of the thorax is more correctly described by Théry as violet purple, than by Macleay as "golden olive," and the excellent description exactly applies to Macleay's species. In this species the preapical "tache" is frequently absent.

Stigmodera donovani C. and G. This species, placed by me as a synonym of *S. jansoni* Saund. in my Revision (Trans. Roy. Soc. S. Aus., 1916, p. 93) is, I now consider, quite distinct from Saunders' species.

Specimens of *S. jansoni* taken by Mr. R. Illidge at Gympie, Queensland, correspond with the description. It is longer, more parallel than *donovani,* the apical spines on each elytron closer, the interspace less oblique than in that species, while the underside is clear green, the same being flavous—the abdominal segments with green margins—in *S. donovani. The ♀ has a concolorous green prothorax without yellow margins*—a fact unnoted in the description.

Mr. Illidge has taken both species in the same district. My examples of *S. donovani* are from Rockhampton.

S. spencei C. and G. Two examples, the sexes, in Mr. Illidge's collection have only one fascia, besides the dark apical mark, on elytra.

S. cydista Rainb. Mr. T. G. Sloane has lately (Dec., 1921) taken three examples of this at Barrington Tops (Mount Royal) that differ only from the typical form in having the medial fascia broken up into two spots on each elytron; one, round, near suture, the other on side. The three are exactly alike.

S. praetermissa Cart. This species appears to be moderately common in Victoria. Since my description appeared, several examples have been sent me for determination, taken by Mr. J. E. Dixon and others.

The following new species of *Stigmodera* have lately come under my notice from various sources:

STIGMODERA AURIFERA, n.sp. (Text-fig. 3.)

Oval, robust; head, prothorax, scutellum, underside, antennae and elytral markings brilliant golden bronze (pronotum with a violaceous tinge near centre), legs and tarsi coppery green; elytra yellow with the basal border widely, a short preapical fascia, interrupted at suture and extending over two-thirds of width and extreme apex, golden bronze.

Head channelled and concave; coarsely, irregularly punctate, the punctures finer between eyes. *Prothorax* truncate in front, moderately bisinuate at base, widest behind middle, thence rather straightly narrowed, lightly towards base, strongly towards apex; disc coarsely punctate at centre, base and sides, the punctures sub-confluent at sides, more widely set towards centre, finer and dense towards apex, a little depressed in front of scutellum, medial line smooth for the greater part. *Scutellum* cordate and concave, nitid and impunctate. *Elytra* well widened behind shoulders, lightly compressed before the middle, margins finely serrated near apex, apices rounded but not quite meeting; striate-punctate, all intervals convex, strongly so at sides and apex, intervals sparsely but distinctly punctate; sternal area coarsely, the abdomen finely and densely punctate. *Dimensions*: 17 x 7 mm.

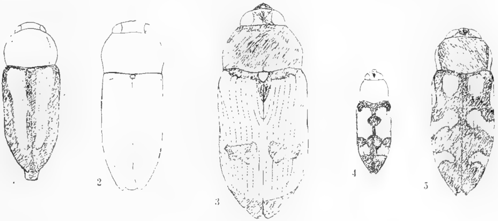
Hab.—N. Queensland (Mr. H. P. Dodd).

A single female, taken by the Kuranda naturalist, was received without locality label. In general form it suggests *S. secularis* Thoms. and *S. fulviventris* Macl., but it is not, in colour, form or pattern, near any of the species appearing in the section of my tabulation (*op. cit.*, p. 102) to which it belongs. "Elytra with basal margins, post-medial fascia and apex only dark." Type in Coll. Cart.

STIGMODERA AUROLIMBATA, n.sp. (Text-fig. 4.)

Oblong oval, lightly attenuated at apex; head, prothorax, scutellum, underside, appendages, basal margin and suture of elytra golden green; elytra yellow with the following markings dark blue (besides the above golden margins): basal fascia, widened and directed backwards on humeral callus; a transverse, oval, pre-medial spot, extending across the suture, an irregular post-medial fascia formed by three connected spots and wide apical mark.

Head channelled and lightly concave, densely punctate. *Prothorax* very convex, truncate at apex, strongly bisinuate at base, widest at middle, sides lightly rounded, feebly sinuate behind; anterior angles obtuse, posterior acute; disc



Text-figs. 1–5.

1. *Neo-bubastes flavo-vittata*, n.sp. 2. *N. aureocincta* Blackb.
3. *Stigmodera aurifera*, n.sp. 4. *S. aurolimbata*, n.sp.
5. *S. clarki*, n.sp.

densely, evenly punctate for the greater part, the punctures coarser and less crowded at sides, a small round pre-scutellary fovea and two transverse basal foveae. *Elytra* enlarged behind shoulders, apices forming a single wide lunation, scarcely spinose; striate punctate, intervals flat save at sides and apex, underside densely punctate. *Dimensions*: 7½ x 3 mm.

Hab.—North Queensland: Cairns district (Mr. H. P. Dodd).

A pretty little species, unique, from Mr. Dodd, of the form of *S. puerilis* Kerr., *S. festiva* Cart. and *S. titania* Cart. with a colour plan near that of *S. auricollis* C. and G., near which it would come in my tabulation. It differs from any other *Stigmodera* by the unusual golden metallic edging to the elytra along the base and suture, with the contrasted dark blue markings outside this. Type in Coll. Carter.

STIGMODERA CLARKI, n.sp. (Text-fig. 5.)

Elongate ovate; head, pronotum, scutellum, underside and appendages dark bronze, pronotum with yellow margins; elytra blue-black with the following markings yellow: oval basal spot, elongate epipleural spot, two fasciae extending to sides but not to suture, the one medial enlarged on disc, the oblique extension to sides narrower, the other preapical, lunate, widest at sides; underside densely clad with white, adpressed hair.

Head channelled and closely punctate. *Prothorax* lightly bisinuate at apex in middle, strongly so at base, anterior angles obtuse, posterior sub-rectangular, sides widest at middle, evenly rounded, disc closely punctate with smooth medial line. *Scutellum* cordate, depressed in middle. *Elytra* convex, sub-parallel, lightly widened at shoulders and compressed before middle, minutely serrated near apex, apices rather widely lunate; striate-punctate, intervals finely wrinkled, convex at sides and apex only. *Dimensions*: ♂. 13 x 5; ♀. 15 x 6 mm.

Hab.—Busselton, Western Australia. (Mr. J. Clark).

Five examples before me can only be confused with *S. serratipennis* mihi. *S. victoriensis* Blackb. and *S. eremita* Blackb. From the first it is distinguished by the absence of the yellow head spot, the apical spot on the elytra and the yellow markings of the underside; from the second it differs in colour, more elongate form, the absence of apical spot on elytra and the impunctate elytral intervals; *S. eremita* Blackb., besides its more oval form, has the ground colour of elytra and underside a clear blue; the medial fascia joining the epipleural spot, wider yellow margins to pronotum, *inter alia*. From all three the unusually densely pilose underside is a good distinguishing character. The pronotum sometimes shows metallic reflections (greenish or violaceous). Types in Coll. Carter.

STIGMODERA FLINDERSI, n.sp. (Text-fig. 6.)

Oblong ovate; head, prothorax, underside, appendages and elytral markings violet coppery, subnitid above, more brilliant beneath; elytra yellow, with the basal margins, suture (triangularly enlarged behind scutellum), wide pre-apical fascia (narrowed at sides) and the apex widely violet copper.

Head lightly concave in middle, densely punctate. *Prothorax* bulbous, a little produced forward in middle, strongly bisinuate at base, sides widely rounded, widest at middle, front angles obtuse, the hind acute; disc densely and finely rugose-punctate, a smooth medial line showing on basal half and a fovea at middle of each lobe. *Scutellum* depressed, nitid, smooth. *Elytra* enlarged behind shoulders, lightly compressed before the middle, apices obliquely lunate; striate punctate, intervals flat in middle, convex at sides and apex; rather coarsely punctate, underside densely so and almost hairless. *Dimensions*: 8 x 3 (plus) mm.

Hab.—South Australia: Flinders Range.

A single specimen in the Australian Museum bears a locality label in the handwriting of the late Mr. G. Masters, probably taken by him. It belongs to the small section of my tabulation that contains *S. skusei* Blackb. and *S. campestris* Blackb., but is quite unlike any of these (Nos. 195-203). The ground colour is the unusual violet copper seen in *S. cupriflava* Saund. and *S. cognata* Kerr. and in the pronotum of *S. aurifera* (*above*). The name commemorates the famous navigator and indicates the habitat of the species. Type in Australian Museum.

STIGMODERA HOBLERAE, n.sp. (Text-fig. 7.)

Oblong oval, rather flat; head and pronotum brilliant dark bronze, elytra yellow with the following markings blue-black: basal margin and scutellary region, post-medial fascia enlarging towards and extending to the sides, connected along the suture with a shorter arcuate fascia situated half way between the former and the apex and extending over about half the width of elytra and the apical spines; underside and appendages blue-black, the former inconspicuously pilose.

Head deeply channelled and concave, finely punctate. *Prothorax* moderately convex, truncate at apex, bisinuate at base, sides nearly straight and strongly narrowed from base to apex, front angles obtuse, hind acute; disc with shallow punctures, fine near centre, coarser towards sides, and three large foveae near basal border, one at middle, the others near posterior angles. *Elytra* slightly widening behind shoulders, feebly compressed before the middle, apices widely truncate, the truncation bounded by two conspicuous spines, the exterior the more prominent; striate-punctate, all intervals convex and impunctate; underside finely and densely punctate. *Dimensions*: 11-12 x 4-4.5 mm.

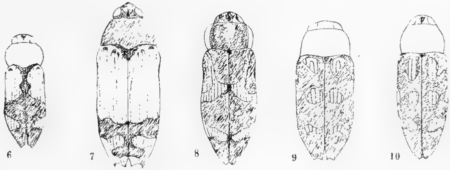
Hab.—S. Queensland: Jandowae (Mrs. Hobler and Mr. R. Illidge).

The four examples of this species, similar in form and pattern, were sent by the captors, and I have much pleasure in naming it after the enthusiastic lady naturalist who has collected so many interesting insects in that district. Belonging to the *andersoni* group, it differs from all described species in it by the darker elytral markings being entirely pre-apical (except the spines). The long and short fasciae, connected at suture, look very like an aeroplane or flying dove, as seen from above. The apical structure is intermediate between that of *S. andersoni* C. and G. and *S. mastersi* Macl. (In the former the spines are subequal, in the latter the suture is rather produced than spinose). The blue-black colour varies with the light in which it is viewed, the blue only clearly displayed when viewed sideways. Type in Coll. Cart.

STIGMODERA MILITARIS, n.sp. (Text-fig. 8.)

Oblong-obovate; head, pronotum, ground colour of elytra, legs, tarsi and parts of underside blue, antennae bronze, sides of prothorax widely yellow or orange, elytra with yellow (or orange) markings as follows: an oblique vitta from the shoulder joining a fascia near the middle of each elytron and forming a loop round the shoulder continued backward on underside of margin, the median fascia interrupted at the suture and obliquely directed backwards towards, and continuous to, the sides, an arcuate pre-apical fascia widening towards and turned upwards at the sides; the abdomen largely, the sternal regions, to a variable degree, yellow or orange. (The ♂ example is almost entirely yellow beneath, in the ♀ the pro-, meso-, and meta-sternum are chiefly blue, the abdominal segments have wide blue margins, the blue sometimes extending over the middle area of segments).

Head punctate, widely excavated between eyes. *Prothorax*: apex lightly bisinuate, base more strongly so, sides widely and evenly rounded, widest behind middle, posterior angles sub-rectangular, disc with round, close, large punctures,



Text-figs. 6–10.

6. *Stigmodera flindersi*, n.sp. 7. *S. hoblerae*, n.sp.
8. *S. militaris*, n.sp. 9. *S. tropica*, n.sp.
10. *S. mansueta* Kerr.

sub-confluent at sides; medial channel distinct in ♀, indicated at base only in ♂. *Scutellum* violaceous, punctate. *Elytra* widest behind middle, apices separately rounded, striate-punctate, intervals uniformly convex in ♀, lightly so (except at apex) in ♂ and distinctly and closely punctate; underside punctate and clothed with a fine, short, pale pubescence. *Dimensions*: ♂. 11 x 4; ♀. 15 x 6 mm.

Hab.—New South Wales: Mittagong (C. F. Deuquet); Victoria: Wonga Park, 25 miles East of Melbourne (Ernest French).

Two examples, the sexes, of this very pretty species are before me, of which the ♂ type is in Coll. Deuquet, the ♀ type belongs to the National Museum, Melbourne. It is most like *S. flavo-signata* Macl., the form, colour, pattern on apical half of elytra being almost identical; but Macleay's insect has a very different pronotum, on which the blue and yellow form alternate horizontal markings; the basal half of elytra being also quite different. The ground colour has the rich blue of *S. klugi* C. and G., the pronotum showing violet reflections. I have called it *militaris* from the resemblance of the vitta and medial fascia to the Sam Brown belts worn by our military officers.

STIGMODERA TROPICA, n.sp. (Text-fig. 9.)

Oblong, glabrous; head, pronotum, underside, legs and antennae brilliant green, the first two with brassy reflections; elytra violet with ten yellow spots as follows: two triangular near angle between base and suture, two oval near middle, one on each side of suture, two preapical forming a short curved fascia, and two, very small, on each side, one behind the shoulder, the other even smaller, opposite the medial spot.

Head channelled and excavated between eyes, and together with the pronotum, regularly and closely punctate. *Prothorax*: apex truncate, base bisinuate, sides rounded, narrower at apex than at base, anterior angles widely obtuse, posterior acute, a smooth medial line terminating in a basal fovea. *Elytra* lightly enlarged near base, sides nearly parallel till near apex, then a little sinuate before the widely bidentate apex, two short teeth bounding an arcuate excision; the exterior rather more prominent, posterior margins not serrated; striate-punctate, intervals convex throughout, steeply so towards apex and themselves clearly punctate; underside densely punctate, flanks of prosternum with coarse, mesosternum with medium-sized, metasternum and abdomen with fine punctures, the whole glabrous. *Dimensions*: 11 x 4 mm.

Hab.—Cape York (Elgner).

A single specimen (? ♂) has long been in my cabinet, labelled by me "near *mansueta* Kerr." A specimen from W. Australia in the South Australian Museum labelled *mansueta* Kerr. by Blackburn exactly corresponds with Kerremans' description, and differs from *S. tropica* not only in pattern, for which see Text-fig. 10 (which I give for comparison with my species, as well as to show my determination of *mansueta* Kerr.), but in having the head and underside bronzy and thickly clad with pale recumbent hair, almost concealing abdomen, the latero-humeral spot connected on the sides with the medio-lateral spot. Type in Coll. Carter.

TENEBRIONIDAE.

Synonymy.—*Menearchus impresso-sulcatus* Carter = *Pseudoblaps dispar* Hbst. It now appears that Mr. Deuquet took this at Colombo, Ceylon, but mixed it with his Australian captures, without labels. (See my note, These Proc., xlv., 1920, p. 231). On his recent visit to London he took his example to the British Museum where Mr. Blair identified it as the Indian insect. I take this earliest opportunity of correcting this blunder, and of withdrawing the name *Menearchus* from the Australian list.

PLATYDEMA SULCATO-PUNCTATUM, n.sp.

Oval, convex, black, sub-nitid; antennae, legs and underside red.

Head closely and rather coarsely punctate, epistoma arcuate in front, its surface depressed below that of forehead, the latter with a strongly raised longitudinal ridge bounding each eye. *Prothorax* sub-truncate (from above) at apex, bisinuate at base, sides arcuately narrowed from base to apex, anterior angles depressed and rounded, posterior acute; disc densely punctate, without any sign of a medial line, the ordinary basal foveae replaced by longitudinal sulci. *Scutellum* large, semi-circular, punctate. *Elytra* ovate, of same width as prothorax at base, each with about 9 sulci containing small, elongate punctures at the base of each sulcus, the intervals steeply convex between these and themselves covered with small punctures. *Dimensions*: $4\frac{1}{2}$ x 2 mm.

Hab.—Cairns District (H. P. Dodd).

A single male was amongst some beetles received from the veteran collector from a region that seems to produce endless species. It is of the general shape and size of *P. striatum* Montr., but differs widely from that species in its densely punctate, sub-opaque surface, and its costate elytral intervals. Type in Coll. Carter.

PTEROHELAEUS ASSIMILIS, n.sp.

Ovate, moderately convex, nitid black, antennae and legs red.

Head minutely punctate, eyes widely separated, antennae with four apical joints transverse. *Prothorax* very transverse, widest at base, thence arcuately and strongly narrowed to apex, anterior angles prominent but rounded at tips, posterior acute, disc microscopically punctate with marked transverse depression near base, besides small basal foveae, foliate margins wide and slightly concave within. *Scutellum* transverse, semi-elliptic. *Elytra* of same width as prothorax at base, foliate margins wide at base, gradually narrowing to apex, irregularly seriate punctate with about 15 rows of punctures, uneven in size and unequally spaced, those near suture small, the punctures greatly increasing in size outwards, the external row containing large, closely-set punctures; the intervals on sutural half not, or scarcely, raised; on lateral half three or four intervals irregularly convex; all intervals smooth and impunctate. Prosternum minutely punctate, a few large punctures round middle coxae, abdomen finely striolate. *Dimensions*: 11-12 x 6-$6\frac{1}{2}$ mm.

Hab.—N. Queensland: Ravenshoe (H. J. Carter).

I took seven examples under decayed fig-tree bark in July, 1921, and at first assumed them to be *P. pusillus* Macl. which is common at Kuranda and which it resembles in general facies. The following comparison is desirable for distinguishing the two species:—

P. pusillus Macl.	*P. assimilis*, n.sp.
Less nitid, more oval and convex.	More nitid and oblong.
Antennal club of 5 joints.	Club of 4 joints.
Elytra, with geminate series of nearly equal sized punctures between convex intervals, the alternate intervals costate.	Punctures uneven in size and position, intervals of equal width—except near sides, where some irregularly raised and wider intervals occur.

P. asellus Pasc. is also allied, but its surface is more opaque than that of *P. pusillus*, the elytra have finer but regular seriate punctures, the alternate intervals are wide but not raised. Types in Coll. Carter.

PTEROHELAEUS HACKERI, n.sp.

Elongate-oblong, parallel, convex laterally, sub-nitid black above, nitid beneath, antennae and tarsi red. Head and pronotum very minutely punctate, the former widest in front of eyes, anterior part nearly flat, epistoma evenly rounded, eyes large and separated by a distance less than lateral diameter of one; antennae with joint 3 shorter than 4-5 combined, 3-7 obconic, 9-10 round, 11 bluntly oval. *Prothorax* 4 x 9 mm. (length measured in middle), anterior angles rounded, posterior acutely produced, sides arcuately converging from base to apex, foliate margins widely horizontal, extreme border very fine; disc with smooth medial line feebly channelled at base, two large basal and two faint lateral depressions. *Scutellum* widely triangular. *Elytra* 15 x 9 mm., each with 17 rows of round punctures (about as large as in *P. walkeri* Br.) besides a small scutellary row, the extreme lateral row faint and irregular; also 8 smooth, nitid costae, the 2nd, 4th and 6th more prominent than the rest, the sutural interval wide and nitid; lateral margin moderately wide (as in *P. elongatus* Macl.) and continuous to apex. Submentum finely punctate, abdomen longitudinally strigose, the rest of underside smooth. *Dimensions*: 20 x 10 mm.

Hab.—Tambourine Mt. and National Park, Queensland (H. Hacker).

Two examples, both, I think, male, show a convex species belonging to Macleay's Sect. ii., Sub-Sect. i., most nearly allied to *P. opacus* Cart. but differing in its more nitid surface, parallel form, the finely punctured head and pronotum, the elytral punctures regular throughout (not confused at base; smaller, but not obliterated, at apex). Type in Queensland Museum.

Since my revision of this group in 1910, the following additions have been described:—*P. cylindricus* Cart., *P. opacus* Cart., *P. darlingensis* Cart. and *P. oblongus* Cart., besides the above species, bringing the total number of the section to 15.

PTEROHELAEUS PERSCULPTUS, n.sp.

Moderately elongate, depressed, nitid black, antennae and tarsi red.

Head coarsely rugose-punctate, widest in front of eyes, epistoma straight in middle, thence obliquely widening to the canthus, eyes rather small, widely separated by space about twice the diameter of one; antennae having 4 apical joints considerably widened, 8-11 nearly round, 9-10 oblate-spheroidal. *Prothorax* 3 x 8 mm., the horizontal foliation occupying one half the width; widest near base, anterior angles widely rounded, posterior acute, though blunted at tip, extreme border moderately thick and reflexed, sides rather widely rounded without sinuation; disc clearly, not closely, punctate with wide, light basal depressions, medial line only indicated feebly at base. *Elytra* two and a half times as long as prothorax, sub-parallel, foliate margins horizontal and wide at base, narrowing to apex, with 16 rows of large, closely set punctures, besides a short scutellary row; those in row near suture showing a tendency to confluence, those in extreme lateral row very large and irregular; some confused punctures in humeral region; intervals narrow, forming mere separating lines between the series, the alternate intervals sub-costate (this more obvious towards apex). Submentum rugose, prosternum finely strigose, abdomen finely and sparsely punctate. *Dimensions*: 17 x 8 mm.

Hab.—Australia.

A single specimen in the Queensland Museum is labelled "No. 3455 Relton Bequest," without locality label. It is a very distinct species, in form somewhat between the elongate species (Sub-Sect. i) and the shorter species (Sub-Sect. iii) of Macleay's Sect. ii. Its most prominent characters are the widely horizontal margins of the prothorax and the strongly sculptured elytra, on which the seriate punctures occupy nearly the whole surface. Type in Queensland Museum.

NYCTOZOILUS CARLOVILLENSIS, n.sp.

Oblong-ovate opaque, brownish black, head and pronotum, in places, with short, decumbent, golden hair, tarsi with golden tomentum, tibiae of male also tomentose within.

Head and pronotum densely and finely punctate, epistoma truncate with oblique sides, a straight sulcus separating the forehead, the latter lightly depressed along the middle, antennae about reaching base of prothorax in ♂, shorter in ♀, joint 3 as long as 4-5 combined, 8-10 flattened and nearly round, 11 oval, longer than 10. *Prothorax* 5 x 6.5 mm., widest at middle, arcuate-emarginate at apex, anterior angles a little produced, acute (about 80°) with blunted tip, sides well rounded, strongly sinuate before the sharply dentate posterior angles, these pointing obliquely outwards, raised border moderately wide at sides, narrower in front of anterior angles and abruptly terminating there, basal border very narrow; foliate margins a little concave and wrinkled; disc transversely depressed near base, a smooth medial line with a shallow fovea on each side of this. *Scutellum* transverse and raised. *Elytra* rather widely oval, wider than prothorax at base and about twice as long; coarsely reticulate, with three nitid, undulate costae generally becoming indistinct and merged into the reticulation on apical half, suture also costate, the spaces within the reticulations coarsely pitted and bearing a few golden hairs; prosternum hardly perceptibly punctate, abdomen strigose, with the two apical segments punctate. *Dimensions*: ♂. 17 x 9 mm., ♀. 17 x 10 mm.

Hab.—Queensland: Charleville (P. Franzen).

Three examples (2 ♂, 1 ♀) have been sent for determination from the Queensland Museum. The species is near *N. reticulatus* Bates in sculpture but differs in the following details:—Size smaller, the prothorax with all angles sharper, especially in the strongly dentate hind angles, the extreme border narrower, disc more finely punctured. Types in the Queensland Museum.

N.B.—My examples of *N. reticulatus* Bates—compared with type—from Guntawang, Cootamundra and Young, N.S.W., are larger than in the author's description, their dimensions being 19-20 x 10-11½ mm.

PROPHANES BREVICOSTATUS, n.sp.

Elongate-ovate, convex; subnitid coppery bronze above, underside more brilliant, the depressed areas on upper surface clothed with short pale hair.

Head flat, labrum very prominent, closely and coarsely punctate, distance between eyes equal to the diameter of one eye; antennal orbit raised and forming a right angle with sides of epistoma, antennae thin, extending beyond base of prothorax, the two apical joints wider than rest, joint 3 one and a half times as long as 4; 4-7 subequal, 8-11 successively shorter. *Prothorax* with surface depressed and uneven; base and apex bisinuate, the anterior angles forming acute teeth pointing nearly directly forward and upward, posterior angles also dentate pointing obliquely outwards, sides slightly rounded in middle, sinuate in front and behind, disc coarsely punctate, more sparsely in middle, more thickly at sides, with a deep transverse depression in middle, connected with two wide depressions near apex, a wide, shallow depression near each side. *Scutellum* large, triangular and nitid. Elytra wider than prothorax at base, very convex on basal portion, sides widening behind the rounded shoulders, then sinuately narrowed at middle, apex of each elytron dentate; lateral margins narrow and occupied by a row of large punctures; disc coarsely, rather closely punctate-rugose in places, with an uneven surface resulting from (1) raised areas, (2) depressions, the former consisting of three abbreviated costae on each elytron, the first near suture extending from base to less than half way, the second half as long as the first, intermediate between the first and the humeral callus, the third (rather a longitudinal hump than a costa) half way between suture and side, extending from the middle for about 6 mm. backwards, the suture also compressed and raised near scutellum and the humeral callus very prominent. All raised areas nearly smooth and paler in colour than the rest. The depressions, chiefly three on each elytron, as follow:—the first basal, between the suture and the first costa, the second medio-lateral, the third pre-apical; the rugose spaces chiefly near sides, the general punctures sub-obsolete near apex. *Submentum* and prosternum closely, meso- and meta-sternum sparsely, epipleurae very coarsely punctate; abdomen finely punctate and rather thickly clothed with adpressed golden hairs. Profemora carinate on inside, the carina terminating in a fine compressed tooth on apical third, front basal tarsi enlarged. *Dimensions*: 25 x 11 mm.

Hab.—Kuranda, N. Q'land (H. P. Dodd).

Two males under examination are near allies to *P. browni* Cart., but differ in the following details *inter alia*: (1) more convex form, (2) coarser sculpture and the presence of elytral costae, (3) pilose surface and absence of metallic lustre, (4) more widely set eyes. Type in Coll. Carter.

Cardiothorax pithecius Pasc. Mr. R. Illidge has lately called my attention to the distinction of this species from *C. errans* Pasc., which I have stated to be synonymous. He has further supplied me with material that I consider bears out the details given by Pascoe as to this distinction. The following comparison shows the differences:—

C. errans Pasc.	*C. pithecius* Pasc.
Colour. Nitid coal-black.	*Elytra* sub-nitid coppery brown black.
Prothorax. Widest near middle, wider than elytra, latero-dorsal groove distinct.	Widest before middle, narrower than elytra, latero-dorsal groove obsolete.

The pronotum of *errans* is more convex and wider than that of *pithecius*, the foliation of the latter being narrow and horizontal, without any sign of a separating sulcus, as seen in some examples of *errans*. I have four examples of *pithecius* from Pine Mountain, Wide Bay and Brisbane, while 15 examples of *errans* are before me from Brisbane and Acacia Creek (within the N.S. Wales border, 7 miles from Killarney, Q'land).

Cardiothorax australis. I have confused two species under this name. Before me are two examples of a *Cardiothorax* from the Victorian Alps that is clearly distinct from *australis*—the types of which came from the Kosciusko district, N.S. Wales—that is described below. *C. australis* is figured in Text-fig. 11.

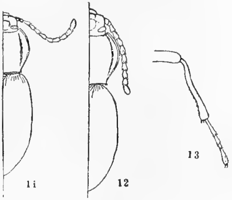
CARDIOTHORAX VICTORIAE, n.sp. (Text-fig. 12.)

Elongate ovate, nitid dark bronze, antennae stouter, the joints longer than in *C. australis*.

Prothorax more widely rounded at sides, the greatest width farther forward, the anterior angles wider, the posterior tooth outwardly directed, finer and smaller than in *C. australis*. *Elytra* with shoulders sub-obsolete, each with six well cut sulci, besides a narrow lateral stria. *Dimensions*: 14-15 x 4-4½ mm.

Hab.—Victoria Mts.: Wood's Point (H. J. Carter); St. Bernard's Hospice (T. G. Sloane).

A narrow, very nitid species allied to *australis* and *aureus* Carter, but distinguished from the former by the more robust antennae, structure of the thorax (especially of the posterior teeth), and the different elytral striation. (In *C. australis* there are *eight* sulci, besides the lateral stria, on each elytron). *C. aureus* is a wider, flatter species with prominent humeri, flat elytral intervals, the thorax with wider foliation and narrower border, the posterior tooth wider. Both *australis* and *aureus* have much narrower tarsi on the posterior feet. I can discern no sexual characters, but think that both of my examples are male. Type in Coll. Carter. *C. australis* also occurs in Victoria at Bright, Beechworth, etc.



Text-figs. 11–13.
11. *Cardiothorax australis* Cart.
12. *C. victoriae*, n.sp.
13. Hind tibia and tarsi of *C. flexipes*, n.sp.

CARDIOTHORAX FLEXIPES, n.sp. (Text-fig. 13.)

Elongate ovate, subnitid black, antennae and tarsi fuscous.

Head and *prothorax* very much as in *C. caperatus* Pasc. and *C. tibialis* Cart., the latter arcuate-emarginate at apex, sub-truncate at base, sides well rounded, widest before middle, foliate margins wide, lateral border well raised, separating sulcus well defined, anterior angles obtuse (the tip a little blunted), a short sinuation preceding the dentate posterior angle, the sub-rectangular tooth twisted downward and outward (somewhat as in *caperatus* Pasc.), disc with deep medial sulcus and an elongate sulcus on each side of this. *Elytra* considerably wider than prothorax at base; oval; epipleural fold forming an arched carina at shoulder, each elytron with nine sulci, the 9th a mere stria at the side—intervals forming rounded costae, the 5th and 7th wider than the rest. Hind tibiae bent downwards near base, the inner margin furnished with a few bristly hairs; posterior tarsi with 1st joint considerably longer than the last. *Dimensions*: 19 x 7 mm.

Hab.—N. Queensland: Ravenshoe (H. J. Carter).

I took a single example—probably ♂ from the tibial character noted above—in July, 1921. A large species near *tibialis* and *caperatus*, it differs from both in (1) more ovate, less parallel, form, (2) unequally wide elytral intervals—all intervals wider and more closely set, (3) the tibial and tarsal characters noted above. It is very different from *C. curvipes* Bates—an elongate, polished black species, in which the hind tibiae of ♂ are strongly bent inwards. Type in Coll. Carter.

ADELIUM VESICULATUM, n.sp.

Oval, convex; nitid black, glabrous, elytra purple, antennae and tarsi reddish.

Head clearly but finely punctate; forehead depressed, antennae robust, extending beyond base of prothorax, joints 3-10 obconic, 3 not quite as long as 4-5 combined, 11 elongate-ovate. *Prothorax* bisinuate at apex, front angles well advanced, obtuse and a little blunted at tip, widest behind middle, foliate margins wide and separated from disc by a foveoid sulcus, sides well rounded, rather abruptly narrowed before the widely rectangular posterior angles; extreme border narrowly raised and feebly crenulate on anterior half; base truncate, disc with close, shallow punctures and some irregular depressions, medial channel clearly marked and emphasized by a small fovea in the middle. *Elytra* ovate and rather strongly convex, wider than prothorax at base, shoulders widely rounded; somewhat abruptly narrowed at apex; very finely striate-punctate, the striae nearest suture straight, the others following the outlines of the intervals, the latter consisting of series of little elongate bladder-like swellings continuous to apex, the 2nd, 4th, 6th and 8th intervals wider than the others and bearing a few large punctures widely separated. Underside smooth, or nearly so, intercoxal process widely and rather squarely oval; the male with the 4th tarsi on front feet rounded and flattened. *Dimensions*: ♂. 11 x 4½ mm., ♀. 12 x 5½ mm.

Hab.—North Queensland: Kuranda (H. J. Carter), Malanda (Mr. G. F. Hill).

Four examples are before me, three taken by myself under dead leaves, the fourth taken by Mr. Hill, of the Institute of Tropical Medicine, Townsville.

The species is unique in sculpture and cannot be confused with any other. In general structure it is nearest to *A. geminatum* Pasc. and *A. barbatum* Cart.

SEIROTRANA TUMULOSA, n.sp.

Oblong-oval, depressed; nitid dark bronze above, nitid black beneath, palpi, apical joints of antennae and tarsi rufo-piceous.

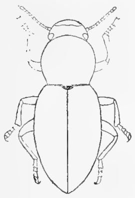
Head rather coarsely punctate, a raised circular impression on forehead; antennae short, moniliform, apical joint longer and wider than tenth. *Prothorax* sub-truncate at apex and base, widest at middle, all angles obtuse but defined, sides rather widely rounded, a little sinuate before the posterior angles, without lateral foliation; extreme border narrow, disc closely covered with fine punctures, with a few large punctures irregularly placed. *Scutellum* very small and transverse. *Elytra* wider than prothorax at base and closely adapted to it, flat, shoulders rather square, the epipleural fold sharply raised in this region, forming a continuation of lateral border evident from above throughout; punctate-striate, the striae clearly cut, the punctures close, round and regular, the 3rd, 5th, 7th and 9th intervals consisting of a succession of feebly raised tumuli, or elongate pleats, marked off by a puncture between each pair—these punctures of about the same size as those in the striae and about six on an interval; the 2nd, 4th and 6th intervals narrower than the former, flat and unpunctured; the sutural interval also flat but bearing three or four punctures; sides of prosternum and epipleurae of elytra with large scattered punctures, the rest of underside smooth except for the finely punctate apical segment of abdomen. *Dimensions*: 10-11 x 4 mm.

Hab.—North Queensland: Herberton (H. J. Carter).

I took ten examples of this distinct species under dead boughs of *Eucalyptus citriodora,* sometimes in company with *Adelium barbatum* Cart., during my visit in June, 1921. It is distinguished by its combination of unusually nitid surface, flat form and feebly raised elytral impressions, which, however, are wider than the costiform studs in *S. repanda* Pasc. and others, occupying the whole width of the interval. It belongs to the second group of my tabulation in which the edge of pronotum is entire, and the disc contains large punctures scattered amongst the finer ground punctures. The males are smaller and narrower than the females and have the fore tarsi enlarged. Types in Coll. Carter.

OMOLIPUS OVATUS n.sp. (Text-fig. 14.)

Elongate bi-ovate, the whole surface and appendages nitid dark blue, tarsi rufo-tomentose beneath, apical joints of antennae sub-fuscous.



Text-fig. 14.
Omolipus ovatus, n.sp.

Head minutely punctate, clypeal suture sinuous. *Prothorax* convex, ovate, apex arcuate and gibbous in middle, base truncate, sides widely and evenly rounded, posterior angles widely obtuse, surface polished and impunctate, the narrow lateral margin unseen from above, basal margin forming a minute tooth at side. *Scutellum* transverse and short. *Elytra* elongate obovate, sulcate-punctate, each with eight sulci, containing a chain of elongate, contiguous, oval punctures that form crenulations on the sides of sulci, the scutellary row represented by a single large puncture, the narrow horizontal margin more vaguely crenulated by punctate impressions; meso-sternum concave and moderately long, minutely punctate, abdomen smooth. *Dimensions*: 11½-14 x 4½-5½ mm.

Hab.—Mondrain Island, Recherche Group, S.W. Aust. (Messrs. Grant and Wright).

Two examples are amongst the insects collected on the recent expedition organized by Mr. H. L. White, led by Mr. Basset Hull. The smaller example is labelled *"no data,"* but is a fresh specimen differing only in size from the other. The species is quite distinct by the following combination of characters:—elongate bi-oval form, sulcate elytra with its series of large elongate punctures, and dark appendages. In my table (These Proc., 1915, p. 535) it should come before *O. cyaneus* Pasc. Types in Australian Museum, Sydney.

CISTELIDAE.

EUCISTELA, n. gen.

Maxillary palpi long, apical joint subulate, mandibles simple, antennae rather short, joints 1, 2, oval, (1 very tumid), 3 obconic, 4-10 cupuliform, of about the same length as 3 but successively wider, 11 elongate ovate, considerably longer than 10; all joints bearing many short bristles and a few long setae. Eyes hemispherical and prominent, entirely lateral (widely separated above and below in both sexes); prothorax subcordate, at its widest wider than the head; truncate at apex and base, lateral carina sub-obsolete (unseen from above); scutellum large, semi-circular; elytra much wider than prothorax and nearly five times as long as it, sub-parallel (or feebly elongate elliptic) and rather flat; in some examples (? ♀) shorter than the body; four hind feet with 2 penultimate joints lamellate, unilamellate on fore feet; claws pectinate; body winged.

A genus quite unlike any other known to me, but probably nearer *Neocistela* Borch. than any other, but clearly separated from it and allied genera by the combination of subulate palpi, cupuliform antennae, the curiously formed prothorax and irregularly punctate elytra. The prosternal episterna apparently enclose the front coxae, which are sub-contiguous. It is the smallest Cistelid of group i. (of my Revision) and all the specimens are mounted on cards. With such fragile insects I am unwilling to reset them for closer inspection.

EUCISTELA CYANEA, n.sp.

Elongate-elliptic, brilliant metallic blue, oral organs, antennae and legs black, the antennae opaque, legs nitid, upper surface with sparse long upright hairs.

Head produced into a beak, the wide forehead with a few large setiferous punctures. *Prothorax*: apex of same width as forehead between eyes, thence obliquely widened, strongly rounded at its widest (well behind middle), then rather abruptly narrowed with a sinuation before the base, the latter clearly narrower than apex; front angles obsolete, hind angles obtuse; basal border narrow; disc with a few large scattered punctures, those near sides bearing long setae; a deep transverse impression near base and a few other irregular depressions. *Elytra*: humeri rather squarely rounded, slightly widened beyond the middle; irregularly punctate, each puncture bearing a long upright hair; underside sparsely and lightly punctate, with pale decumbent hairs on sides of abdomen, legs of moderate length. *Dimensions*: $3\frac{1}{2}$-4 x $1\frac{1}{2}$-$1\frac{3}{4}$ mm.

Hab.—North Queensland: Cairns District (H. P. Dodd).

Six specimens of this interesting little novelty were received from Mr. Dodd. I have not been able clearly to differentiate the sexes. Type in Coll. Carter.

CHROMOMOEA VIOLACEA, n.sp.

Elongate, parallel; above and below a rich violet colour, oral organs, antennae, legs and tarsi testaceous, base of femora infuscate.

Head densely punctate on epistoma, striolate on forehead; antennae: joint 1 bulbous, 2 bead-like, 3-10 linear-triangular, successively shorter than preceding, 11 as long as 10, ovate-acuminate. *Prothorax* of same width as head, longer than wide, apex produced in middle, base truncate, sides parallel, covered with close, shallow punctures, medial sulcus impressed throughout, terminating behind in a large oval depression. *Scutellum* transversely oval, bilobed. *Elytra* considerably wider than prothorax at base, shoulders squarely rounded, sides parallel till near apex, then rather bluntly rounded; striate-punctate, each elytron with eight wide striae containing close, confused punctures separated by transverse striolae, the wide convex intervals similarly and closely striolate, the fifth interval narrower than the rest. Underside glabrous and nearly impunctate, mesosternum with fine, shallow punctures; apical segment of ♂ depressed in middle, legs unarmed in both sexes. *Dimensions*: $13\frac{1}{2}$-15 x 4-$4\frac{1}{2}$ mm.

Hab.—New South Wales: Barrington Plateau (T. G. Sloane).

Six specimens were taken in December by Mr. Sloane in the Mt. Royal Range. The colour precludes confusion with any other Cistelid except *Anaxo fusco-violaceus* Fairm., which is only 8-9 mm. long, with dark legs and tarsi, apex of tibiae piceous, and elytral intervals flat. In general form *C. violacea* comes near *C. rufescens* Bates. Type in Coll. Carter.

HOMOTRYSIS TORPEDO, n.sp.

Elongate narrow, navicular; chocolate brown, nitid, sparsely pilose, antennae and tarsi red.

Head clearly punctate, eyes large and prominent, sub-contiguous in ♂, more widely separated in ♀, antennae very long, joints linear, 3-4 longer than the rest, 5-10 more or less equal in length, joints near apex feebly widened in front, 11 narrower than 10. *Prothorax* widest at base, arcuately converging anteriorly, apex produced forward in middle, anterior angles quite rounded off, posterior sub-rectangular, base feebly bisinuate, disc rather coarsely and closely punctate, basal foveae small, without medial line. *Scutellum* semi-circular. *Elytra* a little wider than prothorax at base and more than three times as long, striate, intervals convex and coarsely punctate, about two lines of punctures occupying each interval, the striae apparently without punctures. Pro-, meso- and meta-sternum coarsely punctate, abdomen nearly smooth, the apical segment in male deeply sulcate, the forcipital process extruded. *Dimensions*: ♂. 13 x 3½, ♀. 13 x 4 mm.

Hab.—Queensland: National Park (Mr. H. Hacker), Caboolture (Mr. E. Wilson).

Six examples (2 ♂, 4 ♀) show a species near *H. macleayi* Borch. (*Allecula flavicornis* Macl) but even more narrowly elongate than it, besides having dark legs. The short upright hairs are most evident on pronotum, the sides and apex of elytra, and legs. Types in the Queensland Museum.

METISTETE SUB-OPACA, n.sp.

Narrowly obovate; sub-opaque black, palpi, tarsi, basal half of femora, apex of tibiae, basal joints of antennae testaceous, upper surface with short dark bristles, besides a few long pale hairs at sides of pronotum and elytra.

Head and pronotum coarsely, sub-confluently punctate, eyes rather widely separated (by a space nearly the diameter of an eye in ♂, more widely in ♀) antennae very long, slender and lineate, joints 3 and 4 equal, each longer than the succeeding, 5-11 successively a little shorter and wider than the preceding. *Prothorax* very convex, truncate at apex and base, sides well rounded, a little straighter towards base than towards front, lateral margin not seen from above, basal border very narrow, disc with a slight depression at middle near base and two small transverse basal foveae, posterior angles obtuse. *Scutellum* small, transverse. *Elytra* of same width as prothorax at base and more than thrice as long, widest behind middle; striate-punctate, the punctures in striae small and regular, placed at a distance of the diameter of one; intervals lightly convex and finely punctate; under a strong lens about 3 rows of distant punctures to be seen on each interval. Abdomen finely transversely striolate, tibiae curved. *Dimensions*: 9-10 x 3-3½ mm.

Hab.—North Queensland: Herberton (H. J. Carter).

Seven examples (4 ♂, 3 ♀) were taken under dead Eucalyptus boughs, in company with *Dimorphochilus pascoei* Macl. The species is superficially like *Homotrysis pallipes* Cart. but the wingless, obovate body, short metasternum and different elytral sculpture are at once seen on closer inspection. The male examples are narrower than the females and show the usual forcipital process. Types in Coll. Carter.

NOTOCISTELA DISPAR, n.sp.

Ovate; head and prothorax dark bronze, elytra coppery bronze, subnitid; oral parts, antennae and legs red.

Head densely punctate, eyes large, prominent and widely separated, antennae very slender, joints 3-11 subequal in length but slightly successively stouter. *Prothorax* convex and ovate, truncate at apex and base, all angles rounded off, lateral margins not seen from above, disc very densely and uniformly punctate, without medial line or foveae; very sparsely setose. *Elytra* convex and narrowly elliptic in ♂, wider in ♀; of same width as prothorax at base; finely seriate punctate, intervals flat, the 1st, 3rd, 5th and 7th bearing small round setiferous pustules, larger and more pronounced towards sides and apex; abdomen sparsely punctate, tibiae slender, the fore and mid-tibiae of ♂ armed with a small tooth on inside near middle, post-tibiae straight and unarmed, the front tarsi of ♂ enlarged. In the ♀ all tibiae unarmed. *Dimensions*: ♂. 6 x 2 mm., ♀ 9 x 3 mm.

Hab.—Ooldea, South Australia (Mr. J. A. Kershaw).

Mr. Kershaw has sent me four examples, two of each sex of this species—the third of an interesting genus—which he took in this arid region where, as he says, "every beetle obtained is well earned." It is distinguished from *N. tibialis* Cart. by colour, size (especially in the marked sexual disparity), antennae, straight post-tibiae of male, the pustulose 1st interval of elytra, *inter alia*. Types in National Museum, Melbourne.

NEW GYRODACTYLOID TREMATODES FROM AUSTRALIAN FISHES, TOGETHER WITH A RECLASSIFICATION OF THE SUPER-FAMILY GYRODACTYLOIDEA.

By Professor T. Harvey Johnston, M.A., D.Sc., and O. W. Tiegs, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

(Plates ix.-xxii., and one Text-figure.)

[Read 26th April, 1922.]

Australian Trematodes have received considerable attention from certain parasitologists, among whom are to be mentioned especially S. J. Johnston and W. Nicoll. These authors, however, have confined their attention almost entirely to digenetic species. Of the monogenetic forms no Gyrodactylid has so far been recorded from Australia; indeed, only two species have been described from the Southern Hemisphere, viz. *Fridericianella ovicola* Brandes and *Lophocotyle cyclophora* Braun from South America. A considerable number of forms are known from central Europe, mainly as a result of the work of van Beneden and Hesse, Wagener, Perugia and Parona, Diesing, Creplin, Wegener and a few others. A number of species have been discovered in North America, most of them by MacCallum, while Goto has recorded a few from Japan.

In the present paper seventeen new species are described, all from the gills of Australian marine and freshwater fishes. As was to be expected, these were found, with two exceptions, to be generically quite distinct from any hitherto described. Some have proved to be so remarkable that they must fall into a new family (*Protogyrodactylidae*), whilst others cannot be included in any of the other known subfamilies, as defined by various authors. This has made possible a considerable extension of our conception of this group of Heterocotylean Trematodes and the opportunity has been taken to suggest a reclassification of the group and to incorporate, and to a certain extent rename, some remarkable species described by MacCallum from North America. This matter has been rendered very difficult by the imperfect accounts of some of the forms; indeed, so many essential characters have been omitted from these descriptions, that it has been found necessary, occasionally, merely to append certain genera to certain subfamilies or families from which they may have to be removed when our knowledge of them is more complete.

With the exception of two new species, one assigned to *Monocotyle* and the other to *Calceostoma,* all the new Australian forms described in this paper fall into new genera; indeed most of the species considered are so distinct from one another that they have had to be regarded as new generic types. Since only a relatively small number of host-species was examined for the presence of these trematodes, and as the parasites were often present on the gills, especially in the freshwater forms, in enormous numbers (sometimes as many as a dozen on a single minute gill-filament), it seems that this group, if more extensively investigated, will be found to be exceedingly well represented in our waters, the existence of such an array of monotypic genera being scarcely likely.

An interesting result of the work is the establishment of a totally distinct and sharply defined subfamily, *Lepidotreminae,* to include certain genera found on fishes in the freshwater rivers of Central Queensland (inland drainage system) as well as closely allied genera occurring on our marine fishes.

Though the rivers of Central Queensland now belong to an extensive inland drainage system, they formerly had a communication with the ocean. Mr. A. McCulloch, Zoologist to the Australian Museum, Sydney, with whom we discussed this matter, drew our attention to the fact that all Australian freshwater fishes belong to families which are essentially marine, e.g. most of them belong to the perch family (*Serranidae*), others to the *Atherinidae, Mugilidae,* etc., while the catfishes belong to the *Plotosidae* (*See* Tate Regan, Proc. Zool. Soc. Lond., 2, 1909, p. 770, footnote).

Of course there is a large anadromous fish population, e.g. species of *Galaxias, Anguilla,* gobies, mullets, etc., but we have not yet systematically searched members of these groups.

We might point out that almost the whole of the freshwater material dealt with in this paper came from the Thomson River at Longreach, Central Queensland,—a tributary of Cooper's Creek; and most of the remainder from the Upper Burnett River which flows into the Pacific. Both collections were made by Miss M. J. Bancroft, B.Sc., whilst engaged in an attempt to ascertain the cause of widespread mortality of fish in Queensland waters (Johnston and Bancroft, 1921).

The types of all the new species described in this paper have been deposited in the Australian Museum, Sydney.

In the present paper there are proposed one new superfamily (*Gyrodactyloidea*); one new family (*Protogyrodactylidae*); five new subfamilies (*Protogyrodactylinae, Lepidotreminae, Merizocotylinae, Dionchinae, Protomicrocotylinae*); and seventeen new genera or subgenera. Of the latter, five are based on species described by G. A. MacCallum from North American fish, while the other twelve are founded on new species described in this paper as infesting Queensland fish.

These twelve, with their type species, are as follows:—*Protogyrodactylus* (*P. quadratus*); *Trivitellina* (*T. subrotunda*); *Anchylodiscus* (*A. tandani*); *Haliotrema* (*H. australe*); *Daitreosoma* (*D. constrictum*); *Empleurosoma* (*E. pyriforme*); *Lepidotrema* (*L. therapon*); *Flabellodiscus* (*F. simplex*); *Lepidotes* (*L. fluviatilis*); *Empleurodiscus* (*E. angustus*); *Acleotrema* (*A. girellae*); *Lamellodiscus* (*L. typicus*).

The five new genera proposed for species already known are *Diplectanotrema*—for *Diplectanum pleurovitellum* MacC.; *Empruthotrema*—for *Acanthocotyle raiae* MacC.; *Cathariotrema*—for *Monocotyle selachii* MacC.; *Dionchotrema*—for *Acanthodiscus remorae* MacC.; *Protomicrocotyle*—for *Acanthodiscus mirabilis* MacC. No less than thirty-six genera are herein listed under the new superfamily.

In addition to the seventeen Australian species described as new, fresh names have been proposed for two others described by MacCallum from North American Elasmobranchs, and belonging to the genera *Amphibdella* and *Monocotyle.*

The following table indicates the scheme of classification proposed in the present paper:

Superfamily *Gyrodactyloidea* J. & T.

I. *Protogyrodactylidae*

- *Protogyrodactylinae.*
  - 1. *Protogyrodactylus*
  - 2. *Trivitellina*

II. *Gyrodactylidae*

- i. *Gyrodactylinae*
  - 3. *Gyrodactylus*
  - 4. *Dactylogyrus*
- ii. *Tetraonchinae*
  - 5. *Anchylodiscus*
  - 6. *Ancyrocephalus*
  - 7. **Dactylodiscus*
  - 8. **Diplectanotrema*
  - 9. *Tetraonchus*
  - 10. *Amphibdella*
  - 11. *Haliotrema*
  - 12. *Daitreosoma*
  - 13. *Empleurosoma*
  - 14. *Tetrancistrum*
- iii. *Lepidotreminae*
  - 15. *Lepidotrema*
  - 16. **Flabellodiscus*
  - 17. *Lepidotes*
  - 18. *Empleurodiscus*
  - 19. *Acleotrema*
  - 20. *Lamellodiscus*
- iv. *Merizocotylinae*
  - 21. *Merizocotyle*
  - 22. *Empruthotrema*

III. *Monocotylidae*

- i. *Monocotylinae*
  - 23. *Monocotyle*
  - 24. *Trionchus*
- ii. *Calicotylinae*
  - 25. *Calicotyle*
- iii. *Pseudocotylinae*
  - 26. *Microbothrium*
  - 27. *Pseudocotyle*

IV. *Calceostomidae*

- i. *Calceostominae*
  - 28. *Calceostoma*
  - 29. *Fridericianella*
  - 30. ?*Cathariotrema*
- ii. *Dionchinae*
  - 31. *Dionchus*
  - 32. *Dionchotrema*
  - 33. ?*Anoplodiscus*

V. Appendix (? families)

- *Acanthocotylinae*
  - 34. *Acanthocotyle*
  - 35. *Lophocotyle*
- *Protomicrocotylinae*
  - 36. *Protomicrocotyle*

*Names so marked indicate subgenera of the preceding genus.

TREMATODA HETEROCOTYLEA.

Superfamily *GYRODACTYLOIDEA*, n. superfam.

This superfamily includes certain monogenetic trematodes characterised by the absence of suckers of the ordinary type, although the higher and more specialised members of the group may have structures which function as such.

The organ of attachment to its host is a posterior clasping disc which may or may not be distinctly marked off from the body of the worm. The disc is supplied with a hook apparatus which may reach an extraordinary degree of complexity.

At the anterior end of the parasite (except in the *Monocotylidae*) are masses of glandular tissue, which open on the surface by very characteristic "head organs," or, in the higher members of the superfamily, by a very large number of minute ducts, not concentrated in groups. In the *Monocotylidae* these glands have apparently disappeared.

The mouth leads into a buccal cavity which may be short or fairly long; never very long. A pharynx is always present. An oesophagus may be present or absent. The intestine has one or two limbs, with or without caeca.

Excretory ducts open either at the anterior end or, in some forms, probably at the posterior end.

Eyes may be present or absent. The nervous system consists of a poorly developed brain, below or considerably behind the eyes. A pair of lateral nerves, from which smaller branches arise, are given off from the brain.

The testis is a compact or only slightly lobed organ, single or double, and never lies anterior to the ovary. The vas deferens may be a simple tube hardly expanded into a vesicula seminalis, or it may be widely dilated, sometimes enormously so in the Australian species. A bulbus ejaculatorius may or may not be present. The cirrus may range from a simple chitinous tube to a structure of considerable complexity, while an accessory clasping apparatus may occur.

The ovary may be a branched or unbranched organ, lying either in the midline or asymmetrically. A vagina may be present (single or double) or absent, and there may be a receptaculum seminis connected with it.

Shell-glands may vary from simple glandular thickenings of the ootype, to very prominent glands connected by long ducts with the female duct. The female aperture usually lies immediately behind the male opening, but sometimes at a considerable distance from it, generally laterally. Never more than one egg is present in the uterus. The egg may be laid, or it may be retained in the uterus to develop into a young worm which may, while *in utero,* produce a second generation.

The yolk system may be poorly or strongly developed. In the most primitive members of the group there is a very distinct communication between the yolk system and the intestine in the posterior region of the animal.

The members of the group occur, as far as is known, on the gills, nasal gland, or skin of fishes, both Teleosts and Elasmobranchs.

Key to families of Gyrodactyloidea.

A. a. Glandular structures present on head .. .. B.
   b. Glandular structures entirely absent .. .. *Monocotylidae*
B. a. Ducts from the glands concentrated into distinct "head-organs" .. .. .. C.
   b. Ducts from glands scattered diffusely over part of the head . *Calceostomidae*

C. a. Minute, very robust worms, in which the yolk system has, in addition to the ordinary transverse duct anterior to ovary, at least one posterior transverse duct which communicates with the intestine .. .. .. *Protogyrodactylidae*

b. Slender worms, in which this character of the vitelline system is quite absent .. .. *Gyrodactylidae*

Family I. PROTOGYRODACTYLIDAE, n. fam.

These are primitive, minute Gyrodactyloidea, about as broad as long, with a greatly developed clasping disc bearing two pairs of relatively very large clasping hooks and numerous minor hooks which are rather larger than usual.

The cephalic glands open to the exterior by well-defined head-organs. There is a prominent pharynx. The intestine is bifurcated, the limbs ending blindly or uniting posteriorly. Intestinal caeca absent.

Neither testis nor ovary is branched. There is no vagina. The uterus is very short. The cirrus is a simple chitinous tube, enclosed in a cirrus-sac. The yolk system is very remarkable in that it consists of numerous long thin "yolk-tubes," arranged in two sets, the one anterior, the other posterior, to the ovary. The transverse yolk-ducts so formed are connected by a longitudinal median yolk-duct which opens into the ootype. The posterior transverse yolk-duct has a distinct connection with the intestinal limbs.

Found, so far, only on the gills of freshwater fishes.

Type genus, *Protogyrodactylus* J. & T., 1922.

The family also includes *Trivitellina* J. & T. Should the discovery of other genera belonging to the family necessitate its subdivision, then these two, owing to their close relationship would be included in the same subfamily, *Protogyrodactylinae.*

1. Protogyrodactylus, n.gen.

Protogyrodactylidae, slightly broader than long; the clasping disc very broad, not sharply marked off from the body, strongly "padded," bearing four very large, and twelve minor hooks, the latter rather larger than usual. A very short oesophagus present; the limbs of the intestine not united posteriorly. Four eyes present, lying above the brain. A single posterior transverse yolk-duct connected with the intestine.

Found on the gills of freshwater fishes.

Type species, *Protogyrodactylus quadratus* J. & T.

Protogyrodactylus quadratus, n.sp. (Plate ix., Fig. 1-5; x., Fig. 6.)

The worm is short and thickset, a little broader than long, and about three times as long as thick. Its length is about .23 mm. On account of the wing-like expansions of the sides, the head is distinctly marked off from the body of the animal. Two distinct head-lobes are developed on it.

The disc is very prominent, but is not sharply marked off from the rest of the body, as is indicated in the section on Plate ix., figure 3. It is provided with four hooks, two of which are very large, powerful and strongly curved, the other two somewhat smaller, straighter and more slender. The bases of the hooks are supported by a transverse chitinous bar, articulating with the ends of which are (1) a pair of small pieces of chitin, to which the powerful muscles of the disc become attached in part, and (2) a pair of larger inwardly-directed chitinous pieces. There are also twelve minor hooks, rather larger than usual, ten of which are arranged around the margin of the disc, while the other two are more centrally situated (Pl. x., fig. 6).

The disc has a curiously swollen appearance. In section the swelling is seen to be due to the presence of a mass of peculiar tissue, apparently syncytial in nature, arranged as a number of thick masses vertical to the longitudinal axis of the animal (Pl. ix., fig. 4). This tissue probably acts as a kind of "padding."

The animal is covered with a thin cuticle which undergoes strong chitinisation on the disc. Longitudinal and transverse muscle-layers can be distinguished, the former presenting a marked development on either side of the mid-ventral line and assuming the form of two very large muscles passing from the anterior end of the animal backward to become inserted into the hook apparatus of the disc. The posterior portion of these muscles is further strengthened by the addition of another pair, each member of which passes upward, closely applied to the ovary, to become continuous with the longitudinal muscle-layer on the dorsal side.

The mouth is ventral, but not at the anterior extremity. It leads into a large pharynx which, in turn, opens by a short oesophagus into the intestine. The latter broadens out posteriorly and ends blindly. Into its anterior end, close to the oesophagus, there opens, on either side, a mass of elongated glands. Three pairs of head-organs are also visible at the anterior end, but the corresponding glands could not be seen, probably on account of the large mass of yolk surrounding them. No trace of excretory system could be recognised.

Of the nervous system only the brain was visible. In close connection with this are two pairs of eyes, the anterior being smaller and closer together than the posterior pair. They lie sunk within the body at a distance from the dorsal surface equal to about one-fifth of the thickness of the animal in this region.

The testis is a large triangular organ, situated above and partly behind the ovary, in the mid-dorsal region (Pl. ix., fig. 4). The vas deferens is a short, wide, rather irregularly bent tube, opening into the large transversely-placed vesicula seminalis which is connected by a short duct with the cirrus. The latter is a thin, slightly bent tube, lying in a spacious cavity enclosed by the cirrus-sac. The male opening lies mid-ventrally immediately behind the pharynx.

The ovary is situated slightly anterior to, and below, the testis. The oviduct or uterus is a short wide tube opening close behind the male aperture. The shell-gland is only slightly developed, being merely a glandular thickening of the oviduct. There is no vagina.

The structure of the yolk system is remarkable. There are numerous elongated yolk-tubes which converge in two systems and unite to form two transverse yolk-ducts, one lying in front of the ovary and testis, the other posterior to them. The anterior system arises by the junction of three minor systems on either side, which bring the yolk from the anterior, middle, and more posterior regions of the body.

The posterior transverse duct is formed by the junction of a large number of "yolk-tubes" from the lateral body regions, posterior to the anterior system; into this duct there also open a pair of large yolk-ducts (Pl. ix., figs. 1, 4) which bring the yolk from the dorsal region of the animal. From the middle of the posterior transverse yolk-duct a longitudinal duct is given off, which passes forward beneath the ovary and opens into the ootype. It could not be observed whether the anterior transverse yolk-duct united separately with the ootype, or whether it and the median longitudinal yolk-ducts had a common duct leading into the ootype.

The posterior transverse duct possesses a wide lumen and is very remarkable in that it is connected by a wide opening with the cavity of the intestinal limbs (Pl. ix., fig. 3).*

The uterus does not contain more than one egg. The latter is almost spherical and is provided with a large spine, measuring about .025 mm. in diameter.

Found, generally in pairs, on the gills of *Therapon carbo* Ogilby and McCulloch, and *T. hilli* Castelnau from the Thomson River, Longreach, Central Queensland.

2. TRIVITELLINA, n.gen.

Protogyrodactylidae, rather longer than broad; clasping disc sharply marked off from the body and not strongly "padded," bearing four very large, and twelve minor hooks, the latter rather larger than usual; three pairs of "head-organs"; oesophagus absent; limbs of the intestine united posteriorly; four eyes; beside the anterior yolk system, there are two posterior systems, one of which is connected with the intestine.

Found on the gills of freshwater fishes.

Type species, *Trivitellina subrotunda* J. & T.

TRIVITELLINA SUBROTUNDA, n.sp. (Plate x., fig. 7.)

This minute organism, measuring about .2 mm. in length and .18 mm. in greatest breadth, is a short, thickset parasite with lateral, somewhat wing-like expansion, and, except for the presence of the disc, is almost circular in shape. The posterior two-thirds of the worm generally lie well beneath the surface of the gill-filament, only the anterior third protruding. The disc projects backward and is sharply marked off from the rest of the body, differing in this respect from *Protogyrodactylus*.

The curious "padding tissue" characteristic of the last-named is absent, but seems to be represented by a modified parenchyma present at the posterior end of the animal and consisting of three paired masses, with a smaller mass between them. The anterior masses approach the intestine, while the posterior lie within the disc and are closely related to the small hooks on it.

The disc is proportionally large and its posterior part is ornamented with curious chitin-pieces. Four large hooks are present, the dorsal pair being the smaller, and each of the four is supported by a small chitinous rod, giving the hook a triradiate appearance. The posterior hooks are very large and strongly curved outwards, their bases being connected by a transverse bar. The base of each large hook articulates with a small triangular chitin-piece into which the muscles of the hook are inserted. Each is supplied with a pair of muscles: (1) the longitudinal musculature of the body, which runs forward as far as the pharynx, and (2) a small transverse muscle, which arises from the ventral portion of the disc. The latter is armed also with six pairs of rather large secondary hooks whose distribution is shown on Plate x., figure 7.

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*The presence of a communication between the female system and the intestine has been described by Ijima as occurring in certain monogenetic Trematodes *(Polystomum, Diplozoon, Octobothrium)*. Von Graff found two such connections in the land Planarian, *Rhynchodemus*, and one in *Pelmatoplana;* Bendl (Zool. Anz., 35, 1909, p. 294) found one to occur in the Rhabdocoele, *Phaenocora*, while Haswell discovered a genito-intestinal canal in the Polyclad, *Enterogonia pigrans*.

Professor Haswell has recently drawn our attention to a paper by Merton (Zool. Anz., 41, 1913, p. 413) in which a remarkable organ called "vesicula resorbiens" by him, is described as lying in the wall of the intestine of *Temnocephala semperi*, into which it may apparently open at intervals, the organ communicating directly with the female ducts.

The mouth opens ventrally, some distance behind the anterior end. The long buccal cavity communicates with a pharynx which passes almost vertically upwards so that, in dorsal view, the latter appears spherical instead of ovoid. The pharynx opens postero-dorsally into the intestine which is practically a ring-shaped sinus with a large lumen, lined by a single layer of flattened epithelial cells. At either side of the pharynx is a mass of digestive glands connected with the intestine.

The cephalic glands have undergone a curious change in position owing to the head being flattened transversely and the glands coming to occupy a position at the angles of the head. Their ducts consequently pass, not forward, but inward. Three pairs of head-organs are present. There are two pairs of eyes, situated well within the body-parenchyma, the anterior pair being very small and the posterior more than usually large. The brain could not be distinguished. No trace of excretory system was recognisable. The ovoid testis lies practically in the centre of the animal, and antero-laterally gives off a large uncoiled vas deferens which passes forwards into a transversely-dilated vesicula seminalis. The cirrus closely resembles that of *Protogyrodactylus,* as does also the curious cirrus-sac.

The female genitalia are more difficult to observe. The ovary, which lies below and somewhat in front of the testis, is strongly elongated transversely. The uterus appears to be a short duct with a wide lumen. The nature of the shell-gland could not be definitely made out, but it appears to be merely a glandular thickening of the ootype. The comparatively large spherical egg measures about .05 mm. in diameter and possesses a backwardly directed spine.

The vitellaria are of the *Protogyrodactylus* type, i.e. there are long "yolk-tubes," converging to form transverse ducts. Of these there are three, not two as in that genus, one being situated in front of the ovary and the other two posterior to it. The anterior transverse vitelline duct is formed by the convergence of a very large number of elongated yolk-tubes, occupying the anterior half of the body. Of the posterior yolk-ducts, one is situated ventrally, the other more dorsally. The dorsal posterior transverse duct lies immediately behind the ovary and receives the secretion from two systems of yolk-tubes, a posterior and an anterior, on either side. This transverse duct has a communication with the intestine, similar to that of *Protogyrodactylus.* The ventral posterior transverse duct, which possesses no communication with the intestine, is rather narrower and lies a little behind the dorsal duct. The three transverse yolk-ducts are joined by a common median duct, running below the ovary and apparently opening into the ootype.

Found on the gills of *Therapon fuliginosus* Macleay, from the Thomson River, at Longreach, Central Queensland.

Family II. GYRODACTYLIDAE Van Beneden and Hesse, 1863.—emend. J. & T.

(Syn. *Amphibdellidae* Carus, 1885.)

These are elongated Gyrodactyloidea with well developed clasping disc which may or may not be distinctly marked off from the remainder of the body, and may, in the highest members of the group, bear suckers. The disc bears large and small hooks, sometimes forming a chitinous armature of great complexity.

Cephalic glands are present and always open to the exterior by means of well defined head-organs.

The pharynx may be large or small; the intestine single or with two limbs, with or without caeca. Eyes may be present or absent. Both testis (always single) and ovary are unbranched organs which may be situated laterally or in the midline. The vesicula seminalis may undergo enormous distension. The chitinous penis may be simple or very complex. The vagina may be present or absent, single or double. The vitellaria are never in the form of elongated converging "yolk-tubes" and there is never any connection with the intestine.

Key to subfamilies of Gyrodactylidae.

A. a. Adhesive disc provided with numerous small suckers .. .. . *Merizocotylinae*
b. Disc devoid of such suckers .. .. B.
B. a. Disc provided with a pair (dorsal and ventral) of accessory structures, consisting of concentrically arranged rows of scales or broader lamellae .. .. *Lepidotreminae*
b. Disc devoid of such structures .. .. C.
C. a. Disc with four large hooks .. .. *Tetraonchinae*
b. Disc with two large hooks .. .. *Gyrodactylinae*

Subfamily I. GYRODACTYLINAE Monticelli, 1892.—emend. J. & T.

Gyrodactylidae in which the disc is distinctly marked off from the rest of the body, and bears two large hooks, with fourteen or sixteen minor hooks. Head with very distinct lobes related in position to the head-organs. Eyes present or absent. A prominent pharynx. The intestine bilobed and devoid of caeca; a posterior communication between the limbs present or absent. Ovary and testis unbranched organs. The penis a fairly simple chitinous tube. Accessory copulatory structures may be present. A vagina present or absent.

Found on the gills of freshwater and marine fishes.

3. GYRODACTYLUS Nordmann, 1832.

Gyrodactylinae in which the disc bears two large and sixteen minor hooks. A single pair of head-lobes present; no eyes; intestinal limbs end blindly. Vagina absent; the worm may be viviparous. Gonads situated just behind the middle of the body.

Found on the gills of freshwater fishes.

Type, *G. elegans* Nordm., 1832, from *Cyprinus* and many other European freshwater fish.

The following species belong to *Gyrodactylus*:—*G. elegans* Nordm., 1832; *G. medius* Kathariner, 1894; *G. rarus* Wegener, 1910; *G. groenlandicus* Levin, 1881; *G. fairporti* van Cleave, 1921. *G. gracilis* Kathariner, 1894, is perhaps a synonym of *G. elegans*.

No members of the genus have yet been described from Australia.

4. DACTYLOGYRUS Diesing, 1850.

Gyrodactylinae in which the disc bears two large and fourteen minor hooks, but the large hooks may undergo considerable diminution in size in some species. Four head-lobes. Intestinal limbs (usually ?) communicate behind. Penis generally with an accessory copulatory structure. Vagina probably always present. Gonads situated in, or just behind, the middle of the body.

Found on the gills of freshwater and marine fishes.

Type, *D. auriculatus* (Nordm., 1832) Dies., 1850.

The genus has not yet been recorded from Australia; Goto and Kikuchi (1917) have, however, described a form, under the name *D. inversus*, from Japan.

The following species appear to belong to *Dactylogyrus*:—*D. parvus* Wegener, 1910; *D. difformis* Wag., 1857; *D. fraternus* Wegener, 1910; *D. minor* Wag., 1857; *D. crucifer* Wag., 1857; *D. cornu* Linst., 1878; *D. intermedius* Wegener, 1910; *D. falcatus* (Wedl., 1857) Dies., 1858; *D. alatus* Linst., 1878; *D. sphyrna* Linstow, 1878; *D. similis* Wegener, 1910; *D. fallax* Wag., 1857; *D. macracanthus* Wegener, 1910; *D. amphibothrium* Wag., 1857; *D. anchoratus* (Duj., 1845) Wag., 1857; ? *D. forceps* Leuckart, 1857; *D. gracilis* Wedl., 1861; *D. major* Wag., 1857; *D. malleus* Linstow, 1877; *D. megastoma* Wag., 1857; *D. mollis* (Wedl., 1857) Dies., 1858; *D. siluri* Wag., 1857; *D. tenuis* (Wedl., 1857) Dies., 1858; *D. trigonostoma* Wag., 1857; *D. tuba* Linst., 1878; *D. inversus* Goto and Kikuchi, 1917 (Japan); *D. dujardinianus* Dies., 1850; *D. auriculatus* (Nordm., 1832), Dies., 1850; *D. uncinatus* Wag., 1857.

Subfamily II. TETRAONCHINAE Monticelli, 1903.—emend. J. &. T.

(Syn. *Diplectaninae* Monticelli, 1903; *Amphibdellidae* Carus, 1885.)

Gyrodactylidae with the cuticle devoid of scaly papillae. The disc either sharply constricted off from the body, or merging into it directly. Four large hooks always present. Eyes present or absent. The intestine either a single median tube, or bifurcated, with the limbs ending blindly or joining up behind. Intestinal caeca present or absent.

Testis occasionally, ovary never, lobed. Vagina present or absent. Penis generally simple, occasionally somewhat complex, but never attaining the extraordinary degree of complexity seen in the next subfamily (Lepidotreminae). Occasionally an accessory male copulatory structure present.

From the gills of marine and freshwater fishes.

This subfamily includes the following genera and subgenera:—*Anchylodiscus*, n.gen.; *Ancyrocephalus* Creplin, 1839; *Dactylodiscus* Olsson, 1893; *Diplectanotrema*, n.gen.; *Tetraonchus* Diesing, 1858 (type genus); *Amphibdella* Chatin, 1874; *Haliotrema*, n.gen.; *Daitreosoma*, n.gen.; *Empleurosoma*, n.gen.; *Tetrancistrum* Goto and Kikuchi, 1917.

Key to genera of Tetraonchinae.

A. 1. Body very distinctly constricted near mid-region .. .. B.
2. Body not constricted .. .. C.
B. 1. Testis and ovary in posterior region of body; eyes absent; intestinal limbs not connected behind .. .. *Haliotrema*.
2. Testis and ovary near middle of body; eyes present; intestinal limbs connected behind .. .. *Daitreosoma*.
C. 1. Intestine bifurcated .. .. D.
2. Intestine not bifurcated .. .. *Tetraonchus*.
D. 1. Intestinal limbs provided with caeca .. .. *Tetrancistrum*.
2. Intestinal limbs devoid of caeca .. .. E.
E. 1. Disc connected with body by a distinct petiole, and developed laterally into short processes .. .. *Dactylodiscus*.
2. Otherwise .. .. F.
F. 1. Body rather long and slender; intestinal limbs ending blindly .. .. G.
2. Body robust; intestinal limbs connected behind .. .. *Empleurosoma*.
G. 1. Yolk system confined to a region behind the transverse yolk-duct .. .. *Amphibdella*.
2. Yolk system extending as far as, or almost as far as, the pharynx .. .. .. H.
H. 1. Yolk system consisting of a longitudinal row of separate yolk-glands. *Diplectanotrema*.
2. Yolk system continuous on each side .. .. I.
I. 1. Vagina absent .. .. *Anchylodiscus*.
2. Vagina present .. .. *Ancyrocephalus*.

5. Anchylodiscus, n.gen.

This genus is characterised by the occurrence of four very large hooks on the clinging disc, together with fourteen minor hooks scattered over it. Three pairs of head-organs. Four eyes, the anterior pair farther apart than the posterior. Pharynx large and rounded. Intestinal limbs end blindly. Vesicula seminalis not highly dilated. Testis directly above ovary. Penis a simple chitinous tube. Shell-glands probably simply glandular thickenings of the walls of the oviduct. Vitelline system very well developed. Egg of relatively enormous size.

Found, so far, only on the gills of Siluroid fishes in Queensland.

Type species, *Anchylodiscus tandani* J. & T.

Anchylodiscus tandani, n.sp. (Plate x., figs. 8, 9; xi., figs. 10, 11.)

This parasite is rather small, but thick-set, measuring about .3 mm. in length, .06 to .08 mm. in breadth.

The head-end is indistinctly marked off from the remainder of the animal. The disc (Pl. x., fig. 9), which is very prominent and fairly sharply marked off from the body, is armed with four relatively very large hooks, each slightly bifurcated basally, the bases of each pair of hooks being joined by a simple cross-bar. The edge of the disc is prominently lobed to form partial supports for the larger hooks. Fourteen minute hooks are also present.

Of the body musculature the outer circular and delicate internal longitudinal layers are visible. The longitudinal layer of the posterior end is strongly developed to form the musculature supplying the disc.

Three pairs of head-organs are present. Anterior to the median pair, the "head" possesses a pair of small but distinct lobes. The cephalic glands lie laterally to the anterior pair of eyes.

The mouth appears to open ventrally, but could not be definitely observed. The pharynx is prominent, its anterior portion lying immediately behind the posterior pair of eyes. There is a definite oesophagus of moderate length. The bifurcated intestine ends blindly. Unicellular glands are visible in the pharynx. There is also a pair of prominent glands situated on either side of the oesophagus.

No trace of the excretory system could be recognised. Of the nervous system, only the brain was visible, lying immediately between the eyes. The latter are very large and prominent and are situated in the body parenchyma, immediately below the body wall. Their arrangement differs from that of most other Gyrodactylids in that the smaller anterior eyes are farther apart than the posterior.

The reproductive organs are of a rather simple type. The testis is elongated and lies dorsally to the ovary, reaching from well in front to a short distance behind it. The vas deferens arises from it laterally, passes in the dorsal region of the body almost to the right side, then turns forward, inward and downward to open in the middle line into a large, transversely-placed, reniform vesicula seminalis which lies close behind the pharynx. The more anterior portion of the vas deferens undergoes a slight dilatation a short distance before the permanent vesicula. From the latter the vas deferens passes backward as a rather narrow tube and opens into a small rounded bulbus ejaculatorius, lying at the base of the cirrus. The latter is a simple chitinous tube, bent almost into a complete circle and opening immediately in front of the female aperture.

The ovary lies in the midline, immediately below the testis. It is slightly oval and elongated longitudinally. A vagina is absent. The oviduct leaves the ovary ventrally and travels forward. It has not been observed in whole specimens, but is plainly visible in sections. The shell-glands are represented merely by a glandular thickening in the uterus along its whole length. The vitellarium follows the path of the intestine fairly closely. It is very strongly developed in the posterior region of the worm, where it occupies practically the whole of the body. Transverse yolk-ducts open into the oviduct immediately in front of the ovary. No permanent yolk-reservoir is present.

The egg is of relatively immense size, forcing the other structures in its neighbourhood out of position when it is fully developed (Pl. xi., fig. 11). The intestine becomes bent to one side and the vas deferens appears to be pulled from its lateral position to lie more centrally, close beside the intestine. Posteriorly the egg bears a short blunt spine. The egg figured, which came from a rather small adult, measured .075 mm. in length by .035 mm. in breadth.

Found on the gills of the freshwater jewfish or catfish, *Tandanus tandanus* Mitchell, from the Burnett River, South Queensland.

ANCHYLODISCUS sp.

A worm belonging to this genus was found in very small numbers on the gills of a closely allied catfish, *Neosilurus hyrtlii*, from the Paroo River, Southwest Queensland. No detailed study of its anatomy was possible.

6. ANCYROCEPHALUS Creplin, 1839.

(Syn. *Diplectanum* Diesing, 1858, and other authors; *Tetraonchus* Diesing, 1858, in part.)

More or less elongated Tetraonchinae, in which the disc is not very sharply marked off from the body. Supporting chitinous armature of the disc present or absent. Minor hooks varying greatly in number; occasionally absent, never more than fourteen. Eyes present. Intestine bifurcated, the limbs devoid of caeca and not joining behind. Position of testis and ovary at times in the middle, or in anterior region, or well within the posterior half of body. Testis usually simple but occasionally slightly lobed. Penis simple; accessory copulatory structures at times present. Vagina always present. Vitelline system extending on either side as a continuous gland from the pharynx to the region immediately behind the termination of the intestine.

From the gills of marine and freshwater fishes. Known, as yet, only from Europe and North America.

Type species, *A. paradoxus* Creplin, 1839.

In 1857 Wagener placed a number of new species in the genus *Dactylogyrus*, a procedure which has led to considerable confusion in the nomenclature of this group. One species, *D. aequans* Wagener, 1857, was made, in the following year, the type of a new genus *Diplectanum* by Diesing, who also placed *Dactylogyrus pedatus* Wagener in this genus. Wagener, at the same time (1857), described under the name *Dactylogyrus unguiculatus*, a worm which proved to be identical with *A. paradoxus* Creplin, and added another species, *Dactylogyrus monenteron*. Diesing, in 1858, placed these two forms, as well as *Gyrodactylus cruciatus* Wedl., in a new genus, *Tetraonchus*, failing to recognise the identity of *T. unguiculatus* with Creplin's original species (*A. paradoxus*). It was not till 1889 that Monticelli showed these two forms to be the same. The name was however not altered till Lühe (1909) reintroduced that of Creplin. In 1889 Parona and Perugia added Wagener's *Dactylogyrus echeneis* to *Diplectanum.*

In 1910 Wegener removed *T. monenteron* from *Tetraonchus,* owing mainly to the character of its intestine, proposing for its reception a new genus, *Monocoelium.* Of the three original species of *Tetraonchus, T. cruciatus* is now definitely placed under *Ancyrocephalus*; *T. unguiculatus* is identical with *A. paradoxus* of Creplin; hence, as suggested by Stiles and Hassall (1908, p. 370), *T. monenteron* becomes by elimination the type of the genus *Tetraonchus,* Wegener's name (*Monocoelium*) being a synonym.

The remaining species listed under *Tetraonchus* and *Diplectanum* belong to *Ancyrocephalus.*

Lühe uses the latter term in a wide sense to include both *Tetraonchus* (of authors) and *Monocoelium.*

MacCallum (1915, 1917) described a number of new species of *Diplectanum* which he regarded as a subgenus of *Tetraonchus,* i.e. *Ancyrocephalus.* Monticelli (1903) on the other hand, actually proposed a new subfamily, *Diplectaninae,* for the reception of the genus, regarding it as quite distinct from his *Tetraonchinae.*

So far as we have been able to observe from the available published accounts of MacCallum and of the earlier workers, no anatomical distinction of generic value can be recognised amongst the various species included under *Ancyrocephalus* and *Diplectanum.*

The genus *Ancyrocephalus,* as defined above, would include *A. paradoxus* Creplin, 1839; *A. cruciatus* (Wedl., 1857) Lühe, 1909; *A. vanbenedenii* (Par. and Per., 1890) J. and T., 1922; *A. aequans* (Wag., 1857) J. and T., 1922; *A. echeneis* (Wag., 1857) J. and T., 1922; *A. pedatus* (Wag., 1857) J. and T., 1922; *A. sciaenae* (Ben. and Hesse, 1863) J. and T., 1922; *A. teuthis* (MacCallum, 1915) J. and T., 1922; *A. lactophrys* (MacCallum, 1915) J. and T., 1922; *A. balistes* (MacCallum, 1915) J. and T., 1922; *A. longiphallus* (MacCallum, 1915) J. and T., 1922; *A. tylosuri* (MacCallum, 1917) J. and T., 1922.

7. Subgenus a. DACTYLODISCUS Olsson, 1893.

Small *Tetraonchinae* in which the disc is connected to body by a long petiole, and is produced laterally into a number of finger-like processes. Minor hooks apparently absent. Four eyes present; intestine probably bifurcated. Testis and ovary solid and near the middle of the animal. Large unlobed vesicula seminalis. Penis apparently simple. Opening of oviduct probably provided with hooklets. Anterior fifth of worm devoid of vitellaria.

Olsson did not mention the characters of the genus very fully, nor did he indicate whether a vagina was present. The above diagnosis is based on his figures and description of the type species.

The accentuated constriction of the disc from the body, a condition which is already evident in *Ancyrocephalus tylosuri* (MacCallum, 1917), and the irregular lobes of the disc, an indication of which is seen in the same species, are characters which are scarcely of generic value. A careful determination of the presence or absence of the vagina would be of much greater value. The form, however, probably deserves to rank as a subgenus of *Ancyrocephalus.* Monticelli (1903, p. 336; 1905, p. 79) quoted Olsson's genus as a synonym of *Tetraonchus.*

From the gills of *Thymallus vulgaris* and *Coregonus lavaretus.*

Type species, *Ancyrocephalus* (*Dactylodiscus*) *borealis* Olsson. Known only from Sweden.

8. Subgenus b. DIPLECTANOTREMA, n.subgen.

[Syn. *Diplectanum* (in part).]

A small worm, having the usual characteristics of *Ancyrocephalus*, but differing in the very remarkable disposition of the vitellaria, which are arranged in the form of numerous separate yolk-glands along the whole of the length of the body. Ovary and testis situated in anterior quarter of the animal.

From the gills of the marine fish *Teuthis hepatus* and *Anisotremus virginicus*. Known only from the United States.

Type species, *A.* (*Diplectanotrema*) *pleurovitellum* (MacCallum, 1916).

9. TETRAONCHUS Diesing, 1858.—emend. J. & T.

(Syn. *Dactylogyrus* G. R. Wagener, 1857 (in part); *Monocoelium* G. Wegener, 1910.)

Tetraonchinae in which the disc is broader than the body. Four large hooks articulating with a large chitinous supporting apparatus (furcula); fourteen minor hooks. Four eyes. Intestine not bifurcated; devoid of caeca. Testis in middle of body. Vagina apparently absent. Penis with accessory clasping apparatus.

Type species, *T. monenteron* Wagener, 1857, from the gills of *Esox lucius*. The genus is known only from Europe (freshwater). The synonymy of this genus has been discussed in connection with *Ancyrocephalus*.

10. AMPHIBDELLA Chatin, 1874.

Relatively large *Tetraonchinae* measuring about 4 to 6 mm. in length. Head rather pointed. Disc fairly distinctly marked off from body. Twelve minor hooks always (?) present. No eyes. Intestine bilobed, devoid of caeca, the limbs not joining behind. Vagina apparently absent. Yolk system confined to a region posterior to the transverse yolk-duct. Penis simple.

Type species, *A. torpedinis* Chatin, 1874. From the gills of marine fishes (*Torpedo* and allies).

Not yet reported from Australia.

Monticelli (1889, p. 116; 1890; 1903, p. 336) regards *Amphibdella* as a synonym of *Tetraonchus*, i.e. of *Ancyrocephalus*. The pointed head, absence of vagina, and the remarkable position of the yolk system are characters which oppose this view.

Known species, *A. torpedinis* Chatin, 1874 (Mediterranean) *nec* MacCallum, 1916; *A. flavolineata* MacCallum, 1916 (Massachusetts).

AMPHIBDELLA MACCALLUMI, nom. nov.

(*Syn.* A. torpedinis MacCallum, 1916, *nec* Chatin.)

A comparison of MacCallum's figure of *A. torpedinis* with that given by Parona and Perugia (1890) leads us to conclude that the Mediterranean and American forms belong to different species and hence we have removed the latter from Chatin's species and renamed it as above.

Host, *Tetranarche occidentalis* (from Massachusetts).

11. HALIOTREMA, n.gen.

Tetraonchinae in which the disc is distinctly marked off from the body, and is provided with four large hooks supported by chitinous bars, as well as with fourteen minor hooks. Head with two pairs of head-lobes. Body slightly constricted near mid-region. Eyes absent. Intestinal limbs devoid of caeca and without a terminal junction. Vagina with chitinous lumen. Testis and ovary lying in the mid-line and occupying the posterior third of the mid-region of the body of the worm. Penis large, not simple.

From the gills of marine fishes.

Type species, *Haliotrema australe* J. & T.

HALIOTREMA AUSTRALE, n.sp. (Plate xi., figs. 10, 12, 13, 14.)

Length of adult .64 mm.; maximum breadth .24 mm. The disc is distinctly marked off. Two pairs of head lobes are present. Slightly in front of its mid-region the body undergoes a definite constriction which is not so pronounced, however, as in *Daitreosoma*.

The disc bears two pairs of large hooks (Pl. xi., figs. 10, 12), each with a very distinct biramous basal portion whose roots are connected by a very definite and apparently chitinous membrane, complete except in one small place near the point of origin of the roots. The supporting chitin bars are two in number and slightly crescentic in shape, the convexity of the bars articulating with one another. Fourteen minor hooks are present, distributed as shown in Pl. xi., fig. 10. Of the body musculature the longitudinal layer is fairly well developed; behind, the fibres concentrate to form the muscles of the disc. Distinct circular fibres are absent, but there is a slight development of oblique muscles.

The mouth is a small transverse slit, lying ventrally at a considerable distance behind the anterior termination of the worm. The pharynx is large and distinct. Leading into the short, conical buccal cavity are two pairs of gland-cells. Into the short oesophagus open the ducts of a number of digestive glands; but in the specimens available the exact connections of these glands could not be observed. The intestine is bifurcated, the limbs approaching each other slightly in the region of the body constriction but diverging again behind. No junction takes place between the limbs posteriorly. Caeca are absent.

Situated in each side of the head, and stretching considerably behind the pharynx, is a mass of gland-cells. Their ducts were not visible, but they appear to be connected with the head-organs which lie in the first lobe of the head. It is possible that some of the posterior gland-cells supply the pharynx or oesophagus. Eyes are absent. The brain lies immediately in front of the pharynx.

The testis is a large solid organ lying between the intestinal limbs, almost at the posterior end of the animal. The vas deferens passes forward as a wide tube opening in the region of the body constriction into the vesicula seminalis. The latter, which is a fairly large structure with strongly lobed outer margin, extends forward almost as far as the beginning of the intestine, then bends back upon itself and continues as a large vas deferens which runs beside the penis and opens into it behind. The penis is a very distinct chitinous tube, lying slightly obliquely and enclosed in a fairly distinct penis-sac. It consists of two parts, a posterior simple tube, which appears to have a distinct articulation with an anterior portion, the latter, at its distal end, developing into a curious chitinous structure shown in Pl. xi., fig. 14.

The ovary is much smaller than the testis, in front of which it lies. Ova are prominent in its anterior region. The oviduct is a fairly wide tube, but only its proximal portion could be seen. Shell-glands could not be detected. A very distinct vagina is present, opening on the ventral surface near the right side of the animal in the vicinity of the body constriction. The lumen of the vagina, on its distal half, is strengthened with a very prominent chitinous lining which extends posteriorly into a definite receptaculum seminis which gives off a short narrow pouch to the right. The vitellaria are very well developed, lying above and below the intestinal limbs which they embrace over their whole length. The transverse yolk-duct is clearly visible at a considerable distance in front of the ovary, and at its middle is dilated into a distinct yolk-reservoir. No ripe eggs were present in the material available.

Found on the gills of the marine black-spotted goat fish, *Upeneus signatus* Gunther, from Moreton Bay, S.E. Queensland.

12. DAITREOSOMA, n.gen.

Tetraonchinae in which the disc is not very sharply marked off from the body. Four large hooks present on disc, together with a pair of minor hooks. Body markedly constricted into a short anterior and long posterior portion. Intestinal caeca absent. Intestinal limbs communicating behind. Vagina present. Cirrus a long thin tube. Ovary and testis not lobed. Yolk does not extend into the posterior third of the body.

Found on the gills of freshwater fishes of the genus *Therapon*.

Type species, *D. constrictum*, n.sp.

DAITREOSOMA CONSTRICTUM, n.sp. (Plate xii., figs. 15-19; xiii., fig. 20.)

This worm measures about .45 mm. in length, .16 mm. in greatest breadth.

The anterior third of the body is marked off by a deep constriction from the posterior two-thirds, giving the worm a characteristic appearance. In general shape the parasite varies considerably according to the state of contraction; if uncontracted there appears a long, rather narrow, posterior portion which bears the disc, but if well-contracted, the worm may be oval.

The disc which is not very sharply marked off from the body, bears two pairs of large hooks, the ventral pair being much the larger and more strongly curved, lying in a pair of postero-ventrally directed lobes of the body wall (Pl. xii., fig. 16). At their bases they articulate with a large transverse chitinous bar and each with a small anteriorly and slightly inwardly directed chitin-piece, on which the well developed longitudinal muscles are in part inserted. The dorsal hooks are more slender and not so strongly curved. They are directed upward, the ventral hooks downward. At the side is a pair of small lateral lobes, each armed with a very small chitinous hook.

The body cuticle is smooth. The longitudinal muscle-layer has undergone great development in the ventral region to form a pair of longitudinal muscles, arising below the ovary and inserted, at their distal end, into the hook apparatus of the disc. These two muscles are joined by a second longitudinal pair lying internally to them and converge proximally in the vicinity of the posterior end of the intestine. These muscles form definite projections on the ventral body-wall.

The mouth is situated median-ventrally; the pharynx is prominent, broader than long and there is no definite oesophagus. The intestinal branches pass backward, approach each other in the region of the body constriction, then diverge again, but join immediately behind the testis. Intestinal caeca are absent. Ventrally, immediately behind the constriction, there are on either side two large masses of heavily-staining tissue which appear to open into the intestine and are perhaps digestive glands. A few simple glands are also present in the walls of the pharynx.

Situated laterally to and just behind the pharynx are two masses of glands, whose ducts run forward and inward to terminate in three pairs of head-organs. The excretory system could not be recognised. Of the nervous system, only the brain could be seen, lying between the eyes. The latter are situated immediately below the epidermis.

The testis is a large organ, posterior to, and partly enveloping, the ovary. The vas deferens is a thin-walled tube with a rather wide lumen even when empty. It is capable of immense distension and may act as a large vesicula seminalis. with lobed walls, occupying a considerable part of the dorsal region of the worm. Anteriorly it becomes continuous with a large ejaculatory bulb opening into the cirrus by an ejaculatory duct. The latter is a very long thin tube which passes first backward, then, bending upon itself, runs forward and inward towards the midline where it enters the cirrus. The latter is a simple chitinous tube which passes vertically downwards, and is retractile into the cirrus-sac, in which it may generally be seen coiled up.

The ovary is a large rounded structure, immediately in front of the testis; from its anterior end the oviduct travels vertically downward and into it the vagina opens. Into the latter, immediately before it communicates with the oviduct, there enters the vitelline duct. The oviduct then travels forward as a wide tube to terminate immediately behind the male aperture. The shell-gland is represented by a simple glandular thickening of the wall of the oviduct. The vagina is a narrow tube passing straight to the left side of the animal, where it opens in the region of the body constriction on a small bulbous expansion. It is provided, in its anterior portion, with a large thick-walled receptaculum seminis. The yolk system is well developed, but confined to the anterior two-thirds of the body, where it lies in close relation with the intestine. In the region of the body constriction a pair of transverse yolk-ducts is formed which open into an ill-defined yolk-reservoir.

The egg is oval, .048 mm. in length and .024 mm. in breadth, and bears at its posterior end a short blunt spine (Pl. xii., fig. 17).

The species was found, sometimes in large numbers, on the gills of *Therapon carbo* Ogilby and McCulloch, from the Thomson River, at Longreach, Central Queensland.

DAITREOSOMA BANCROFTI, n.sp. (Plate xiii., figs. 21, 22.)

This species closely resembles *D. constrictum,* but differs from it in the following characters:—

It is a slightly larger worm, measuring, when full grown, .56 mm. in length; .19 mm. in greatest breadth. The head is not regularly rounded as in that species, but is sharply indented immediately in front of the mouth (Pl. xiii., fig. 22). The four head-organs are close together, the last not so distinctly separated from the others as in the foregoing species.

The vesicula seminalis is quite different from that of *D. constrictum.* It lies only on the left side of the body (Pl. xiii., fig. 21) and does not undergo the great dilatation characteristic of that species, but appears as a tube bent slightly upon itself anteriorly, only moderately distended, and distinctly lobed only on its outer wall.

The vagina does not terminate in a small rounded bulb, but possesses a narrow funnel-shaped opening lying on the left side, within the body constriction.

This is especially plain in the specimen figured, where the body had been accidentally drawn out, the body constriction being in consequence obliterated. The receptaculum seminis is rather small. The yolk-reservoir is clearly visible.

Found on the gills of *Therapon hilli* Castelnau, from the Thomson River, at Longreach, Central Queensland.

13. EMPLEUROSOMA, n.gen.

Small *Tetraonchinae,* with strongly developed lateral body regions. Disc not sharply marked off from body; provided with four large and two very small hooks, as in *Daitreosoma.* Eyes present. Intestinal limbs communicating posteriorly and devoid of caeca. Vagina absent. Cirrus a simple elongated tube. Yolk confined to the anterior region of the body.

Found on the gills of a freshwater fish.

Type species, *E. pyriforme* J. & T.

EMPLEUROSOMA PYRIFORME, n.sp. (Plate xiv., fig. 31; xv., figs. 32-34.)

This is a small parasite, about .37 mm. in length, and .11 mm. in greatest breadth, with broadly expanded sides and rather thick body.

The disc, which is not sharply marked off from the body of the worm, is provided with two pairs of large hooks, viz., a posterior ventral pair, the bases of which are joined by a short transverse chitinous bar; and a more anterior, laterally directed pair, each of which is ankylosed at its base with an inwardly and posteriorly directed chitin-bar. These large hooks are all slightly biramous at their bases. Laterally the clasping disc possesses two small lobes each bearing a small hook, as in *Daitreosoma.* The large posterior hooks also articulate at their bases each with a very minute chitin-piece. To these chitin-pieces the musculature of the hooks is attached.

Four ventral longitudinal muscles supply the disc; an outer pair serving the more anterior pair of hooks, and a median pair inserted into the small chitin-pieces articulating with the posterior hooks. A transverse muscle uniting these basal pieces is also present.

The body-wall is thick and devoid of epidermal papillae. The circular muscle-layer is strongly marked; while the inner (longitudinal) series is prominent ventrally but could not be detected dorsally and laterally. In the posterior half of the animal the ventral longitudinal muscles are highly developed to form the four longitudinal muscles supplying the disc, as already described. These muscle-layers separating the several organs from the intestine are prominent in the anterior region of the animal. The body parenchyma in the posterior narrow portion of the worm is curiously developed, giving it a peculiar globular appearance, somewhat similar to that seen in *Daitreosoma.* There are four pairs of prominent head-organs on either side, the glands which supply them lying laterally to the pharynx. On either side of the pharynx are two pairs of remarkable glands which open on the body surface, ventrally, close to the cirrus; it is possible that they possess a copulatory function.

The mouth opens ventrally. The large, almost spherical pharynx is followed by a very short oesophagus. The two limbs of the intestine unite behind and are devoid of caeca. The intestinal walls are of remarkable thickness, but consist, nevertheless, of only a single layer of narrow columnar and very vacuolated cells, resting on a prominent basal membrane.

Neither excretory nor central nervous systems could be detected. Two pairs of eyes are present, situated well within the parenchyma, each pair at approximately equal distances apart. The posterior pair lies above the pharynx, the anterior pair immediately anterior to that organ. Connected with the posterior pair is a definite globular vesicle.

The large testis lies immediately anterior to the end of the intestine and in section appears wedge-shaped. The vas deferens is a short wide tube opening into the large vesicula seminalis. The cirrus is a simple slightly curved chitinous tube. No other male sexual organs appear to be present.

The small ovary is situated anteriorly to the testis and somewhat transversely. The oviduct is given off from its ventral portion and runs forward close below the vesicula seminalis. A vagina is absent.

The shell-glands appear to be simple glandular thickenings of the uterus. The female opening is situated immediately behind the male aperture in the median ventral line. No eggs were present in any of the specimens examined. The yolk system is strongly developed but is confined to the anterior region of the animal. The transverse yolk-ducts lie immediately in front of the ovary. No reservoir was visible.

Found on the gills of *Therapon unicolor* Günther, from the Burnett River, South Queensland.

14. TETRANCISTRUM Goto and Kikuchi, 1917.

Rather small *Tetraonchinae* measuring 1.2 to 2 mm. in length. Body dilated in middle. Disc not sharply marked off from body and devoid of minor hooks. Eyes absent. Pharynx elongated; intestine bilobed, provided with caeca, the limbs communicating behind. Testis and ovary situated about the middle of the body. Penis simple, with accessory chitin-piece attached. Vagina present.

From the gills of a marine fish of genus *Siganus*. From Japan.

Type and only known species, *T. sigani* Goto and Kikuchi, 1917.

Subfamily III. LEPIDOPTREMINAE, n. subfam.

These are *Gyrodactylidae,* which have, as a common characteristic, the development of scale-like papillae over the greater part of the body except in *Lamellodiscus.* On the disc these papillae are arranged in the form of a pair of scaly sucker-like organs (for which the name *Squamodisc* is proposed) which may or may not be provided with accessory hooks. Four powerful hooks, with basal supporting apparatus are present; also numerous minute hooks.

Two pairs of eyes. Intestine forked, ending blindly, not lobed. Ovary and testis solid. Penis simple or very complex. Vagina present.

From the gills of freshwater and marine fishes in Queensland.

This subfamily includes the following new genera:—*Lepidotrema* (type genus), with a subgenus *Flabellodiscus*; *Lepidotes*; *Empleurodiscus*; *Acleotrema*; *Lamellodiscus.*

Key to Genera of Lepidotreminae.

A. a. "Squamodisc" provided with accessory hooks .. .. D.
   b. "Squamodisc" devoid of such hooks .. .. B.
B. a. Body covered with scaly papillae; each of the concentric ridges of "squamodisc" consisting of numerous scales .. .. C.
   b. Body devoid of scaly papillae; concentric ridges consisting of only two very broad lamellae .. .. *Lamellodiscus.*
C. a. Cirrus-sac very highly developed; very large genital chamber present .. .. *Acleotrema.*
   b. Cirrus-sac simple, genital chamber not markedly developed .. .. *Lepidotes.*

D. a. Disc much broader than body, squamodisc provided with very numerous (about 25 to 30) accessory hooks .. .. *Empleurodiscus.*
b. Disc with only about eleven such hooks, disc not as broad as body .. .. E.
E. a. Cirrus a rather simple structure .. .. *Flabellodiscus.*
b. Cirrus very long, and showing a remarkable complexity of structure .. .. .. *Lepidotrema.*

15. Lepidotrema, n.gen.

Lepidotreminae. The members of this genus are characterised by the presence of about eleven rows of scales on each of the two sucker-like organs of the disc, together with a row of generally about nine hooks on each, arranged like a spread fan. Fourteen minor hooks are scattered over the disc. The large hooks of the disc are supported by four powerful chitinous bars imbedded in the substance of the disc.

The penis is exceedingly complex. The testis is more or less degenerate in the adult, the sperms being stored in an immensely dilated vesicula seminalis. The vagina is extraordinarily large.

Found, so far, only on the gills of freshwater fishes belonging to the genus *Therapon.*

Type species, *L. therapon* J. & T.

Lepidotrema therapon, n.sp. (Plate xv., figs. 35-37; xvi., figs. 38-42; xvii., figs. 45-49.)

Length of adult .5 to .77 mm.; breadth .19 mm. The body is covered with minute scale-like papillae, very minute anteriorly but increasing in size towards the posterior end of the worm.

The disc (Pl. xvi., fig. 40, *a-f*) is provided with an exceedingly powerful clinging apparatus. In the living condition the true posterior end of the disc is turned ventrally, i.e. the true dorsal surface of the disc is turned backward. Four large hooks are present. The ventral pair (Pl. xvi., fig. 40, *c*) are slender, and strongly hooked, and articulate basally each with the end of a chitinous bar which runs towards the centre of the disc, but does not quite reach its fellow. These two bars articulate at their inner ends with a much smaller curved piece of chitin which can be observed only by compressing the disc, its plane being vertical to that of the chitinous bars (Pl. xvi., fig. 40, *e*). Each of these bars is also provided on its outer half with a strong ring-shaped chitinous projection. The dorsal pair of hooks have a biramous basal portion, the two limbs or roots being united by a strong membrane. The anterior (ventral) limbs articulate with the chitinous bars which also give support to the ventral hooks, but the posterior limb has no such chitinous support. Two other inwardly-directed bars of chitin are also present, articulating with the more dorsal pair. They do not quite reach each other, but a slightly curved piece of chitin similar to and at right angles with the one already described, connects them. Fourteen minor hooks are also present, their disposition being indicated in Pl. xvi., fig. 42.

The dorsal and ventral surfaces of the disc (posterior and anterior in the attached animal) each bear, towards their proximal ends, a remarkable sucker-shaped disc, consisting of blunt teeth arranged in eleven curved rows which radiate outward from a point at the proximal end of the disc (Pl. xvi., fig. 40, *f*). In close connection with each of these discs are a number of hooks, varying from seven to eleven, connected by a membrane and spread out like a fan. The rows of blunt teeth, and probably also the hooks, are to be regarded as modifications of the papillae which cover the body. The disc is supplied with muscles which originate from a powerful band in the dorsal region of the posterior end of the body, but their detailed arrangement has not been determined.

On account of the minute size of the worm, the structure of the body-layers is difficult to observe. The most remarkable characteristic of the epidermis is the presence on it of numerous scaly papillae. Delicate longitudinal muscle-layers lie below this, but their arrangement could not be accurately observed. The body parenchyma is well developed.

The very small mouth is situated ventrally immediately in front of the pharynx; the buccal cavity is quite short and the pharynx large, prominent, and projecting upward. Numerous unicellular glands occur in the anterior two-thirds of the wall of the pharynx. No definite oesophagus is present. Immediately behind the pharynx lies a mass of glands (? unicellular), which open into the intestine and are especially visible in young specimens. The forked intestine ends blindly at the posterior end of the worm, but immediately before the termination a junction takes place between the two limbs. In young forms this fusion does not occur. There are no caeca. The intestine is lined by a single row of flattened cells.

Four pairs of head-organs are present, but no corresponding lobes are developed on the head. Through these structures pass the ducts from a pair of prominent masses of unicellular glands, one on either side, antero-laterally to the pharynx. The excretory system could not be traced satisfactorily. At the anterior end, immediately behind the mass of gland-cells there occurs, on each side, a duct terminating on the body-surface by a slightly bulbous opening. Into each of these ducts there appears to open a very fine longitudinal duct, while one of a somewhat similar nature can be seen along each side just above the anterior termination of the lateral vitellaria. It is probable that these structures are parts of a complex excretory system (Pl. xv., fig. 36).

The brain lies anterior to the pharynx and gives off on each side a pair of nerves to the eyes which consist of a mass of minute pigment cells. The eyes lie close to the brain, i.e. within the "head," being situated, however, nearer the dorsal than the ventral surface. The posterior pair are the larger.

In this species the male organs reach maturity before the female. In young forms the testis is very large (Pl. xvi., fig. 41) occupying a great portion of the body behind the ovary which at this stage is quite immature. In these the vas deferens arises from the outer edge of the testis and leads into a long thin vesicula seminalis which proceeds nearly as far forward as the pharynx, then becoming bent on itself. A bulbus ejaculatorius is present, but is difficult to detect and its connection with the vesicula could not be made out in these young forms. The cirrus in these is a simple chitinous tube, lying in the cirrus-sac. In close connection with the posterior end of the vesicula are two large glands, probably prostate, which, when viewed in cleared specimens, have a slightly granular appearance, while in transverse section they appear to consist of a number of deeply-staining rings, each arranged concentrically round a nucleated cell.

In adult forms the testis (Pl. xvi., fig. 38) is greatly reduced or practically absent, having diminished very much in size, with its cavity practically obliterated and containing merely connective tissue fibres, though a few sperms may occasionally be still visible. Sometimes (as in the specimen figured) the testis does not degenerate quite so much (Pl. xv., fig. 35). The adult vas deferens is much thicker and its opening into the vesicula is pushed forward. The vesicula, which has increased enormously in size, due to the emptying into it of the sperms from the testis, appears as a large flattened structure, somewhat lobed at its edges, occupying the greater part of the dorso-medial region of the body from immediately behind the pharynx to the ovary. The whole structure is filled with sperms floating in an albuminous material. The prostate glands have now increased greatly in size. The bulbus ejaculatorius has enlarged considerably and communicates with the seminal vesicle by a plainly-visible duct. The cirrus has grown greatly in size and complexity and has developed a flange which travels along one side of it for about two-thirds of the length of the organ, and then suddenly passes over to the other side and ceases abruptly. This portion of the cirrus runs horizontally, but thence onward it slopes downward and gradually develops another flange which continues almost to the genital opening. The whole structure is enclosed in the large cirrus-sac (Pl. xvi., fig. 39).

The female organs do not mature at so early a stage as do the male. The ovary lies immediately anterior to the testis and on its right side gives off an extension. The oviduct is a narrow tube arising from the median ventral surface of the ovary and travelling forward near the ventral surface of the animal. The extremely large vagina opens on the left ventral side on a level with the prostate glands. A receptaculum seminis is absent. The female genital opening is situated a little behind the male aperture. The oviduct and uterus are extremely thin-walled structures. The shell-glands (Pl. xvii., fig. 49) consist of large masses of glandular cells, situated around and opening into the ootype, but visible only in sections. Never more than one egg is present in the uterus at a time. The egg, which measures .07 mm. by .048 mm., is provided with a short posteriorly-directed spine. The nucleus is visible among the abundant granular yolk material.

The vitellaria are well developed and arranged in two broad bands, one on either side of the body, almost entirely obscuring the intestine. Posteriorly, immediately behind the testis, the yolk accumulates in a large median mass. In adults the organs may extend anteriorly to the pharynx and there is also a slight development of them all along the dorsal surface posterior to this organ.

The individual parasites do not appear to have much effect on the host, though a slight hypertrophy of the gill-tissue has been observed in a few cases. But the great numbers in which this parasite occurs on the gills, must render it a source of considerable irritation to its host, as many as twelve individuals having been counted on a single gill-filament.

Found on the gills of *Therapon carbo* Ogilby and McCulloch, from the Thomson River, Longreach, Central Queensland.

LEPIDOTREMA TENUE, n.sp. (Plate xvi., fig. 43; xviii., figs. 52, 53.)

Length .69 mm. by .14 mm. This species closely resembles *L. therapon* both anatomically and in general appearance, but the majority of the specimens examined were considerably longer and more slender. The clasping disc is very similar in the two species, the large hooks, chitin bars and scaly "discs" being indistinguishable, but the disposition of the minor hooks is different, as is seen by comparing figures 43 and 42 (Pl. xvi.). A very short oesophagus is developed and there is no fusion of the intestinal limbs posteriorly. The most marked differences are visible in the reproductive organs. As in *Lepidotrema therapon*, the testis matures in quite young forms. Degeneration of this organ occurs as in that species, though it is not so complete, a testis containing developing sperms being plainly visible in even the largest forms. Corresponding with this the vesicula seminalis is rather smaller than in *L. therapon.* In some individuals it is almost free from sperms, in others much dilated, the dilatation taking place in a characteristic manner resulting in the formation of a strongly lobed structure. The prostate glands are often very prominent. The cirrus is quite similar to that of *L. therapon.*

The female reproductive organs are like those of the last species. There is a marked development of the vitellaria—even more so than in *L. therapon*—so strongly that in some forms none of the other internal structures are visible through it. In general disposition the yolk system is, in other respects, the same as that of *L. therapon.*

The egg measures .076 mm. by .048 mm., its spine being slightly longer than that of the last species.

Found on the gills of *Therapon hilli* Castelnau, from the Thomson River at Longreach, Central Queensland.

LEPIDOTREMA FULIGINOSUM, n.sp. (Plate xvi., fig. 44; xvii., figs. 50, 51.)

Length .64—.75 mm., breadth .14—.16 mm. This species closely resembles the other species of the genus. The distinctions most easily observed are in the disposition of the minor hooks on the disc and in the structure of the reproductive organs. The arrangement of the minor hooks is clearly seen in the figure (Pl. xvi., fig. 44), and differs from those already described in having one small hook situated between each pair of supporting cross-bars.

Even in full-grown adults the testis is large and distinct, though the size of the vesicula seminalis indicates that the male gland has undergone considerable diminution. The greater part of the vas deferens is dilated into an immense vesicula which travels forward on the right side of the body nearly as far as the end of the penis, then, passing over to the left side, bends back again and communicates by a rather long vas deferens with the penis. The latter closely resembles that of the two previously described species. Two prostate glands are present but not very large.

The vagina is even larger than in the two preceding species. In one rather fortunate preparation the vagina could be seen opening into the ootype a very short distance in front of the opening of the two transverse vitelline ducts (Pl. xvii., fig. 51). Shell-glands were not recognised. The oviduct is remarkable in that it is highly dilated in its mid-region and is lined by a highly refractive cuticle, evidently of a chitinous nature. It opens ventrally on the left side immediately behind the opening of the vagina.

The egg, which measures .064 mm. by .048 mm., resembles that of the other species of the genus.

Found on the gills of *Therapon fuliginosus* Macleay, from the Thomson River at Longreach, Central Queensland.

16. Subgenus FLABELLODISCUS, n. subgen.

Lepidotreminae. In external appearance this subgenus closely resembles *Lepidotrema,* but the organisation of the reproductive system is considerably simpler. The penis is a simple chitinous tube, the twisted flange, so characteristic of *Lepidotrema,* being quite absent. The vagina which is bent once upon itself, is longer than, but not so thick-walled as in the genus mentioned. The testis lies above this more anterior part of the ovary and is rather small in the adult. The vesicula seminalis is exceedingly large.

Type species, *Lepidotrema* (*Flabellodiscus*) *simplex* J. & T.

Found, so far, only on the gills of *Therapon fuliginosus* Macleay.

FLABELLODISCUS SIMPLEX, n.sp. (Plate xviii., figs. 54-55; xix., figs. 61, 62.)

Length .53 mm., breadth .1 mm. The disc is broader than the body, measuring .112 mm. across.

In external appearance this parasite closely resembles *Lepidotrema,* even in regard to the arrangement of the discal armature. The disposition of the minor hooks is shown in Pl. xix., fig. 61. One pair of hooks is present between the cross-bars, as is the case also in *Lepidotrema fuliginosum.* The ventral transverse cross-bar differs slightly from that generally found in the last-named genus in being slightly angular, the edge opposite the obtuse angle giving off the small supporting chitin-piece.

The scale-like papillae of the epidermis are absent on the dorsal surface (Pl. xix., fig. 62). No further details of the structure of the body walls could be seen distinctly.

The alimentary canal and its associated glands are similar to those of *Lepidotrema,* the blindly-ending intestine being in both cases devoid of caeca.

In one specimen examined part of the nervous system could be seen. The brain lies between the eyes, immediately anterior to the pharynx, the lateral nerve cords curving round part of the pharynx and passing down the sides of the worm, close to the alimentary canal. Immediately behind the eyes two pairs of nerves are given off, one running upward to the head, the second inward towards the pharynx. Several other branches arise from the lateral nerve-trunks, both on their inner and outer sides (Pl. xviii., fig. 55). The nerve-trunks in the posterior region of the worm could not be recognised. No trace of excretory system could be detected.

It is in the structure of the reproductive system (Pl. xviii., fig. 54) that the worm differs so much from *Lepidotrema.*

The testis is a curious uniform structure, situated above the anterior end of the ovary. The vas deferens is a long, very narrow, convoluted tube which opens into a highly dilated vesicula lying transversely across the body, immediately in front of the ovary, while the remainder of the sperm duct is a short slightly convoluted tube, which leads into the cirrus. The base of the latter is imbedded in a great mass of muscle. The cirrus is a much simpler structure, the twisted chitinous flange present in *Lepidotrema* being quite absent. It opens in the mid-ventral region of the animal a short distance behind the pharynx. Connected with its termination is a minute unicellular prostate gland.

The anterior end of the ovary is bent sharply upon itself and it is from this region, and not from the median portion of the gland, that the female ducts arise. The oviduct, which is visible only with great difficulty, is a rather wide tube running forward to a point a little behind the end of the cirrus. It is embedded in a dense parenchyma of a rather fibrous nature, in which lie a number of large pyriform cells, heavily staining, and evidently to be regarded as shell glands, but their ducts could not be seen. The vagina is remarkable in that it does not run outwards along the ventral body wall as in other species of the genus *Lepidotrema,* but lies immediately below the dorsal body wall embedded, in part, in the dense parenchyma which surrounds the oviduct. It is a much narrower tube than is found in that genus. Shortly after leaving the oviduct it dilates, and this dilatation is seen to contain a kind of granular material, giving it a resemblance to a prostate gland. This portion may be regarded as a receptaculum seminis, filled with sperms. The tube there narrows, passes forward to a point immediately in front of the opening of the oviduct, then turns sharply upon itself, travels backward, downward, and finally forward again along the ventral body wall where it opens in the midline. This curious arrangement possibly serves to act like a valve, preventing the sperms from leaving the vagina.

The vitellaria of the fully-grown worm are strongly developed and are in general arrangement similar to those of *Lepidotnema.* In the young forms yolk itself is present only to a small extent.

The egg measures .05 mm. by .044 mm. It is rather more rounded than in *Lepidotrema* and the spine is absent.

In young specimens the reproductive system is of the same type, the vesicula seminalis appearing as a narrow transverse tube immediately in front of the ovary. The cirrus is much simpler than in the adult (Pl. xix., fig. 61).

Found on the gills of *Therapon fuliginosus* Macleay, from the Thomson River, at Longreach, Central Queensland.

17. Lepidotes, n.gen.

Lepidotreminae. In this genus the scale-like body papillae are confined to the posterior half of the worm and the squamodisc is devoid of hooks. The posterior disc has four large hooks, supported by intermediate chitinous bars, as well as six pairs of smaller peripheral hooks.

Four pairs of head-organs are present. The intestine ends blindly and is devoid of caeca. Four eyes. Penis simple. Vagina simple, opening laterally; receptaculum seminis present.

Found, so far, only on the gills of a freshwater fish, the golden perch or yellow-belly, *Plectroplites ambiguus* Richardson.

Type species, *L. fluviatilis* J. & T.

Lepidotes fluviatilis, n.sp. (Plate xx., figs. 65-72; xxi., fig. 73.)

This is a rather large species, measuring .95 mm. in length, and .26 mm. in greatest breadth. In preserved specimens the greyish colour of the parasite contrasts sharply with the creamy-yellow of the gill filament.

The shape of the worm varies considerably according to the state of contraction, being sometimes long and slender, at other times much shorter and rather thick-set. The disc (Pl. xx., fig. 67) is very prominent and the arrangement of the hook apparatus complex. Four large hooks are present, the dorsal pair long and slender, the ventral shorter and possessing a biramous basal portion. Muscles can be seen inserted into the base of the hooks.

As in *Lepidotrema* there is a complex chitinous supporting apparatus which does not, however, articulate with the hooks, but seems rather to strengthen the disc. It consists of three bars, a central one with two ventrally and outwardly directed projections, and two lateral outwardly directed pieces closely articulated with the latter. Only six pairs of minute peripheral hooks could be detected.

The two scaly sucker-like discs are very prominent, but are entirely devoid of the fan-like hook-armature so characteristic of *Lepidotrema.* Twenty-five rows of scales are present on each disc (Pl. xx., fig. 69).

The chitinous cuticle is modified on the posterior half of the body to form numerous forwardly projecting papillae which are not so densely arranged as in *Lepidotrema.* Longitudinal and circular muscle-layers are recognisable. The body-parenchyma of the posterior half of the animal is of an extremely loose texture, giving this tissue a reticulate appearance.

The mouth lies ventrally, immediately in front of the pharynx. The latter is large and rounded in dorsal view, and bears numerous unicellular glands in its walls. There is no definite oesophagus. The intestine is devoid of caeca and the two limbs bulge outwards in the region of the testis and end blindly. There are two glands situated one on either side of, and immediately posterior to, the pharynx; they seem to open into the intestine.

There are four pairs of head-organs from which the ducts pass backward to join the cephalic glands. In young forms the head-organs are all clustered closely together; but already in medium-sized forms the adult condition is attained (Pl. xx., fig. 70).

Of the nervous system, only the brain and the origin of the main nerves could be recognised. There are two pairs of eyes, each consisting of a mass of minute oval pigment-grains, lying well within the body-parenchyma.

The sexual apparatus is very complex and difficult to follow out. The following description is based on an examination of whole mounts and serial sections.

The testis is extremely large, occupying all the space between the branches of the intestine. Within the testis the immature sperms are arranged in numerous small clusters, but further details of sperm formation could not be observed in this organ. The vas deferens is a wide tube, passing forward and opening immediately behind the pharynx into a portion of the vesicula seminalis. The latter consists of three large globular portions. The anterior, dorsally situated part appears to open by a duct given off from its lower surface into the ventral portion of a second division lying immediately behind it and likewise dorsally. This opens, in turn, into a third, more ventrally situated portion which appears to open directly into the large bulbus ejaculatorius. This latter is a thick-walled vesicle which opens by a narrow duct into the cirrus. Sperms appear to undergo development in the vesicula, for not until they are found in the ejaculatory bulb do they possess a typical sperm-appearance. The heads are minute and spherical, the tail relatively long, the whole sperm measuring about .008 mm. The cirrus, which lies in a large cirrus-sac, is a rather simple chitinous tube, bent once upon itself. Into the cirrus also open, by a pair of long ducts, two prostate (?) glands and also a large number of very prominent heavily-staining glands ("cirrus glands"), originating as far back as the ovary.

The prominent ovary is situated asymmetrically in front of the testis, on the right side of the body. Into the narrow oviduct opens a large yolk reservoir, generally difficult to see, since it seldom contains yolk. The vagina is a simple tube passing directly to the left side where it opens ventrally. In connection with it there is a large receptaculum seminis, frequently seen full of sperms. In whole specimens it is almost completely obscured on account of the great development of the vitellaria.

The oviduct passes forward as a very thin tube opening close behind the male aperture. Distinct shell-glands could not be recognised but these organs seem to be represented by certain glandular swellings in the walls of the ootype. The large, oval egg, measuring .07 mm. by .04 mm., is well supplied with yolk. Posteriorly it bears a small blunt spine. Of fifty specimens examined only two contained an egg.

The vitelline system is fairly well developed. Two wide transverse yolk-ducts are present immediately behind the ovary and transfer the yolk to a reservoir which is generally very difficult to detect, except when filled.

In general appearance the young differ considerably from the adults. In the smallest forms the head-organs are clustered closely together. Testis and ovary are small. Vesicula seminalis, bulbus ejaculatorius and cirrus are visible;

but prostate glands were not seen. The large "cirrus-glands" are already well developed, as is also the yolk system. The disc, though at first sight quite different from that of the adult, is built on the same plan (Pl. xx., fig. 72). It is proportionally much larger than the adult disc, which evidently becomes formed from that of the young worm by the addition of a quantity of "padding tissue" which is plainly visible within it, giving it a more spherical appearance. In slightly larger worms this immature form of the disc is retained, but the cephalic glands are already of the adult type.

Found on the gills of the golden perch, *Plectroplites ambiguus* Richardson, from the Thomson River at Longreach, Central Queensland.

18. EMPLEURODISCUS, n.gen.

Lepidotreminae. In this genus the scale-like papillae cover practically the whole of the body, being absent only in the head region. The scales of the squamodisc are arranged generally in from seven to nine rows. A large number (25 to 30) of sharp accessory hooks are present. There are 14 minor hooks. The posterior disc is exceedingly broad, being nearly thrice the width of the rather slender body. The cephalic glands are connected with four pairs of head organs. Four eyes are present. The two limbs of the intestine end blindly and are devoid of caeca. The testis is solid; the cirrus simple. The ovary lies transversely in front of the testis. There is no vagina.

Found on the gills of the freshwater fish, *Therapon unicolor* Gunther.

Type species, *E. angustus* J. & T.

EMPLEURODISCUS ANGUSTUS, n.sp. (Plate xix., figs. 56-60, 63-64.)

Length about .32 mm.; breadth .05 mm.

This worm is characterised by the great relative width of the disc, which measures nearly thrice the body breadth. Its armature (Pl. xix., fig. 64) is more complex than that of any other member of the *Gyrodactyloidea.* Four large hooks are present, a dorsal pair with a biramous basal portion, and a more simple slender ventral pair. A complex set of chitinous bars lies between these hooks, but does not form a definite articulation with them, serving probably rather to strengthen the disc as a whole. This chitinous apparatus consists of two pairs (a large and a small) of inwardly directed chitin-pieces which articulate with a complexly made intermediate portion. Muscles can be seen inserted at the base of the hooks. Fourteen minute hooks are also present, their distribution being shown in the figure. Four appear to lie on the dorsal side of the disc, while the others are ventral. Two squamodiscs occur, each bearing nine rows of modified "scales." Each disc is also provided with a variable number, generally about thirty, of sharp slender hooks. The clinging disc of the worm is thus armed with as many as eighty hooks.

The scale-like papillae, characteristic of the *Lepidotreminae,* are absent only on the head. Of the body-muscles, a well-developed circular, and poorly-developed longitudinal layer could be detected.

The head organs of this species are very prominent; a large anterior pair and two smaller posterior pairs being present and it appears that the latter are actually protrusible (Pl. xix., fig. 60). The cephalic glands supplying them are very small and lie well in front of the eyes, close behind the last pair of head-organs.

The mouth lies mid-ventrally, in front of the eyes. A long buccal cavity leads into the pharynx. Lateral to the very short oesophagus is a pair of digestive glands. The forked intestine is devoid of caeca and ends blindly.

No trace of nervous or excretory systems could be seen. There are two pairs of eyes immediately in front of the pharynx, situated just below the body wall in the parenchyma.

The testis is well developed, lying immediately behind the ovary, and in some specimens appears to be distinctly lobed. The vas deferens, which runs dorsally to the ovary and to the right of the uterus, becomes dilated into a large vesicula seminalis and, after narrowing, appears to open directly into the cirrus, no bulbus ejaculatorius being visible. Into the base of the cirrus there opens a small prostate gland. The cirrus is a short incompletely-closed chitinous tube, bent once upon itself and opening immediately anteriorly to the female genital aperture.

The ovary lies transversely in the middle of the body. The oviduct is a very wide, non-collapsible tube opening a short distance behind the oesophagus. The well developed shell-glands are arranged in two groups on either side of the oviduct into which they open each by a long delicate duct. There is no vagina. The vitelline system which is not very strongly developed, lies in close connection with the intestine and discharges its yolk by means of two narrow transverse yolk-ducts, situated immediately anterior to the ovary.

The egg which is relatively large, measuring approximately .06 mm. in length, was rarely present. It is somewhat oval in shape and possesses a short posterior spine.

Found on the gills of *Therapon unicolor* Gunther, from the Burnett River, South Queensland.

19. ACLEOTREMA, n.gen.

Lepidotreminae. Disc considerably broader than body, with four large hooks and a supporting chitin apparatus; fourteen minor hooks. The sucker-like organs consist of about fifteen rows of modified scales and are devoid of accessory hooks. Greater part of body protected by short proclinate spiny papillae. Four eyes present. Ovary and testis in the vicinity of the middle of the body. Vagina thin-walled, bent upon itself anteriorly and opening in the midline. Penis rather simple, but lodged in a highly developed cirrus-sac. Penis and vagina communicate with a remarkable chitinous cavity which opens on the ventral surface.

From the gills of a marine fish of the genus *Girella.*

Type species, *A. girellae* J. & T.

ACLEOTREMA GIRELLAE, n.sp. (Plate xiii., figs. 23-25; xiv., figs. 26-30.)

Length of adult worm averages about .7 mm., breadth of body about .16 mm., breadth of disc about .23 mm.

This is a rather slender species with a disc considerably broader than the body. There is much variation in shape according to the state of contraction or elongation of the individuals; at times the extension of the posterior portion may be remarkably great, the worm in this condition having a totally different appearance from that usually seen. It is chiefly the region posterior to the termination of the intestine which undergoes this elongation.

The disc is provided with fourteen minor hooks, arranged as in Pl. xiii., fig. 25 and Pl. xiv., fig. 27, as well as with four large hooks which are supported by, and articulate with a chitinous basal armature. The latter consists of a powerful transverse chitin-bar, the ends of which articulate each with a second, proximally bifurcated chitin-bar, while the two hooks on either side come into relation with the end of the bar. One of these hooks is rather slender and possesses two well-defined roots. In the other, which is a much more powerful hook, such a basal bifurcation is absent. The disc is provided with two pairs of groups of unicellular glands, the lateral pairs (Pl. xiii., fig. 25) being especially well-defined and appearing to open, by numerous converging ducts, upon the surface of the disc. The two accessory adhesive organs or squamodiscs consist each of about fifteen rows of modified body papillae, and are quite devoid of definite hook apparatus. The disc is well provided with muscles which are modifications of the longitudinal body musculature of the parasite, though it is possible that the circular layer also enters into their formation. The longitudinal muscles of the posterior lateral portion of the worm are arranged on each side in a bundle which passes outwards (Pl. xiii., fig. 25) to become inserted on the large hooks of the corresponding side. From the upper part of the disc near its junction with the body, there arises on each side a bundle of muscles passing obliquely to the hooks of the other side. The musculature of the sucker-like organs is in the form of a pair of muscles travelling down the ventral mid-line of the body.

The cuticle is developed into numerous forwardly projecting papillae, each very sharply pointed (Pl. xiv., fig. 28), but not so closely arranged as in *Lepidotes*. They are especially well developed near the disc, but gradually diminish and disappear towards the anterior half of the animal. The longitudinal layer of body-muscles is fairly distinct, but cannot be said to be strongly developed. The fibres of the outer layer run mostly in an irregular oblique manner; only in places could distinct circular muscles be detected. In the region of the genital openings the musculature undergoes a pronounced modification, a powerful group of irregularly arranged oblique, circular and longitudinal fibres being found, surrounding the huge genital cavity to be described below. Into this mass are also inserted well-defined columns of dorso-ventral fibres. The mouth is a transverse slit opening on the ventral surface, a little in front of the region of the brain. The buccal cavity is short, the pharynx large and distinct, and the oesophagus short. Into the posterior part of the pharynx opens a group of unicellular glands, clearly visible in the living animal, but in stained preparations appearing only as a dark mass. The intestine is bifurcated and devoid of caeca. In section its wall is seen to be composed of a layer consisting of several clear hyaline cells. There is no junction of limbs posteriorly.

Three pairs of head-organs are present, their ducts originating from masses of gland-cells which cause a slight projection on each side of the head. The brain, which lies immediately anterior to and above the pharynx, gives off three pairs of nerves; a small pair to the anterior extremity; the second, slightly larger, pair laterally to supply the sides of the anterior half of the body; the third pair very large and passing right along the animal, lying in close contact with the intestine (Pl. xiv., fig. 27).

The excretory system is clearly visible in living specimens as an irregular tube running close to the intestine and receiving branching vessels in the region of the testis. Posteriorly the limbs communicate close in front of the termination of the intestinal branches. The system opens on either side at about a third of the body-length from the anterior end by a pair of dilated excretory vesicles. Flowing into the base of this vesicle are the excretory vessels of the head, which in the region of the brain have a curiously complicated course (Pl. xiv., fig. 27).

The ovary lies transversely in the mid-region of the body, the oviduct leaving it on its left side to pass inward and then anteriorly where the vagina opens into it. It then passes forward, sweeping round as the uterus past the male and vaginal apertures, to open beside the cirrus sac. Its anterior half is lined with chitin and is therefore very clearly visible. The vagina travels forward after joining the narrow uterus and close behind the male opening bends inward, then turns sharply upon itself, and again bends inward, thus producing a most efficient mechanism for the retention of sperms in the vagina. The latter opens into the large genital cavity, described below. In the walls of the oviduct lie the shell-glands which are not visible in whole mounts of adult animals, but can be clearly seen in sections. They will be more fully described in the young form in which they are clearly recognisable.

The testis is a pyriform structure lying close behind the ovary. The vas deferens passes forwards and in the region of the cirrus-sac bends upon itself, then again forward to open into the penis. The vas is a fairly widely dilated tube but no special portion of it can be regarded as a vesicula seminalis. The penis is a rather simple chitinous tube with a distinct curve near its termination. It is lodged within a highly developed cirrus-sac (Pl. xiv., fig. 26) which consists proximally of a large rounded structure lined with an outer layer of circular muscles, internal to which is a group of radiating muscles, inserted upon the beginning of the penis. The sac extends forward and embraces the penis for a considerable distance. Distally it opens by a distinct, heavily chitinised aperture into the great genital cavity (Pl. xiv., fig. 29). This remarkable structure encloses a relatively large space, with collapsed walls, lined by chitin. Into its front portion open the penis and the vagina. The whole is surrounded by a complex musculature. Probably this organ is to be regarded as having an accessory copulatory function.

On the gills of the same fish which provided the specimens upon which the above description is based there were present other worms, which are probably the young of this species, since the arrangement of the discal armature, head-glands, and intestine are identical; but the genital organs are rather simpler than those above described, though they are founded on essentially the same plan (Pl. xiv., fig. 30). Ovary and testis are well developed, but the former has not yet attained the size it does in the adult worm. The walls of the oviduct lodge a number of small unicellular shellglands, whose ducts pass forward and evidently open each directly into the ootype. The uterus, which is sharply marked off from the latter, is considerably wider and passes straight forward to open close to the male genital aperture. The vagina which is connected with the uterus by a narrow chitinous duct, is constricted anteriorly, then dilated again into a small bulb which gradually tapers off to form a narrow duct opening to the exterior. This terminal portion of the organ already has an indication of the twisting which subsequently becomes so evident. The vagina opens into a small crevice, doubtless the rudiment of the remarkable structure that occurs in the adult. The vas deferens is a fairly straight tube, connected distally with a small bulbus ejaculatorius opening into the penis. The latter is less heavily chitinised than in the adult. The prominent bulbous expansion of the proximal part of the adult cirrus-sac can scarcely be detected in many cases while in others, evidently more advanced individuals, it is more distinct, but not so pronounced as in the adult forms.

Found on the gills of the marine black bream or black fish, *Girella tricuspidata* Q. and G. from Caloundra, South-east Queensland.

20. LAMELLODISCUS, n.gen.

Small slender *Lepidotreminae* in which the body is devoid of scaly papillae. Disc well developed, with the accessory locomotory disc (squamodisc) peculiarly modified in such a way as to present numerous concentric rows consisting each of a pair of laterally elongated lamellae. Eyes present. Intestine ends blindly. Cirrus simple. Vagina present. From the gills of marine fishes.

Type and only species, *L. typicus* J. and T.

LAMELLODISCUS TYPICUS, n.sp. (Plate xxi., figs. 74, 78, 78a.)

A rather small worm, measuring about .124 mm. in greatest width and .528 mm. in length. The anterior end is narrow, especially immediately behind the pharynx, while in the region of the testis the worm is at its maximum breadth, there being a distinct constriction immediately before this region. Disc connected with body by a rather long pedicle.

The disc bears four large hooks of which the ventral is somewhat bifurcated at its base (Pl. xxi., fig. 74). All four articulate with a strong chitinous crossbar. Seven minor hooks are present, their dispositions being as indicated in Pl. xxi., fig. 74. The accessory disc (squamodisc) undergoes a remarkable development, each of the concentric rows consisting, not of scaly papillae as in the other *Lepidotreminae* hitherto described, but of a single pair of laterally-elongated lamellae.

The integument is remarkable in that no trace of scaly papillae could be discovered. This is perhaps correlated in some way with the curious development of the squamodisc, a structure which, as already stated, is probably produced as a modification of these scaly papillae. The muscle-system is feebly developed, the transverse system being scarcely evident in preparations. In the posterior region, however there are two pairs (a dorsal and a ventral) of bundles of longitudinally running fibres passing to the disc (Pl. xxi., fig. 74).

The cephalic glands are well developed and lodged on each side of the pharynx in a pair of distinct swellings (Pl. xxi., fig. 78), their ducts travelling forward to open through three pairs of head-organs.

The mouth is situated sub-terminally; the pharynx is very small, and the oesophagus extremely short. The intestinal limbs are entirely devoid of caeca and end blindly a little before the disc.

Two pairs of eyes are present immediately in front of the pharynx; those of the posterior pair being larger and closer together than the anterior. The brain is situated beneath them, but no details of the nervous system could be observed.

The testis is situated in the middle of the body and is so large that it produces a distinct bulging of the body in this region. The vas deferens appears to originate at its posterior portion; it travels forward, then turns inward towards the midline and then forward again to pass as a rather widely dilated duct serving as a seminal vesicle, into the region of the cirrus, narrowing suddenly before it enters the latter structure from above. The cirrus is a medium-sized, simple chitinous tube, passing directly backward to terminate at the male genital aperture.

The ovary is a curved organ lying just in front of the testis. The oviduct passes inward from its most anterior portion and then forward as the uterus. The vagina is a simple thin-walled tube, which appears to be lined with a thin layer of chitin. It passes backward, crosses the path of the uterus, then turns inward and forward again and opens into the ootype. There is formed a small distension in its posterior region, which apparently serves as a receptaculum seminis. Shell-glands could not be seen.

The vitelline system is very well developed. It closely follows the limbs of the intestine, but undergoes a great development in the mid-region of the body, there occupying a considerable area immediately anterior and posterior to the testis, when it stretches right across the body so as to encircle the male gland. The yolk is transferred to the female tubes by a pair of transverse yolk-ducts, situated considerably anterior to this region. No eggs were present in the specimens examined.

From the gills of the common marine bream (silver bream), *Sparus australis* Gunther, from Moreton Bay.

Subfamily IV. MERIZOCOTYLINAE, n. subfam.

Syn. *Anisocotylinae* Monticelli, 1903 (in part).

Gyrodactylidae in which the disc is provided with suckers as well as major hooks. Cephalic glands open by distinct head-organs. Testis single or double. Ovary unbranched. Vagina present.

From the gills and nasal glands of marine fishes.

This subfamily includes the following genera:—*Merizocotyle* Cerfontaine and *Empruthotrema* J. and T.

21. MERIZOCOTYLE Cerfontaine, 1894.

Medium-sized worms, in which the disc is provided with a small number (five to seven) of central suckers and a ring of from twelve to eighteen marginal suckers, the latter provided each with a minor hook. Two major hooks present. Four eyes. Cirrus simple. Testis and ovary single and compact. Two vaginae present (according to MacCallum). Vitellaria well developed.

From nasal gland and gills of stingrays in America and Europe.

Type species, *M. diaphana* Cerf.

This genus has been placed by various authors in the *Monocotylidae, Anisocotylinae* and *Tristomidae*. The presence of distinctly glandular head-organs undoubtedly shows its relationship with the *Gyrodactylidae*. At the same time the double vagina and the remarkable "sucker-disc" are characters which distinctly separate the genus from members of any other subfamily belonging to that family. (See also under genus *Lophocotyle*).

Known species:—*M. diaphana* Cerf., 1894; *M. minor* Cerf., 1898; *M. dasybatis* MacCallum, 1916.

22. EMPRUTHOTREMA, n.gen.

Medium-sized robust *Merizocotylinae*, about 1.6 mm. in length, in which the disc is nearly as wide as the body, and is provided with fourteen marginal and five central suckers. Major hooks are absent, but minor hooks are found marginally, one between each pair of suckers. Anterior end broad and provided with three head-organs, doubtless glandular. Small pharynx; short oesophagus. Intestinal limbs end blindly. Testis double and very large; penis fairly simple. Ovary compact; shell-glands strongly developed. Vagina paired.

From the gills of *Raja erinacea*—Massachusetts.

Type species, *E. raiae* (MacCallum, 1916).

This species has been described and figured by MacCallum as a species of *Acanthocotyle*, a decision which is obviously incorrect. The author does not mention the presence of cephalic glands, but his figure suggests that they do occur; in almost every other respect the worm is closely allied to *Merizocotyle*.

Family III. MONOCOTYLIDAE Taschenberg, 1879.

Small, slender or robust, medium-sized *Gyrodactyloidea* in which the glandular head-organs are absent. The disc has developed into a sucker-like structure, a character which is already present in the *Merizocotylinae*. Major hooks present, though apparently at times absent. Eyes present or absent. Testis simple and compact or broken up into follicles. Ovary simple. Vagina present (or absent?), generally paired. Intestine bifurcated, caeca present or absent.

From the gills of Elasmobranchs.

It is customary to include the *Monocotylidae* with the *Tristomoidea*, but the affinities of the group are much more with the *Gyrodactylidae*, *Merizocotyle* forming an intermediate link.

The following genera belong to the family:—*Monocotyle* Tschbg., 1878; *Trionchus* MacCallum, 1916; *Calicotyle* Dies., 1850; *Microbothrium* Olsson, 1869; *Pseudocotyle* v. Ben. and Hesse, 1865; perhaps also *Leptocotyle* Montic., 1905.

Key to sub-families of Monocotylidae.

A. a. Disc about as broad, or a little broader than body .. .. .. *Monocotylinae*
b. Disc much narrower than body .. .. B.
B. a. Anterior end of worm narrow, posterior end very broad; disc divided by radii into several suckers and armed with hooks .. .. .. *Calicotylinae.*
b. Both ends attenuated, disc very small, devoid of radii, and of large hooks .. .. *Pseudocotylinae.*

Subfamily I. MONOCOTYLINAE Gamb., 1896.

Slender *Monocotylidae* in which the disc is about as broad as body and provided with two or three major hooks. Testis compact. Vagina single (or double ?).

In addition to *Monocotyle*, we are including *Trionchus* in this subfamily.

23. MONOCOTYLE Taschenberg, 1878.

Elongated worms with large posterior clasping disc, divided by eight radii into as many suckers. Two major hooks and numerous minor hooks, the latter scattered over the disc, especially at its margin. Mouth very large, situated at anterior end. Vagina single (or double ?). Intestinal limbs end blindly. Eggs oval and provided with a filament. From Elasmobranchs.

Type species, *M. myliobatis* Tsch.

Known species:—*M. myliobatis* Tsch., 1878 (Europe); *M. ijimae* Goto, 1894 (Japan); *M. dasybatis* MacCallum, 1916 (U.S.A.).

MONOCOTYLE MINIMA, nom. nov.

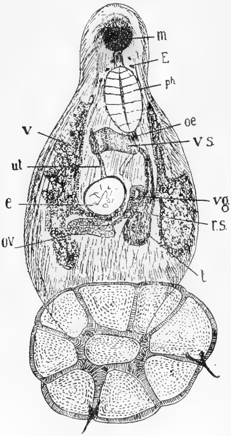
(Syn. *M. dasybatis minimus* MacCallum, 1916.)

In 1916 MacCallum described two species of *Monocotyle* from a stingray, *Dasybatus pastinacus*, from Massachusetts,—viz., "*M. dasybatis* nov. sp." and "*M. dasybatis minimus* nov. sp." Both are well figured and a glance is sufficient to show that the two are quite distinct, not only in their dimensions but in regard to the major hooks of the disc, the oral region, disposition of the ovary and testis, etc. No suggestion was made by the author that the second species was to be regarded as a variety or subspecies of the former, but the two were evidently considered as quite distinct species. It seems to us that the second name is a pure trinomial and accordingly invalid as a combination. In order to avoid unnecessary confusion we have deemed it expedient to rename the species as *Monocotyle minima*.

MONOCOTYLE ROBUSTA, n.sp. (Text-fig. 1.)

This is a rather small stout species, measuring about .72 mm. in length and .30 mm. in maximum body-breadth. The disc is nearly circular and relatively very large, measuring about .31 mm. in diameter. The anterior end of the worm is narrow and dome-shaped, but the body immediately behind the pharynx broadens out, reaching its maximum breadth in the region of the ovary, then narrowing considerably to be joined by a relatively broad pedicle to the disc.

The disc bears a small sucker in its middle, from whose walls eight radii pass outwards and divide the margin into as many marginal suckers. The disc is therefore a very powerful adhesive organ, but its efficiency is increased by a pair of large hooks situated on the outer angles of the two posterior suckers. In other species minor hooks have been described, one belonging to each sucker;



Text-fig.1.—*Monocotyle robusta*, entire animal.

but in this form their presence has not been seen with certainty. Each of the larger hooks has two roots, one very long, the other relatively short and provided with minute muscles.

The skin is quite devoid of papillae. Longitudinal and circular muscle-layers can be distinguished, but only the latter is well developed, especially in the region of the mouth which must be a fairly labile organ. The pharynx which lies close behind the mouth is relatively very large, measuring nearly .1 mm. in length. There is a short oesophagus. No details of the intestine could be made out in the material available.

Immediately in front of the pharynx are four eyes, the posterior two being larger and situated further apart.

The genitalia are rather difficult to observe on account of the closeness with which they are massed together in this short animal. The ovary is situated in the midline slightly behind the middle of the animal. It is bent once upon itself in the transverse direction and then opens by a short oviduct into the uterus. The latter is a long narrow tube, apparently lined distally with a thin layer of chitin. It opens close beside the pharynx, and when an egg is present is seen to be considerably distended in this region where the shell-glands lie. A very short vagina is present, opening on the mid-ventral region by a very distinct aperture. What appears to be a very large receptaculum seminis is to be seen in close connection with the vagina.

The vitelline system is very well developed and obscures all structures beneath it. The transverse yolk-ducts pass inward towards the female ducts immediately in front of the ovary. The yolk-glands extend from the region of the pharynx right to the posterior end of the body, where they are especially abundant.

The testis is fairly large, lying beside and close behind the ovary. The vas deferens passes forward on the left side of the body, to open into a very prominent vesicula seminalis close behind the pharynx. The penis seems to be a fairly large, though not very distinct structure, lying close to the vesicula, but its exact structure could not be made out.

From the gills of a common stingray, *Urolophus testaceus* Mull. & Henle from Sydney.

24. TRIONCHUS MacCallum, 1916.

"The mouth large and sub-terminal, much like an ordinary sucker; genital pore central; cirrus chitinous; single testicle posterior to ovary; a relatively large sucker disc with one large loculus in the centre and three small marginal ones. There are also on the disc three hooks, one large one terminating in two points and also two smaller ones" (MacCallum). To which may be added:—pharynx remarkably small; ovary very large and bent in a semicircle; vagina apparently absent.

Type and only known species, *T. dasybatis* MacCallum, 1916, from the gills of *Dasybatus pastinacus* at Wood's Hole, Massachusetts.

Subfamily II. CALICOTYLINAE Monticelli, 1903.

Rather large robust *Monocotylidae,* much broader behind than in front; the disc very much narrower than the body and divided into a number of suckers. Large hooks present on disc. Vagina double. Testis broken up into numerous follicles. Cirrus simple.

Calicotyle Dies. is the only genus as yet known belonging to this subfamily.

25. CALICOTYLE Diesing, 1850.

Disc divided by seven radii into as many marginal suckers; a small central sucker also present on disc. Minor hooks absent, but two large powerful hooks present. Testis elongated transversely and broken up into numerous follicles.

Cirrus simple. Ovary small, elongated transversely and coiled slightly. Vagina double.

From marine fishes (Elasmobranchs).

Type species, *C. kroyeri* Diesing, 1850. There are various spellings for this name e.g. *Calycotyle, Callocotyle, Calliocotyle, Callicotyle* but *Calicotyle* has precedence.

Known species: *C. kroyeri* Dies., 1850 (Europe); *C. mitsukurii* Goto, 1894 (Japan); and *C. stossichi* Braun, 1899 (Europe).

Subfamily III. PSEUDOCOTYLINAE Monticelli, 1903.

Robust *Monocotylidae,* with attenuated ends; sucker exceedingly small and devoid of hooks or suckers. Intestinal limbs provided with caeca. Vagina paired or unpaired. Testis compact or broken up into follicles.

26. MICROBOTHRIUM Olsson, 1868.

Pseudocotylinae with "elliptical body with attenuated ends. Vagina unpaired, opening on left of ventral surface. One large compact testis"—(Pratt). From Elasmobranchs (N.W. Europe, Canada).

Type and only known species, *M. apiculatum* Olss., 1869.

The genus was described as a member of the *Tristomidae.* In 1879 Taschenberg considered it to be a synonym of *Pseudocotyle,* as also did Monticelli (1903), Braun (1890) and Stafford (1904). Pratt's figures (1900) show them to be distinct, and in view of our lack of the necessary literature we have listed the two genera separately.

Although Monticelli (1892, 1905) referred to *Microbothrium* as a synonym of *Pseudocotyle,* yet he admitted (1905, p. 70, footnote) that it might be retained as a subgenus of the latter, and at the same time proposed *Leptocotyle* as a subgenus, its type species being *P. minor.*

Olsson (1869) in describing *M. fragile,* assigned this parasite of *Raja batis* doubtfully to *Microbothrium.* Braun (1890) placed it under *Pseudocotyle.* In 1897 Jaegerskiold described an ectoparasitic Triclad (*Micropharynx parasitica,* n.g. et sp.) from two other Scandinavian rays *R. clavata* and *R. laevis,* and mentioned its possible identity with Olsson's species. Stafford (1904) accepted the synonymy and reported the presence of the worm in Canadian waters. In view of these statements the species can be removed from the Gyrodactyloidea.

27. PSEUDOCOTYLE v. Beneden and Hesse, 1865.

Pseudocotylinae in which the vagina is very small and paired. Testis broken up into numerous follicles. Intestinal caeca very long and slender.

From skin of Elasmobranchs.

Type species, *P. squatinae* Ben. and Hesse, 1865.

Known species: *P. squatinae* Ben. and Hesse, 1865; *P. minor* Montic. 1888.

As already mentioned above, it has been stated that *Microbothrium* is a synonym of *Pseudocotyle.* In 1905 Monticelli proposed a subgenus, *Leptocotyle,* to receive *P. minor,* but as we have not access to the literature, we refrain from discussing its status.

Family IV. CALCEOSTOMIDAE (Parona & Perugia, 1890) Monticelli, 1903—emend. J. & T.

Gyrodactyloidea in which the cephalic glands do not open by ducts concentrated into head-organs, but remain scattered over a considerable area on either side of the head. Posterior disc showing a tendency towards sucker-like structure, though no distinct sucker is produced. Correlated with this, there is a diminution or even disappearance of the major hooks. Eyes present or absent. Intestine with or without caeca. Testis single or double. Ovary simple or branched. Cirrus simple. Vagina present or absent.

From the gills of fishes.

The name *Calceostomidae* was first used by Parona and Perugia in 1890, but was employed to designate a subfamily, Monticelli in 1903 raising the subfamily to the status of a family.

We have subdivided the family into the *Calceostominae* and *Dionchinae.*

Subfamily I. CALCEOSTOMINAE Monticelli, 1892.

(Syn. *Calceostomidae* Parona and Perugia, 1890.)

Calceostomidae with a bifurcated intestine provided with very marked caeca. Vagina (apparently) present or absent. Testis single. The head develops a pair of head lappets.

Including the genera *Calceostoma* v. Ben., 1858, and *Fridericianella* Brandes, 1894.

28. CALCEOSTOMA van Beneden, 1858.

Calceostominae. Large worms, measuring from about 5 to 8 mm. in length. Posterior disc broader than body and somewhat cup-shaped; unarmed or provided with an armature consisting of a central group of two comparatively small hooks as well as minute marginal hooks. From the anterior end, immediately in front of the eyes, are developed a pair of very remarkable head-lappets. A pair of large glands occupy the greater part of the head and open by numerous ducts in the vicinity of the mouth. Eyes present (or absent according to accounts of the European species). Pharynx large; intestine bifurcated with prominent caeca. A single elongated testis; cirrus rather simple. Ovary branched. Vitellaria well developed. Vagina absent.

Found on the gills of marine fishes.

Type species, *C. calceostoma* (Wagener, 1857) J. & T., 1922, Syn., *C. elegans* van Beneden, 1858. Other known species, *C. inerme* Par. & Per., 1889.

CALCEOSTOMA GLANDULOSUM, n.sp. (Plate xxi., figs. 75-77; xxii., figs. 79-86.)

This is a large worm, measuring about 5 mm. in length and .9 mm. in breadth.

The disc is broader than the body of the worm and somewhat cup-shaped in general appearance, with a very strongly crenated margin. The dorsal and more posteriorly lying portion of the "cup" is marked off from the anterior and more ventrally situated part by a prominent septum which has a less strongly crenated free edge (Pl. xxii., fig. 86). The anterior section of the cup is rather larger than the posterior and contains the powerful hook apparatus. This consists of two large hooks articulating with a small chitinous complex which, in turn, rests at the end of a long bar of chitin. An intricate system of muscles is developed in connection with the whole apparatus. The hooks are powerful, sharply-pointed and curved almost into a semicircle. The basal part of each is broad, with short irregular projections, the mechanical action of which upon the chitinous complex probably serves to give perfection to the action of the whole clasping apparatus. The chitin complex, with which the hooks articulate, rests upon the top of a long supporting bar and is provided on each side, on its more ventral portion, with three long processes, the upper two pairs being the largest; while the more dorsal part is developed into two pairs of short stout bosses. The hooks articulate with the complex between the ventral pair of processes. The musculature of the hook apparatus is attached to these processes. A pair of very large powerful muscles, lying on either side of the median chitin bar, are inserted on the common base of the two large more dorsally and posteriorly situated of the processes, while weaker muscles are attached to the smaller processes. Numerous transverse muscles—excessive development of the outer circular muscle-layer—are inserted on the longitudinal supporting bar and add to the complexity of the whole structure. A more weakly developed transverse muscle lies immediately in front of the longitudinal chitin-bar and lodges a small sesamoid-like piece of chitin which articulates with the base of the latter.

Immediately internal to the crenated margin of the disc are two rows of numerous very minute hooks, each with a bifurcated basal attachment (Pl. xxii., fig. 84).

The head develops two prominent head-lappets (characteristic of *Calceostoma*) provided with the curious ornamentation seen in the figure. The fact that blood-corpuscles from the host occur in the intestine of the parasite suggests that these organs have a suctorial function; though it is also possible that an undulating movement, for which they seem well adapted, would serve to waft food towards the mouth.

The integument (Pl. xxi., fig. 76) possesses a well developed cuticle, below which lie the muscle-layers with which it is connected by a rather loose subcuticular tissue. The outer circular musculature is very poorly developed, and in places quite absent. The longitudinal layer is strongly marked and interior to it lies a second circular layer, much more prominent than the outer circular.

In the posterior region of the animal, behind the intestine, lie masses of unicellular glands which appear to open on the ventral surface.

The mouth lies ventrally immediately behind the lappets and just in front of the pharynx. The buccal cavity is short; the pharynx large, prominent, and devoid of gland-cells within its walls. There is no definite oesophagus. The intestine is bifurcated, the two limbs joining again behind the testis. Intestinal caeca are well developed, especially on the outer side of the intestine, one pair extending forwards half way along the pharynx. There is a similar posterior extension considerably behind the connecting piece of the intestinal limbs. The intestine is lined by a single layer of cells.

In the anterior portion of the body are two great masses of unicellular glands beginning considerably behind the pharynx at the sides of the body and gradually broadening out to form two prominent masses just in front of the pharynx. From each cell a duct is given off (Pl. xxii., fig. 82) uniting with ducts from neighbouring cells. In this way are formed a large number of transverse ducts which run below the pharynx and appear to open into the buccal cavity and, possibly also, into the ventral part of the pharynx.

It is possible that these glands are homologous with the cephalic glands of *Gyrodactylidae*, the characteristic head-organs of that family being probably an accumulation of numerous ducts which are seen separated and distributed in *Dionchus* where the arrangement seems to be intermediate between the two types of structure.

No other glandular organs could be seen in connection with the intestine.

The excretory system can be observed in serial section lying immediately below the intestine on each side (Pl. xxi., fig. 75) as a tube with a moderate lumen containing a small amount of spongy tissue. In close connection with these ducts are a number of muscle fibres. The tubes extend forward as far as the pharynx, increasing in size and becoming more infiltrated with spongy connective tissue, then pass forward and downward to open by a number of minute openings into the posterior portion of the vestibule which is surrounded by the head lappets (Pl. xxi., fig. 77). Posteriorly the longitudinal ducts can be traced as far back as the end of the intestine. In the region of the pharynx the excretory ducts give off a large spongy sinus-like extension over this structure, thus forming a connection between the left and right tubes. Dorsally to the pharynx this connecting branch also receives two smaller ducts which run along the dorsal surface above the intestine and immediately below the body-wall for about half the length of the animal.

Two pairs of eyes are present lying below the body-surface, immediately in front of the pharynx. The anterior eyes are rather farther apart and somewhat smaller than the posterior. Both pairs, however, are abnormally small and this may account for their reported absence in the European species. Moreover, in specimens which have been compressed, the granules of the eyes generally break apart and this may further account for their not having been found previously in this genus.

The brain is very feebly developed and is visible in section simply as a small mass of nervous tissue between and before the eyes. The lateral nerves could not be observed.

There is a large, very faintly lobed testis reaching back as far as the posterior junction of the intestinal limbs. The vas deferens is given off from it anteriorly in the median-ventral line, then passes to the left slightly and dilates into a large vesicula seminalis, a second vesicle being formed a little further on. The vas deferens continues thence as a narrow tube forwards, then backwards to communicate with the cirrus. Into its most anterior portion opens the duct from a very prominent prostate gland. The cirrus is a simple chitinous tube, passing vertically downwards and giving off a second chitin-tube to the right (Pl. xxii., fig. 81).

The strongly branched ovary lies well in front of the testis. The oviduct passes almost vertically downward from it (Pl. xxii., fig. 81) after receiving the yolk from an indistinct yolk-reservoir, then forward as a moderately distinct tube, opening to the exterior close behind the male genital aperture. The shell-glands appear to be merely glandular thickenings of the uterine walls. The egg has not been found. The vitelline system is strongly developed and closely follows the contour of the intestine, which it almost surrounds, appearing therefore, in side view, as a double-layered system. The transverse yolk-duct lies immediately in front of the centre of the ovary and opens into the ootype just before that structure bends down to continue forwards as the uterus.

Found on the gills of the marine jew-fish, *Sciaena antarctica* Castelnau, from Caloundra, South Queensland.

Two other species of *Calceostoma* have already been recorded from marine fishes, *C. calceostoma* (Wagener)—usually known as *C. elegans* Ben.—and *C. inerme* Parona and Perugia, both from Europe. In these species eyes have not been seen; if they are present, their minute size and the ease with which they disintegrate may account for their not having been observed. The head-lappets of *C. glandulosum* are rather less prominent than those figured for *C. calceostoma.* A comparison of the hook apparatus with that of the known species is not possible, since the descriptions given indicate that certain of its components had either been missed, or had dropped off. Wagener's species is stated to possess a single large central hook, but it is possible that the minor hooks have not been observed in this form. In *C. inerme,* on the other hand, it may be that the large hooks have dropped off, or, as frequently happens in *C. glandulosum,* are hidden by the folding of the clasping disc.

29. FRIDERICIANELLA Brandes, 1894.

Calceostominae. A rather large species (4 to 5 mm. in length) in which the head-lappets, though prominent, do not attain the extraordinary development seen in *Calceostoma.* Glandular protuberance on one side of body. Eyes? Ovary not branched. Vagina present. Single testis. Intestine similar to that of *Calceostoma.*

Type and only known species, *F. ovicola* Brandes, from the eggs of *Arius commersonii,* a fresh- and brackish-water fish from South Brazil. The male of this fish carries the eggs in its mouth till the emergence of the young, a fact which probably accounts for the curious position recorded for the parasite which we suspect normally infests the gills of its host.

According to Brandes there is a vitello-intestinal duct present, opening apparently on to the dorsal body surface! It seems more reasonable to accept Goto's suggestion (1899) that this is the true vagina, the "Seitenwulst" of Brandes being probably an accessory copulatory organ.

APPENDIX TO *Calceostominae.*

30. CATHARIOTREMA, n.gen.

In this subfamily is possibly to be included a worm described and figured by MacCallum (1916) as *Monocotyle selachii.* The remarkable nature of the anterior end and the presence of numerous minor suckers on the adhesive disc seem to exclude the species from that genus. The head-lobes are exceedingly suggestive of *Calceostoma,* while the "sense-papillae" may readily be regarded as the scattered openings of cephalic glands. If this view be eventually found to be correct, then the genus, for which the name *Cathariotrema* is suggested, must undoubtedly be classed amongst the *Calceostominae.* Meanwhile, it is simply classed as an appendix to that group.

Diagnosis:—Rather large forms in which the disc is distinctly broader than the body and is provided with numerous minute suckers. Two large hooks and many minor hooks present. Anterior end provided with large lappets, enclosing the mouth behind. Eyes absent. Intestine bifurcated, devoid of caeca, and ending blindly behind. Testis and ovary simple. Vagina apparently present. Vitelline system very extensive. From the nasal glands of sharks.

Type, *C. selachii* (MacCallum, 1916) J. & T., from *Carcharias obscurus* and *Cestracion zygaena* (= *Sphyrna zygaena*)—from Massachusetts.

Subfamily II. DIONCHINAE, n. subfam.

Calceostomidae in which the posterior disc possesses two diminutive major hooks and at times numerous minor hooks. Distinct head-lappets absent. Eyes present. Intestine bifurcated, devoid of caeca. Testis double (see, however, Appendix to *Dionchinae*). Penis simple. Ovary unbranched. Vagina present or absent.

From the gills of marine fishes.

Including the genera *Dionchus* Goto, 1899; *Dionchotrema,* n.gen.; *Lophocotyle* Braun, 1896; and possibly *Anoplodiscus* Sonsino, 1890.

Monticelli (1903) placed *Dionchus, Anoplodiscus, Lophocotyle* and *Merizocotyle* in the *Monocotylidae, Anisocotylinae*; while Pratt (1900) grouped the first, third and fourth of these in his key as a separate section of the *Monocotylidae,* while the second was placed among the *Gyrodactylidae.*

31. DIONCHUS Goto, 1899.

Dionchinae. Goto defined the genus thus:—"Body flat and elongated; with a single posterior sucker, the inner surface of which is divided by radial ridges into ten areas, with one pair of chitinous hooks. Mouth at a short distance from the front end; intestine bifurcated, simple. With four eye-spots. Porus genitalis communis submarginal. Testes two, one lying in front of the other. No vagina."

To this diagnosis may be added:—strong development of cephalic glands whose ducts do not become concentrated into head-organs, but open separately round the margin of the head.

Type and only known species, *D. agassizi* Goto, 1899, from gills of a marine fish *Remora brachyptera.* From Newport, Rhode Island, U.S.A.

Goto regards this form as combining Gyrodactylid and Monocotylid characters, showing a specially close resemblance to *Fridericianella* in the former group, a genus which seems to us to be intermediate between *Calceostoma* and *Dionchus.*

32. DIONCHOTREMA, n.gen.

(Syn. *Acanthodiscus* MacCallum, 1916, *nec* 1918; *nec* Uhlig, 1906.)

A small species with the disc distinctly marked off from the body and provided with two large and numerous smaller hooks. Cephalic glands prominent, opening on the surface by scattered apertures. Eyes present. Intestine bifurcate. Ovary simple. Vagina present. Vitelline system well developed. Two testes. Penis simple.

Type (and only known) species, *D. remorae* (MacCallum, 1916) J. &. T. From the gills of *Echeneis naucrates,* from New York Aquarium.

The presence of distinct cephalic glands opening apparently diffusely on the head, two large discal hooks and a pair of testes show that *Dionchotrema* is closely allied to *Dionchus.* In the latter genus, however, the vagina is lacking.

MacCallum (1916) placed this form in the Family *Gyrodactylidae,* genus *Acanthodiscus,* a name which had not previously been used in connection with Trematoda. Two years later he employed the same name, designating it as a new genus, so presumably he had intended employing it as such in 1916, though it was not so indicated and no generic diagnosis was given. The two species which he referred to this generic name are considered by us to represent two different genera and, since the name was already preoccupied by Uhlig in 1906 for a Molluscan genus, we have proposed two new genera viz., *Dionchotrema* for his *A. remorae,* and *Protomicrocotyle* for his *A. mirabilis* (see later).

APPENDIX TO *Dionchinae.*

33. ANOPLODISCUS Sonsino, 1890.

In 1890 Sonsino described a new trematode to which he gave the name *Anoplodiscus richiardii,* from the gills of a marine fish, *Pagrus orphus.* He regarded it as having affinities with the Tristomids and Gyrodactylids. His very insufficient description was slightly amplified in 1905 by Monticelli. From the account given by the latter it seems possible that the species dealt with is a member of the *Gyrodactyloidea,* with affinities towards *Dionchus.*

St. Remy and also Perrier regarded it as belonging to the *Udonellidae.* Monticelli placed it in the *Calceostominae* (1892) but at a later date (1905) considered it as in no way related to *Calceostoma* and placed it in the *Monocotylidae,* forming with *Lophocotyle, Merizocotyle, Dionchus* and *Lintonia* the subfamily *Anisocotylinae,* to which reference has already been made. Pratt included it amongst the *Gyrodactylidae.* The insufficient descriptions published prevent us from being able to classify the genus definitely.

It is apparently to be diagnosed as follows:—Body fairly elongate, anterior end sub-truncate; cephalic glands present (?), opening to anterior end by numerous scattered apertures. Disc not sharply marked off; devoid of hooks. Eyes absent. Intestine not bifurcated; extending to posterior end of animal. Testis and ovary in anterior portion of body; single and not lobed. Penis simple. Vagina absent.

From the gills of a sea bream, *Pagrus orphus* (Mediterranean).

Type and only known species, *A. richiardii* Sonsino, 1890.

V. Appendix to *Gyrodactyloidea.*

Subfamily I. ACANTHOCOTYLINAE Montic., 1903.

34. Acanthocotyle Monticelli, 1888.

Small or medium-sized trematodes in which the posterior disc is provided with numerous radiating rows of minute hooks; two larger hooks, or a small terminal accessory disc bearing minor hooks may be present. Anterior end provided with head-organs into which unicellular glands open; or (apparently) with several small suckers. Intestine bilobed, devoid of caeca. Eyes present or absent. Testis very extensive and in the form of numerous small follicles. Vagina apparently present. Ovary simple, unbranched. Yolk system very extensive. Parasitic on the skin of rays.

Type species, *A. lobianchi* Monticelli, 1888.

Known species: *A. lobianchi* Montic., 1888; *A. oligotera* Montic., 1899; *A. elegans* Montic., 1890; *A. concinna* Scott, 1902; *A. monticellii* Scott, 1902; *A. verrilli* Goto, 1899; *A. branchialis* Willem, 1906 and *A. bothi* MacCallum, 1913. A species which MacCallum (1916) described as *A. raiae* is clearly not a member of this genus; no head-organs are mentioned: it appears to be a member of the *Merizocotylinae* and has been referred to under *Empruthotrema.*

The affinities of this genus are doubtful. Both Monticelli and MacCallum gave an account of species in which they mention the presence of oral suckers. Goto (1899) described *A. verrilli* as having cephalic glands opening on the head in the typical Gyrodactylid manner and as a result of his examination of some specimens of Monticelli's *A. lobianchi,* stated that what this author took for oral suckers were in reality the openings of glands, similar to those occurring in *A. verrilli.* Monticelli (1890, 1899) also described two other forms, *A. oligoterus* and *A. elegans,* which Goto did not re-examine. MacCallum (1913, 1917) described another form *A. bothi* from the United States, in which he saw four pairs of oral suckers which he calls tactile areas in his figure (1917, fig. 27), and actually noticed the worms attaching themselves by these alone. He does not, however, state whether glands open into these organs or not. MacCallum (1916, p. 23) regards the genus as belonging to the *Gyrodactylidae,* while Monticelli considers it as a member of the *Tristomidae* (1888) *Acanthocotylinae* (Montic., 1903). Until the other species are more fully described it will not be possible to determine their systematic position. Monticelli's subfamily name, *Acanthocotylinae* may be retained at present. Meanwhile, the following suggestions may be made:—

It seems certain that *A. verrilli* Goto and *A. lobianchi* Montic. are Gyrodactyloidea, allied, perhaps, to the *Gyrodactylinae.* The presence of an accessory armed disc in *A. verrilli* is suggestive of what occurs in the *Lepidotreminae,* but there is probably no real relationship. The follicular nature of the testis shows Microcotylid affinities, a view which is strengthened when we consider that in this genus *Acanthocotyle* we have a transition between head-organs and the oral suckers of that group. This view is rendered more probable when we remember that in *Empleurodiscus* the head-organs are actually protrusible and may therefore have some secondary attaching function.

APPENDIX TO *Acanthocotylinae.*

35. LOPHOCOTYLE Braun, 1896.

Body flat, tongue-shaped, with distinctly marked off head region, at the front of which two groups of unicellular glands open. Disc large, circular, provided with numerous large radial ridges, and a ring of hooklets marginally. Intestine bifurcate, provided with caeca. Genital pore close behind pharynx just to left of midline. Testes numerous; vas deferens with large convoluted vesicula; cirrus with straight spicule. Ovary oval, in front of testis. Vagina ?. Eggs provided with operculum and with basal filament. Parasites on body of marine bony fish.

Type and only known species, *L. cyclophora* Braun.

From *Notothenia* sp., locality Puerto Toro (Hamburg Magellan-Expedition).

This genus which, in its form and intestinal characters, reminds one of *Epibdella,* is usually considered as a member of the *Monocotylidae,* but the presence of glandular head-organs will not admit of its inclusion in that group. Monticelli (1903, p. 336; 1905, pp. 68-70) grouped it along with *Dionchus, Merizocotyle, Anoplodiscus* and *Lintonia* * in his subfamily *Anisocotylinae* but the non-existence of a generic name corresponding with the subfamily designation prevents the retention of Monticelli's name. Pratt (1900) placed it next to *Dionchus* but the presence of numerous testes and intestinal caeca, as well as the general structure, seem to us to prevent its inclusion in the *Calceostomidae.* The testicular arrangement and general form of the worm remind one of *Acanthocotyle* Montic., but the latter does not possess intestinal caeca. In the light of our present knowledge we propose to attach the genus provisionally as an appendix to the *Acanthocotylinae.*

Subfamily II. PROTOMICROCOTYLINAE, n. subfam.

36. PROTOMICROCOTYLE, n.gen.

(Syn. *Acanthodiscus* MacCallum, 1918, *nec* 1916; *nec* Uhlig, 1906.)

An elongate minute form, with distinct disc clearly marked off and bearing several hooks. Four small suckers towards the posterior end of the body. Pos-

*Lintonia was proposed by Monticelli (1904) to receive *Nitzschia papillosa* Linton from *Gadus callarias* from Massachusetts. We have not been able to consult Monticelli's paper but Linton's figures and short account (1898) show that the species cannot rightly be included under *Nitzschia.* The general form and the character of the testes suggest that *Lintonia* belongs to the *Gyrodactylidae* but in view of our lack of information regarding the "lateral suckers," as to whether they are "bothria" or else glandular "head-organs," we are unable to state whether the genus is to be regarded as a member of the Gyrodactyloidea or the Tristomoidea.

terior part of body-surface apparently developed into spiny papillae. No eyes. Two mouth suckers present. Small pharynx. Numerous follicular testes and a long narrow vas deferens. Penis armature in the form of a coronet of spines. Single ovary. Apparently a single egg with a spine and a long filament.

From the gills of a marine fish, *Caranx hippos*—New York Aquarium.

Type and only known species, *P. mirabilis* (MacCallum, 1918), J. &. T.

This remarkable worm was described by MacCallum (1918) under the name *Acanthodiscus mirabile*, n.gen. et sp. As already pointed out the generic name was already preoccupied and therefore not available for use. The name *Protomicrocotyle* is therefore suggested and is intended to emphasize the systematic relationship of the worm.

The presence of a distinct disc and (apparently) of a single egg, suggests Gyrodactyloid affinities. On the other hand, there are two mouth-suckers, a long series of testes, a "cirrus-coronet," and suckers on the posterior portion of the body, characters which distinguish the *Microcotylidae.*

MacCallum suggested that the genus was a member of the *Gyrodactylidae.* This is clearly incorrect, the entire absence of head-organs serving to exclude it from that group. Nor is it a true Microcotylid. It seems more probable that we have here an organism which is intermediate between the Gyrodactyloidea and the *Microcotylidae,* with stronger affinities towards the latter group, and that a more accurate study of its anatomy may lead to its falling into a new family. For the present it may stand as the type of a new subfamily, *Protomicrocotylinae,* whose characters, as far as is now known, would be those of the genus.

List of Australian hosts and gill-parasites referred to in this paper. Freshwater fish indicated by an asterisk.

Family *Dasyatidae* (Stingrays).	
Urolophus testaceus Muller & Henle	*Monocotyle robusta* J. &. T.
Family *Plotosidae* (Eel catfishes.)	
* *Tandanus tandanus* Mitchell.	*Anchylodiscus tandani* J. and T.
* *Neosilurus hyrtlii* Steind.	*Anchylodiscus* sp.
Family *Serranidae* (Perches).	
* *Therapon carbo* Ogilby and McCulloch.	*Protogyrodactylus quadratus* J. and T. *Daitreosoma constrictum* J. and T. *Lepidotrema therapon* J. and T.
* *Therapon fuliginosus* Macleay.	*Trivitellina subrotunda* J. and T. *Lepidotrema fuliginosum* J. and T. *Flabellodiscus simplex* J. and T.
* *Therapon hilli* Castln.	*Daitreosoma bancrofti* J. and T. *Lepidotrema tenue* J. and T.
* *Therapon unicolor* Gunther.	*Empleurosoma pyriforme* J. and T. *Empleurodiscus angustus* J. and T.
**Plectroplites ambiguus* Richdsn.	*Lepidotes fluviatilis* J. and T.
Family *Sparidae* (Sea breams).	
Girella tricuspidata Q. and G.	*Acleotrema girellae* J. and T.
Sparus australis Gunther.	*Lamellodiscus typicus* J. and T.
Family *Mullidae* (Red Mullets).	
Upenaeus signatus Gunther.	*Haliotrema australe* J. and T.
Family *Sciaenidae* (Jew fishes).	
Sciaena antarctica Castln.	*Calceostoma glandulosum* J. and T.

Acknowledgment is gratefully made to those who have helped us in the collection of material and the procuring of necessary literature. Miss M. J. Bancroft, B.Sc., collected most of the freshwater species, while to Mr. H. A. Longman, Director of the Queensland Museum, we are indebted for providing us with some infected gills from marine fishes.

To Mr. W. Rainbow, Librarian of the Australian Museum, and Dr. B. H. Ransom of the U.S. Bureau of Animal Industry our sincerest thanks are due for providing us with indispensable literature.

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Explanation of lettering.

a.d. attaching disc; *b.c.* buccal cavity; *b.ej.* bulbus ejaculatorius; *br.* brain; *c.* cirrus; *c.b.a.* chitinous basal apparatus; *c.g.* cephalic glands; *c.m.l.* circular muscle layer; *c.s.* cirrus-sac; *ct.* cuticle; *c.v.d.* converging vitelline ducts; *d.* ducts from glands; *d.p.* dermal papillae; *e.* eggs; E. eye; *ex.* excretory ducts; *ex.o.* opening of excretory ducts; *g.c.* gland-cells; *g.ch.* genital chamber; *g.o.* one of the female genital openings; *h.* major hook; *h.a.* hook apparatus in section; *h.l.* head-lappet; *h.o.* "head-organ"; *i.* intestine; *i.c.* intestinal caeca; *i.c.l.* inner circular muscle-layer; *l.m.l.* longitudinal muscle-layer; *m.* mouth; *m.h.* minor hooks; *od.* oviduct; *oe.* oesophagus; *ov.* ovary; *p.g.* penial glands; *ph.* pharynx; *pr.* prostate gland; *p.t.* padding tissue; *pt. vd.* posterior transverse vitelline duct; *r.s.* receptaculum seminis; *s.c.t.* subcuticular tissue; *sh.g.* shell-glands; *s.m.* sphincter muscle; *s.* spine; *t.* testis; *t.vd.* transverse vitelline duct; *u.o.* uterine opening; *ut.* uterus; *v.* vitellaria; *v.d.* vas deferens; *v.g.* vagina; *v.g.c.* gland-cells whose ducts open ventrally; *v.r.* vitelline reservoir; *v.s.* vesicula seminalis; *x.* opening of transverse vitelline duct into intestine.

EXPLANATION OF PLATES IX.—XXII.

Plate ix.

Figs. 1-5. *Protogyrodactylus quadratus.*

1. Entire animal, ventral view; 2. Cirrus and adjacent structures; 3. Transverse section through posterior transverse yolk-duct, showing opening into the intestine; 4. Longitudinal vertical section at about mid-region of worm; 5. Egg.

Plate x.

Fig. 6. *Protogyrodactylus quadratus.*

Disc in ventral view.

Fig. 7. *Trivitellina subrotunda.*

Entire animal, ventral view.

Figs. 8-9. *Anchylodiscus tandani.*

8. Entire animal, ventral view; 9. Disc in side view.

Plate xi.

Figs. 10, 12-14. *Haliotrema australe.*

10. Disc in ventral view; 12. Major hooks and supporting apparatus; 13. Entire animal, ventral view; 14. Cirrus.

Fig. 11. *Anchylodiscus tandani.*

To show the relative size of egg.

Plate xii.

Figs. 15-19. *Daitreosoma constrictum.*

15. Entire animal; 16. Attaching disc; 17. Egg; 18. Large hooks; 19. Transverse section in region of body constriction.

Plate xiii.

Fig. 20. *Daitreosoma constrictum.*

Reproductive organs.

Figs. 21-22. *Daitreosoma bancrofti.*

21. Reproductive organs; 22. Head.

Figs. 23-25. *Acleotrema girellae.*

23. Portion of disc viewed from its anterior side, to show articulation of major hooks. Three minor hooks are also shown; 24. Entire animal showing its capacity for great elongation; 25. Disc in ventral view.

Plate xiv.

Figs. 26-30. *Acleotrema girellae.*

26. Entire animal; 27. Entire animal, showing excretory and digestive systems; 28. Skin papillae; 29. Genital organs of adult; 30. Genital organs from young animal.

Fig. 31. *Empleurosoma pyriforme.*

Transverse section through anterior end.

Plate xv.

Figs. 32-34. *Empleurosoma pyriforme.*

32. Entire animal; 33. Anterior end; 34. Transverse section of intestine.

Figs. 35-37. *Lepidotrema therapon.*

35. Entire animal; 36. Anterior end; 37. Egg.

Plate xvi.

Figs. 38-42. *Lepidotrema therapon.*

38. Male reproductive organs; 39. Cirrus; 40. (a) Disc, ventral view; (b) Disc, lateral view; (c) Ventral major hook; (d) Dorsal major hook; (e) Basal supporting apparatus; (f) Toothed-disc (squamodisc); 41. Young animal; 42. Disc, to show arrangement of minor hooks. Those of dorsal side are blackened; those of other side not so.

Fig. 43. *L. tenue.*

Disc.

Fig. 44. *L. fuliginosum.*

Disc.

N.B. Figs. 42, 43, 44 are drawn in approximately identical positions, in order to show the relative positions of the minor hooks.

Plate xvii.

Figs. 45-49. *Lepidotrema therapon.*

45. Longitudinal vertical section through posterior region, to show the great accumulation of yolk; 46. Longitudinal vertical section through entire animal; 47. Transverse section of male and female reproductive organs; 48. Transverse section through anterior end, in region of pharynx; 49. Transverse section in region of shell-glands.

Figs. 50-51. *Lepidotrema fuliginosum.*

50. Reproductive organs; 51. Opening of vagina and transverse vitelline tubes into female duct.

Plate xviii.

Figs. 52-53. *Lepidotrema tenue.*

52. Entire animal; 53. Reproductive organs.

Figs. 54-55. *Flabellodiscus simplex.*

54. Reproductive organs; 55. Nervous system.

Plate xix.

Figs. 56-60. *Empleurodiscus angustus.*

56. Entire animal; 57. Transverse section in region of transverse yolk-duct; 58. Cirrus with "prostate" gland; 59. Egg; 60. Head end, showing partial projection of "head-organs."

Figs. 61-62. *Flabellodiscus simplex.*

61. Young form; 62. (adult) Transverse section through anterior end.

Figs. 63-64. *Empleurodiscus angustus.*

63. Toothed disc; **64.** Posterior disc in actual attachment to gill-filament as viewed from ventral side, through the gill-tissue.

Plate xx.

Figs. 65-72. *Lepidotes fluviatilis.*

65 Entire animal; **66.** Reproductive organs slightly diagrammatic; **67.** Disc. ventral view; 68. Transverse section through head region; 69. Toothed disc; **70.** Head of half-grown animal; 71. (adult) Transverse section through region posterior to testis; 72. Young animal (ventral view).

Plate xxi.

Fig. 73. *Lepidotes fluviatilis.*

Transverse section through region of cirrus.

Figs. 74, 78, 78*a*. *Lamellodiscus typicus.*

74. Disc; 78. Entire animal; 78a. Cirrus.

Figs. 75-77. *Calceostoma glandulosum.*

75. Transverse section in region of oviduct; **76.** Transverse section of skin; **77.** To show excretory openings in head region.

Plate xxii.

Figs. 79-86. *Calceostoma glandulosum.*

79. Entire animal; **80.** Head in side view; **81.** Reproductive organs; **82.** A small portion of the cephalic glands; **83** To show the articulation of the hooks; 84. Two minute hooks; 85. Hook apparatus of disc; 86. Disc, ventral view.

A SECOND BIRD CENSUS.

By J. B. Cleland, M.D.

[Read 31st May, 1922.]

I have previously in the *Emu* (Birds of the Pilliga Scrub, xviii., 1919, p. 272) described the method I have adopted for obtaining a fair general idea of the actual numbers of our native birds. This consists in noting down, much as one scores the runs at cricket, the numbers of each kind of bird as one sees them whilst motoring, driving or walking. The reliability of the method depends on the ease with which any particular species can be seen, flushed or otherwise recognised. The distance on each side of the track over which they can be identified will also vary much, both with the species of bird and the type of country. Large birds, such as hawks, in open country may be seen on each side, say, for a quarter of a mile, small birds keeping to cover perhaps for only a chain or so, whilst in dense scrub only the birds immediately beside the road can be counted. Nevertheless, with such imperfections, the method seems sufficiently reliable to be worth placing the results on record, and these results should give us some idea at least of the actual numbers of certain species over certain areas. Perhaps 50 or 100 years hence, some one may cover again the same ground—and in this hope the details of the journeys taken are given, with the time of year, weather notes and present appearance of the country—and compare his results with those of to-day. A first Census, covering nearly the same distance as the present one but along different routes, has been submitted to "The Emu" for publication, but is appearing in such a reduced form that much of its value to the bird-observer of the future will be lost. The bird names and numbers are taken from the Check-List in Vol. xii. of "The Emu."

The area covered by the present census has been divided into six districts (A, B, etc.) and comprises the birds seen on 49 journeys, usually by motor car but occasionally whilst walking or driving in a coach. Some of the journeys cover the same ground as previous ones, usually representing the return. Such further covering of the same tract is indicated by the letters a, b, c, etc., after the number. These later trips along the same road may be considered as equivalent to parallel traverses. They also act as a check on the reliability of this method of census-taking and indicate to a certain extent the fluctuations of the bird population and the degree of variation that may be found along one track.

The distance traversed was approximately 1318 miles, the number of species of native birds seen was about 140 and the individuals of these counted was more than 11,249. In addition 5 introduced species and 4754 individuals of these were noted. About 9 native birds were seen, on an average, per mile covered.

Of Emus, 25 were met with in 3 districts on 4 journeys. Ground Doves are widely distributed, 23 being seen on 10 journeys in 5 districts. The Crested Pigeon is common in certain interior localities, 63 being noted on 12 journeys. Attention may again be called to the scarcity of birds of prey, only 138 being met with along the 1318 miles, or less than 1 to every 10 miles. These birds are so conspicuous and can be seen in most parts at such a distance that the smallness of their numbers in comparison with other birds is accentuated.

Galahs are of course common in many inland areas, 241 being counted. Sixty-three Laughing Jackasses were seen on 12 journeys in 3 districts, being about 1 to every 21 miles. They are less numerous in South Australia, in which many of the journeys were taken, than in New South Wales. Fifty-eight Bee-eaters were seen, their presence depending on the time of year.

The useful swallows are, one is glad to see, abundant. The Welcome Swallow and Martins were seen in all districts and on 38 and 37 journeys respectively; 644 Welcome Swallows and 1722 Fairy and Tree Martins were counted. Only 25 Brown Flycatchers or Jacky Winters were met with, these birds not being numerous in South Australia. Robins were few. The Willie Wagtail and the Ground Lark (*Anthus*) are two of our most widely distributed birds, each being found on 37 journeys, the numbers seen being 177 and 410 respectively or about 1 to every 7½ and 3 miles. *Graucalus melanops* is widely distributed but not numerous. *Ephthianura albifrons* is fairly common, 324 being seen on 15 journeys. The figures for the Acanthizas are certainly much too low. Only 42 Harmonious Thrushes were seen or heard on 12 journeys; 271 Wood-Swallows were counted—with most species of this genus, the number depending on the time of year; 179 Grallinas (Magpie-Larks) were noted on 23 journeys or 1 to about every 7 miles. In suitable country the Whiteface (*Aphelocephala*) was common (169). Only 29 Tree-Creepers were seen. The Honey-eaters, except the larger forms, are probably much under-estimated. 283 Minahs (of the two species) were seen on 29 journeys or one to 4½ miles. Crows are ubiquitous, 1128 being counted on 35 journeys in all districts. Of Magpies, one is glad to notice an abundance, especially in South Australia; 920 were noted on 41 journeys in all the districts or about one to every 1.4 miles travelled. One regrets to see the abundance and wide distribution of sparrows and starlings.

Journeys undertaken.

District A.—Southern Coastal Queensland.

A1.—Gympie to Imbil, motor, 23 miles, August 28, 1921. 8 a.m. to 11 a.m., cool, sunny. Open forest mostly with grass land. A1a.—Return, August 29, 1.30 to 3.15 p.m., drizzling rain in part. A2.—Imbil to 6 miles west, motor, August 28. Mild, mostly sunny. Forest, some brush and creeks. A3.—Brisbane, *via* Goodna and Ipswich, to Mt. Crosby Reservoir and on to Cabbage Tree Reservoir, motor, 40 miles, August. 10.30 a.m. to 2 p.m. Bright day, breezy, moderately cool. Mostly open forest. A3a.—Return by northern side of Brisbane R. to Indooroopilly Ferry, 24 miles, 4 to 5.30 p.m.

District B.—Blue Mts., N.S.W.

B1.—Mt. Victoria to Jenolan Caves, motor, 36 miles, Nov. 7, 1919. Morning, bright, sunny. B1a.—Return, Nov. 8, afternoon. B2.—Mittagong to Bullio, walking, 22 miles, Nov. 28, 1919. Warm, rather cloudy. Partly farms, partly sandstone and forest. B3.—Bullio to Wombeyan Caves, walking, 20 miles, Nov. 29. Cloudy, then a drizzle for half-way, muggy. Down to Wollondilly R. and up again. Trees. B4.—Wombeyan Caves to Taralga, driving in sulky, 21 miles, Dec. 1, morning. Cool, cloudy. Hilly, wooded except last 6 miles. B5.—Taralga to Goulburn, motor, 28 miles, Dec. 1, 5 to 6.45 p.m. Cool.

District C.—S.W. Plains, N.S.W.

C1.—Yanco to Leeton, motor, 4 miles, Nov. 20, 1919, midday. C2.—Leeton to 11 miles W., motor, Nov. 21. Fairly warm, windy, rather dusty. C2a.—Return, morning. C3.—Leeton, *via* Whitton and Yenda, to Mirroul, motor, 50 miles, Nov. 21, afternoon. C3a.—Return, 16 miles only.

District D.—Adelaide District.

D1.—Adelaide to Mt. Compass, *via* Willunga, motor, 40 miles, Oct. 26, 1920, morning. Sunny, but with showers, cool. Open clear country with fields and vineyards for 34 miles, then 3 miles through forest, then 3 miles of mallee and swamps. D1a.—Return, 32 miles only. D1b.—Same journey, Feb. 5, 1921, warm to hot. D1c.—Return, Feb. 6. D1d.—Same journey, Nov., 1921, 38 miles. D1e.—Return. D2.—Encounter B. to Waitpinga, buggy, 8 miles, Jan., 1921, 9.30 to 11 a.m. Breezy sunny day, cool. D2a.—Return, 4.30 to 6 p.m. D3.—Adelaide to Strathalbyn, motor, 36 miles, Nov., 1921. D4.—Strathalbyn to Wellington, 30 miles. D5.—Wellington to Point Macleay, 30 miles. D5a.—Return. D6.—Wellington to Milang, Finniss and Giolwa, 47 miles.

District E.—Renmark District.

E1.—Morgan to Cobdogla (L. Bonney), motor, 57 miles, Jan. 1, 1921, 2 to 4.30 p.m. Muggy, cloudy, sultry. In parts cleared and almost treeless, but mostly mallee and sometimes yellow sand and pines, occasionally near the river. E1a.—Return, *via* Monash, 75 miles, Jan. 8. Hot. E2.—Berri to 2 miles on Cobdogla road, Jan. 3, bright, sunny, windy, cool. E3.—Berri to Barmera, 10 miles, Jan. 3. E4.—Cobdogla to Berri, 14 miles, Jan. 3. E5.—Berri, *via* Renmark, to near N.S.W. border and then north, 44 miles, Jan. 4, 2 to 7 p.m. Fairly warm. Orchards and mallee, skirting Murray R. and adjacent billabongs for some distance, some miles of saltbush, some tracts of pine. E6.—About 70 miles N.E. of Berri, 25 miles, Jan. 5, 8 to 11 a.m. Hot. Belah, mallee, etc. E5+6a.—Return to 8 miles from Renmark, 75 miles, Jan. 6, 11.30 a.m. to 7 p.m. Hot. E7.—Berri to Renmark, 14 miles, Jan. 7, 9 to 10.30 a.m. Hot. Orchards, mallee. E7a.—Return, 3 to 4 p.m.

District F.—Central North of South Australia.

F1.—Quorn to Richi-Tichi Pass, 8 miles, motor, Aug. 14, 1921, afternoon. Mild, sunny. Plain, then between hills. F1a.—Return. F2.—Parachilna to 10 miles west near L. Torrens, coach, 10 miles, Aug. 19, afternoon. Sunny, cool. Saltbush plains, then low sandhills. F2a.—Return. F3.—Parachilna to Blinman, coach, 12 miles only, Aug. 20, 3.30 to 5.45 p.m. Sunny, cool. 6 miles across plains of saltbush and tobacco. Rest up mountain gorges ascending to plateau at 2,000 ft. F3a.—Return, whole way, 20 miles, Aug. 22. Showery, cold. F4.—Blinman to Wirrialpa Stn., coach, 24 miles, Aug. 21. Mild, sunny, windy. Along plateau, then gradually descending through gum creeks and over downs covered with saltbush, cassia, etc. F4a.—Return. F5.—Pt. Augusta west to Iron Knob, motor, 50 miles, Aug. 23, morning. Bright, sunny. Across saltbush plains and past occasional low hills with scattered mulga. F5a.—Return, 34 miles only, 4 to 5.30 p.m.

List of species and numbers of Birds observed.

1.	*Dromaius novae-hollandiae* (Emu). C3a (2)*, E5 (11), E5+6a (9), F2 (3).	3— 4— 25†
	"Stubble Quail." D1b (1).	1— 1— 1
	Quail. A2 (2), B4 (1), D2 (1), E5+6a (1).	4— 4— 5
27.	*Geopelia tranquilla* (Ground Dove). A1 (1), A1a (2), A2 (7), B2 (2), C2 (1), C3 (1), E1a (1), F3 (2), F3a (4), F4a (2).	5—10— 23
30.	*Phaps chalcoptera* (Bronze-winged Pigeon). B2 (2), D2 (1), F4a (1) ("bronze-wing").	3— 3— 4
39.	*Ocyphaps lophotes* (Crested Pigeon). E1 (3), E1a (2), E4 (1), E5 (17), E6 (2), E5+6a (14), F2 (4), F2a (2), F3 (3), F3a (2), F4 (9), F4a (4).	2—12— 63
40.	*Leucosarcia picata* (Wonga-Wonga Pigeon). B3 (1).	1— 1— 1
	Waterhen. C3 (2), C3a (1).	1— 2— 3
	Coots. A2 (3).	1— 1— 3
	Terns. D5a (3).	1— 1— 3
119.	*Larus novae-hollandiae* (Silver Gull). D5 (17), D5a (35), D6 (6).	1— 3— 58
128.	*Lobivanellus lobatus* (Spurwinged Plover). D5 (9), D6 (8).	1— 2— 17
130.	*Zonifer pectoralis* (Black-breasted Plover). C3a (1), D5 (5), E5+6a (5).	3— 3— 11
	Plover. A1a (2), F5a (1).	2— 2— 3
138.	*Aegialitis ruficapilla* (Red-capped Dottrel). D5 (2).	1— 1— 2
139.	*A. nigrifrons* (Black-fronted Dottrel). A3 (2), B3 (2), C2 (4), C3 (2), D5 (2), F3 (1).	5— 6— 13
175.	*Ibis molucca* (Glossy Ibis). C2 (3), C2a (4), C3 (9), D5 (1), D5a (2), D6 (3).	2— 6— 22
176.	*Carphibis spinicollis* (Straw-necked Ibis). A1 (1), A1a (2), C2 (11), C3 (9), D6 (17), E5 (2).	4— 6— 42
185.	*Notophoyx novae-hollandiae* (White-fronted Heron). C2 (2), C3a (1), D2 (1), D6 (5)	2— 4— 9
186.	*N. pacifica* (Pacific Heron). C2 (1), C3 (1), C3a (1).	1— 3— 3
198.	*Chenopis atrata* (Black Swan). D6 (31), E5 (14), F5 (2), F5a (2).	3— 4— 49
202.	*Cereopsis novae-hollandiae* (Cape Barren Goose). D5a (5).	1— 1— 5
203.	*Chlamydochen jubata* (Wood Duck). B3 (10?).	1— 1— 10
207.	*Casarca tadornoides* (Mountain Duck). D5 (about 200), D5a (about 150).	1— 2— 350
208.	*Anas superciliosa* (Black Duck). C2 (4), F3a (1).	2— 2— 5
	Duck. D6 (6), E1a (2), E5 (60), E5+6a (6), F5a (3).	3— 5— 77
	Black Shags. D5 (5).	1— 1— 5
	Shags. A2 (1), F5a (6).	2— 2— 7
233.	*Pelecanus conspicillatus* (Pelican). A3 (1), D4 (1), D5 (37), D5a (17), D6 (65).	2— 5— 121
	Owl ? B3 (1).	1— 1— 1
243.	*Uroaetus audax* (Wedge-tailed Eagle). D2 (2), E6 (1), E7a (1), F1a (1?), F3 (3), F3a (6), F4 (1), F4a (4),	

*C3a indicates the district and journey, while the number in brackets shows the number of individuals of the species observed.

†The three numbers indicate respectively the numbers of districts, journeys, and total birds of the species observed.

F5 (1). . . . . . 3— 9— 20

248. *Haliastur sphenurus* (Whistling Eagle). D1a (1). . . . . . 1— 1— 1

Kites. F3 (2), F3a (4), F4 (1), F4a (1). . . . . . 1— 4— 8

257. *Falco subniger* (Black Falcon)? E5 (3). . . . . . 1— 1— 3

259. *Hieracidea berigora* (Brown Hawk). B1 (2?), E5 (1). . . 2— 2— 3

261. *Cerchneis cenchroides* (Nankeen Kestrel). B1 (1), C3 (1), C3a (3), D (2, 2, 2, 2, —, 3, 1, 1, —, 7, 2, 1, 4), E6 (2), F2 (1), F3a (6), F4 (1), F4a (2), F5 (2). . . . . . 5—20— 46

Hawks, small. B1 (1), D3 (1), E6 (1). . . . . . 3— 3— 3

Hawks, medium-size. A1 (1). . . . . . 1— 1— 1

Hawks, large. B1 (1), B1a (3), B3 (4), C2 (2), C2a (3), C3 (3), D1 (1), D1a (1), D6 (2), E5 (3), E5+6a (1), F4 (3), F4a (6), F5 (3). . . . . . 5—14— 36

Hawks, large, white rump. D1 (1), D5 (1). . . . . . 1— 2— 2

Hawks. B2 (1), B4 (2), B5 (4), D4 (1), D5 (1), D6 (1), F3 (2), F3a (3). . . . . . 3— 8— 15

Total Accipitriformes. 138

274. *Trichoglossus swainsoni* (Blue Mountain Lorikeet). A1 (291), A1a (66+13 flocks), A2 (4), D2 (10), D2a (16). . . 2— 5— 400+

T. swainsoni, probably. A3 (1+1 flock), A3a (39+11 flocks). . . . . . 1— 2— 52+

278. *Glossopsitta concinna* (Musk Lorikeet). D1a (6). . . . 1— 1— 6

279. *G. porphyrocephala* (Purple-crowned Lorikeet). D1a (2), D2 (6), D2a (7). . . . . . 1— 3— 15

Lorikeets, unidentified. B2 (3), B3 (21), B5 (8), D1 (1 flock), D1b (6), D1c (7), D6 (1 flock), F1 (1 flock). . . 3— 8— 48+

Lorikeets, small, unidentified. A1 (53), A1a (1 flock). . . 1— 2— 54+

292. *Cacatua leadbeateri* (Major Mitchell Cockatoo). E6 (4), E5+6a (4). . . . . . 1— 2— 8

293. *C. gymnopis* (Bare-eyed Cockatoo). F3a (56), F4 (1), F4a (1). . . . . . 1— 3— 58

295. *C. roseicapilla* (Galah). C2 (26), C2a (13), C3 (4), C3a (18), E5 (2), E6 (25), E5+6a (68), F2 (10), F2a (3), F3 (3), F3a (9), F4 (16), F4a (44). . . . . . 3—13— 241

298. *Calopsitta novae-hollandiae* (Cockatoo Parrot). C2 (8), C3 (5). . . . . . 1— 2— 13

304. *Platycercus pennanti* (Crimson Parrot). B1 (3), B1a (1), B2 (6), B3 (7), B4 (4). . . . . . 1— 5— 21

305. *P. adelaidae* (Adelaide Parrot). D1e (1), D2 (40), D2a (62), D3 (24), D6 (1). . . . . . 1— 5— 128

311. *P. eximius* (Rosella). B2 (41), B3 (12), B4 (6), B5 (32). 1— 4— 91

315. *Barnardius barnardi* (Ring-necked Parrot). C3a (5), E5 (62), E6 (4), E5+6a (54), F1a (2), F3 (1), F3a (11), F4 (10), F4a (20). . . . . . 3— 9— 169

319. *Psephotus haematogaster* (Blue Bonnet). C3a (3), E5 (7). 2— 2— 10

323. *P. multicolor* (Many-coloured Parrot). E5+6a (14). . . . . 1— 1— 14

324. *P. haematonotus* (Red-backed Parrot). C1 (7), C2 (2), C3 (7), C3a (23), D1c (3), D1e (8), D3 (2), D4 (32?). 2— 8— 84

P. sp., Murray R. near Renmark. E1a (1), E5 (40), E5+6a (71). . . . . . 1— 3— 112

Psephotus, unidentified. E1 (3), E3 (1), F1 (8), F5a (8). 2— 4— 20

327. *Euphema elegans* (Grass Parrot). D1b (3), D2a (8). . . 1— 2— 11

333. *Melopsittacus undulatus* (Betcherrygah). E1 (2), E5 (28), E5+6a (50). . . . . 1— 3— 80
Parrots, unidentified. E5 (5), F2a (2). . . . . 2— 2— 7
341. *Eurystomus pacificus* (Dollar Bird). B1a (2). . . . . 1— 1— 2
345. *Dacelo gigas* (Laughing Jackass). A1 (6), A1a (9), A3a (2), B (1, 2, 17, 9, 10, —), D2 (1), D2a (4), D4 (1), D5a (1). . . . . 3—12— 63
349. *Halcyon sanctus* (Sacred Kingfisher). B3 (4), C2a (1), C3 (1), D1e (2). . . . . 3— 4— 8
Swifts. B4 (9). . . . . 1— 1— 9
361. *Cuculus pallidus* (Pallid Cuckoo). B2 (1). . . . . 1— 1— 1
Cuckoos, large, unidentified (mostly heard). B2 (9), B3 (14), B4 (1), D3 (1), D5 (1), F1 (2). . . . . 3— 6— 28
Lamprococcyx sp. (Bronze Cuckoo). B4 (1). . . . . 1— 1— 1
384. *Hirundo neoxena* (Welcome Swallow). A1 (5), A3 (13), A3a (1), B (4, 2, 17, 17, 5, 3), C (3, 7, 8, 9, 4), D (2, 4, 1, 1, 21, 22, —, —, 13, 27, 64, 101, 123), E1 (2), E2 (9), E3 (23), E4 (2), E5 (103), F (4, 4, —, 2, 3, 3, 2, 5, 5, —). . . . . 6—38— 644
385. *Cheramoeca leucosternum* (White-backed Swallow). D4 (3), D5a (2), E1a (3), E3 (7), E4 (5), E5 (9), F1a (2?), F3 (2), F3a (1), F4a (2). 3—10— 36
386-7. *Petrochelidon nigricans* and *ariel*. (Tree and Fairy Martins). A1 (49), A1a (3), A3 (1), B (—, —, 47, 1, 21, 18), C (3, 84, 174, 56, 37), D (7, 4, 16, 12, —, 8, —, —, 47, 425, 6, —, 122), E (53, 2, 2, 4, 2, 26, 1, 346, 45, 1), F (—, 28, —, —, 6, 33, 21, 9, 2, —). . . . . 6—37—1722
Swallows, unidentified. A3 (12), F4a (1). . . . . 2— 2— 13
388. *Microeca fascinans* (Jacky Winter, Brown Flycatcher). A1a (3), A2 (2), A3a (1), B2 (1), B3 (3), D1a (1), D2 (5), D2a (1), E1a (1), F1 (3), F1a (4). . . . . . . 5—11— 25
392. *Petroica leggii* (Scarlet-breasted Robin). B2 (2), D1c (1). 2— 2— 3
394. *P. goodenovii* (Red-capped Robin). B2 (2), F3 (1), F4 (1). 2— 3— 4
P. sp., hens or unidentified. B1a (1), B3 (2), B4 (1), F2 (1), F3a (1), F5 (1). . . . . 2— 6— 7
397. *Melanodryas bicolor* (Hooded Robin). B3 (1), D1c (2), D3 (1), D6 (1), E5 (2), F3a (3), F4 (1?), F4a (1). . . . . . . 4— 8— 12
422. *Falcunculus frontatus* (Yellow-bellied Shrike-tit). B2 (1), D1d (1). . . . . 2— 2— 2
425. *Oreoica cristata* (Crested Bell-bird). E6 (1). . . . . 1— 1— 1
430. *Pachycephala rufiventris* (Rufous-breasted Thickhead) (mostly heard). B2 (20), B3 (17), B4 (4). . . . . 1— 3— 41
P. sp. (probably *P. rufiventris*) (heard). A1 (4), A1a (1), A2 (1), B1 (2), B1a (3), C3 (1), D3 (3), E1 (1), E5+6a (1), F4 (1). . . . . 6—10— 18
436. *Rhipidura albiscapa* (White-shafted Fantail). B2 (5), B3 (7), D3 (2). . . . . 2— 3— 14
442. *R. motacilloides* (Willie Wagtail). A (6, 10, 4, 4, 3), B (—, —, 14, 24, 2, 4), C (—, 4, 3, 4, —), D (2, 1, 1, 2, 6, 5, —, 2, 7, 3, —, 2, 4), E (3, 6, —, —, —, 5, 3, 18, —, —), F (3, 1, 1, —, 4, 4, 4, 2, 2, 4). . . . . 6—37— 177

443.	*Seisura inquieta* (Restless Flycatcher). B2 (3), B3 (4). ..	1— 2— 7
457.	*Graucalus melanops* (Black-faced Cuckoo-Shrike). A (1, 1, 1, 2, —), B (1, —, 6, 14, 2, 2), C3 (2), D1b (4), D1c (3), D1e (1), D3 (1), D6 (6), E1 (4), E1a (1), E4 (1), F3 (1), F3a (1), F4a (1), F5 (1), F5a (2).	6—23— 59
	Hylacola sp., ? (Ground-Wren) E5+6a (1).	1— 1— 1
478.	*Pomatorhinus temporalis* (Babbler). C2 (1), C3 (2).	1— 2— 3
479.	*P. superciliosus* (White-browed Babbler). E5 (2), E6 (14), E5+6a (12), F2a (2), F3a (9), F4 (6), F5 (1), F5a (8).	2— 8— 54
	P. sp., unidentified. A3a (5).	1— 1— 5
484.	*Cinclorhamphus cruralis* (Brown Song-Lark). F2 (3), F2a (3), F4 (2), F4a (1), F5 (5), F5a (1).	1— 6— 15
485.	*C. rufescens* (Rufous Song-Lark). D1d (2), D1e (5), D4 (3), D5 (5), D5a (8), D6 (4).	1— 6— 27
	C. sp., unidentified. B2 (8), B5 (1), C2 (1).	2— 3— 10
489.	*Ephthianura albifrons* (White-fronted Bush-Chat). B5 (2), C2a (8), D1b (1), D1d (13), D1e (5), D2 (4), D2a (4), D4 (42), D5 (48), D5a (91), D6 (95), E3 (1), E5 (2), E5+6a (2), F5 (6).	5—15— 324
490.	*E. tricolor* (Tricoloured Bush-Chat). F2 (8), F2a (8), F3a (2), F5 (7).	1— 4— 25
491.	*E. aurifrons* (Orange-fronted Bush-Chat). F2 (2), F2a (3), F5 (2).	1— 3— 7
494.	*Acrocephalus australis* (Reed Warbler). D4 (1).	1— 1— 1
500.	*Origma rubricata* (Rock Warbler). B2 (1 ?).	1— 1— 1
507.	*Acanthiza* (*Geobasileus*) *reguloides* (Buff-tailed Tit-Warbler).B2 (2), B3 (2), D1 (2), D2 (1).	2— 4— 7
508.	*A.* (*G.*) *chrysorrhoa* (Yellow-tailed Tit-Warbler). B1 (1), B2 (14), B3 (22), B5 (6), C2 (6), C2a (3), D1a (1), D1b (3), D1e (1), D2 (9), D3 (5), D4 (2), D5 (3), D5a (3), D6 (2), F1 (a), F3a (4), F4 (2), F5 (7).	4—19— 96
	A. (*G.*) sp., unidentified. A3 (1), D1 (1).	2— 2— 2
509.	*Acanthiza uropygialis* (Chestnut-rumped Tit-Warbler). E5 (2), E6 (4).	1— 2— 6
511.	*A. lineata* (Striated Tit-Warbler). B2 (7), D3 (3).	2— 2— 10
512.	*A. pusilla* (Brown Tit-Warbler). B2 (4), B3 (4).	1— 2— 8
	A., unidentified. A1 (5), B1 (25), B1a (4), B2 (69), B3 (72), B4 (30), D1d (2), D2 (2), E2 (1).	4— 9— 210
	"Tits." E1 (4), E5 (7).	1— 2— 11
517.	*Pyrrholaemus brunneus* (Redthroat). E5 (6).	1— 1— 6
519.	*Sericornis frontalis* (White-browed Scrub-Wren). B3 (1).	1— 1— 1
	S. sp., unidentified. B1 (2), F5a (1 ?).	2— 2— 3
530.	*Malurus cyaneus* (Blue Wren-Warbler). B2 (2), B3 (10), D1 (1), D1e (2), D2 (15), D2a (2), D3 (4), D4 (3), D6 (1).	2— 9— 40
535.	*M. cyanotus* (White-winged Wren-Warbler). E5 (3 ?), F2 (2), F2a (3), F5 (3 ?), F5a (1 ?).	2— 5— 12
538.	*M. assimilis* (Purple-backed Wren-Warbler). F1 (2). ...	1— 1— 2
	M. sp., unidentified. B1a (1), E7 (3).	2— 2— 4
560.	*Artamus superciliosus* (White-browed Wood-Swallow). B2 (1), B3 (2), B4 (1), B5 (7).	1— 4— 11

561.	*A. personatus* (Mashed Wood Swallow). B2 (2), D1e (3), E1a (8), E5 (3), E7a (3).	3— 5— 19
562a.	*A. melanops* (Black-faced Wood-Swallow). F2 (13), F2a (9), F3 (7), F3a (8), F4a (4), F5 (49), F5a (21).	1— 7— 111
	A. personatus or *A. melanops*. C2 (3), C3 (3), C3a (2), E1 (19), E4 (1).	2— 5— 28
564.	*A. sordidus* (Dusky Wood-Swallow). A2 (1), B1a (1), B2 (13), B3 (22), D1 (1), D1c (6), D1d (2), D1e (7), D3 (3), D6 (2), E1 (7), E5 (3), E6 (4 ?), E5+6a (2), E7 (1).	4—15— 75
	A. sp., unidentified. B1 (1), B1a (3), B3 (12), B4 (2), B5 (1), C2 (1), C3 (1), D1 (2), E5+6a (4).	4— 9— 27
566.	*Colluricincla harmonica* (Harmonious Thrush) (mostly heard). A1a (1), B1 (3), B1a (4), B2 (13), B3 (8), B4 (3), D1 (1), D1d (1), D2 (1), E6 (2 ?), F3 (2), F3a (3).	5—12— 42
575.	*Grallina picata* (Magpie Lark). A (37, 20, 13, 16, 8), B (—, —, 11, 5, 2, 1), C (—, 9, 7, 4, 14), D5 (2), D5a (2), D6 (1), E1 (2), E5 (2), E6 (2), E5+6a (14), F1a (2), F3 (2), F3a (3).	6—23— 179
576.	*Struthidea cinerea* (Gray Jumper, Apostle Bird). C3 (10), C3a (8).	1— 2— 18
577.	*Corcorax melanorhamphus* (White-winged Chough). B2 (1), B3 (19), B4 (1), B5 (2).	1— 4— 23
578.	*Aphelocephala leucopsis* (Whiteface). B3 (5), B5 (4), C2 (2 ?), C3 (3 ?), C3a (2 ?), D4 (3), D5a (3), D6 (2), E1 (1), E1a (8), E3 (2), E5 (40), E6 (12), E5+6a (32), E7 (3), F2 (9), F3 (7), F3a (11), F4 (8), F4a (9), F5 (3).	5—21— 169
	Neositta sp. (Tree-runner). B2 (3).	1— 1— 3
592.	*Climacteris picumna* (Brown Treecreeper). B3 (2). . . .	1— 1— 2
593.	*C. leucophoea* (*scandens*) (White-throated Tree-creeper). B3 (1).	1— 1— 1
	C. sp., unidentified. B2 (3), B3 (4), B4 (3), B5 (1), C2 (1), C3 (1), C3a (2), D1e (1), E1 (3), E1a (3), E3 (2), E6 (2).	4—12— 26
599.	*Zosterops dorsalis* (Silver-eye). B2 (1), B3 (1), B4 (1), D1d (2), D4 (1), D6 (1), E7 (1).	3— 7— 8
602.	*Dicaeum hirundinaceum* (Mistletoe Bird). B3 (1), B4 (1).	1— 2— 2
606-7.	*Pardalotus punctatus* or *xanthopygius* (Diamond-Birds). B3 (1).	1— 1— 1
	P. sp., unidentified (mostly heard). A1 (1), B1 (8), B1a (2), B2 (22), B3 (5), B4 (2), E5 (1), E7a (1), F3 (1), F3a (1), F4 (1).	4—11— 45
619.	*Melithreptus brevirostris* (Brown-headed Honeyeater). D2 (13).	1— 1— 13
	M. sp., unidentified. B2 (7), B3 (4).	1— 2— 11
627.	*Acanthorhynchus tenuirostris* (Spinebill). B2 (2), B3 (1).	1— 2— 3
629.	*Glyciphila fulvifrons* (Tawny-crowned Honeyeater). D1c (8), D1d (1), D1e (5), D2 (18), D2a (17).	1— 5— 49
646.	*Ptilotis sonora* (Singing Honeyeater). D6 (1), E5 (3), E7a (1), F2a (3), F3a (2), F4 (1), F5 (6).	3— 7— 17
648.	*P. chrysops* (Yellow-faced Honeyeater). B2 (6).	1— 1— 6
652.	*P. auricomis* (Yellow-tufted Honeyeater). B1 (1).	1— 1— 1

658. *P. plumula* (Yellow-plumed Honeyeater). E5+6a (1). .. 1— 1— 1

661. *P. penicillata* (White-plumed Honeyeater). B3 (2), C2 (1), C3a (1), D1 (5), D1a (2), D1b (9), D1c (2), D4 (2). 3— 8— 24

661a. *P. leilavalensis* (Pallid Honeyeater). F3 (8), F3a (16), F4 (3), F4a (3). .. .. 1— 4— 30

667. *Lichmera australasiana* (Crescent Honeyeater). D1 (1). .. 1— 1— 1

668. *Meliornis novae-hollandiae* (White-bearded Honeyeater). B4 (1), D1 (2), D1c (2), D1d (2), D2 (57), D2a (67). .. 2— 6— 131

671. *Manorhina melanophrys* (Bell Minah). B3 (3). .. .. 1— 1— 3

672. *Myzantha garrula* (Noisy Minah). B (1, —, 88, 12, 2, 5), C (—, —, —, 2, 2), D1b (2), D3 (1), D4 (2), D6 (2). .. 3—11— 119

674. *M. flavigula* (Yellow-throated Minah). E (1, —, —, —, —, 16, 14, 41, 1, 2), F (2, 12, —, 1, 12, 17, 10, 2, 3, 11). .. .. 2—15— 145

M. sp., unidentified. A1 (10), A3 (3), A3a (6). .. .. .. 1— 3— 19

675. *Anthochaera carunculata* (Red Wattle-Bird). B2 (12), B3 (4), D1c (1), D2 (15), D2a (3), F1 (9), F1a (12). .. .. 3— 7— 56

"Wattle-Birds." B1 (2), D1d (4), D1e (4), D3 (5), D5 (3), D6 (33), E3 (1 ?), E6 (1). .. .. 3— 8— 53

679. *Acanthogenys rufigularis* (Spiny-cheeked Honeyeater). C1 (1), C2a (3), C3a (1), D5a (2), E1a (2), E4 (1), E5 (37), E5+6a (1), F2 (9), F2a (8), F3 (2), F3a (1), F4 (7), F4a (2). .. .. 4—14— 77

684. *Tropidorhynchus corniculatus* (Friar Bird, Leatherhead). A3 (6 ?), B3 (10), B4 (1), B5 (1). .. .. 2— 4— 18

Large Honeyeaters. A1 (13), A1a (9), A3a (2), E1a (1), E6 (3). .. .. 2— 5— 28

Honeyeaters. A1 (8), E5 (6). .. .. 2— 2— 14

687. *Anthus australis* (Ground Lark). A1a (1), A2 (1), B (1, 1, 3, —, 2, 7), C (—, —, 3, 3, —), D (9, 2, 19, 16, 17, 10, 3, 2, 4, 11, 57, 55, 28), E (1, —, —, 1, —, 3, 7, 3, —, 1), F (—, 3, 2, 1, 6, 1, 11, 7, 71, 37). .. .. 6—37— 410

688. *Mirafra horsfieldi* (Bush Lark). D1e (4), D5a (1), D6 (1). 1— 3— 6

692. *Stagonopleura guttata* (Spotted-sided Finch). B3 (1), D2 (5), D3 (2). .. .. 2— 3— 8

696. *Taeniopygia castanotis* (Chestnut-eared Finch). D1 (4), D1a (3), D1e (4), D4 (2). .. .. 1— 4— 13

703. *Aegintha temporalis* (Red-browed Finch). D6 (1). .. .. 1— 1— 1

718. *Ptilonorhynchus holosericeus* (Satin Bower-Bird). B2 (1), B3 (1). .. .. 1— 2— 2

732. 734. *Corvus coronoides* and *C. australis*. .. .. (Crows). A (2, 2, —, 2, —), B (1, 1, 4, 12, 7, 5), C (—, 20, 99, 192, 53), D (—, —, 18, 1, —, —, 2, —, —, 27, 67, 54, 3). E (50, 3, —, —, —, 9, 4, 62, —, —), F (3, 3, 67, 13, 20, 28, 144, 84, 30, 36). .. .. 6—35—1128

735. *Strepera graculina* (Pied Bell-Magpie). A2 (2), B3 (5). .. 2— 2— 7

738. *S. anaphonensis* (Grey Bell-Magpie). B2 (2), B4 (2). .. . 1— 2— 4

741. *Cracticus nigrogularis* (Black-throated Butcher-Bird). A1 (3), A1a (4). .. .. 1— 2— 7

745. *C. destructor* (Collared Butcher-Bird). E5+6a (3). .. . 1— 1— 3

C. sp., unidentified. B2 (1). .. .. 1— 1— 1

747. *Gymnorhina tibicen* (Black-backed Magpie). (Excluding birds included below under *G. leuconota* and *G.* sp. unidentified). A1 (1), A1a (4), A2 (1), B (2, 3, 18, 4, 6, 14), C (1, —, —, 21, 14), E1a (5), E5 (24), E6 (5), E5+6a (55), E7 (2), F1 (3), F1a (1). .. .. 5—21— 186

750. *G. leuconota* (White-backed Magpie). A1a (1 ?), D (6, 26, 12, 9, 20, 16, 78, 56, 20, 100, 117, 109, 70), E1 (13), E4 (2), F1a (3), F3a (1), F4a (3), F5 (1). .. .. 4—20— 663

G. sp., unidentified. A1 (4), A3 (3), A3a (1), F1 (17), F1a (3), F3 (1), F3a (7), F4 (16), F4a (15), F5 (3), F5a (1). .. .. 2—11— 71

Unidentified native birds. A (9, 5, 5, 6, 9), B (11, 12, 20, 86, 26, 30), C (—, 6, 3, 8, 4), D (—, —, 16, 3, 4, 9, 17, 2, 1, —, —, —, 16), E (13, 16, —, 2, 2, 33, 27, 79, 9, 1), F (16, 1, 19, 8, 12, 10, 36, 7, 14, 24). .. .. 6—42— 637

Native birds, heard only, unidentified. E1 (27), E1a (3), E3 (3), E4 (2), E5 (3), E6 (4), E5+6a (1), E7 (1). .. 1— 8— 44

Passer domesticus (Sparrows). A (—, —, —, 6, —), B (4, 5, 19, —, 3, 26), C (11, 14, 17, 27, —), D (216, 164, 358, 253, 170, 250, 32, 41, 134, 144, 61, 138, 100), E (22, 8, 1, 4, 7, 13, 6, —, 26, 16), F (5, —, 12, —, —, 12, 4, 4, 10, —). .. .. 6—38—2343

Sturnus vulgaris (Starlings). A1 (4), B (2, 18, 48, 30, 46, 138), C (5, 54, 85, 5, 9); D (101, 79, 262, 196, 57, 58, 23, 98, 45, 106, 109, 141, 108), E5 (45), E5+6a (208), F1 (44), F1a (15). .. .. 6—29—2038

Carduelis carduelis (Goldfinch). B1 (1), B1a (2), B2 (3), B5 (5); D1 (104), D1a (74), D1b (41), D1c (34), D1d (16), D1e (47), D2 (1), D3 (31), D4 (2), D6 (6). .. .. 2—14— 367

Turdus merula (Blackbird). D1 (1), D1d (1), D1e (1), D3 (2). .. .. 1— 4— 5

Ligurinus chloris (Greenfinch). D1 (1). .. .. 1— 1— 1

Bats (by day, 2 to 4 p.m., flying). E5+6a (2). .. .. .. 1— 1— 2

Miles traversed, 1318.

Approximately 140 species and 11,249 individuals of native birds seen.

5 species and 4754 individuals of introduced birds seen.

DESCRIPTIONS AND BIOLOGY OF SOME NORTH AUSTRALIAN TERMITES.

By Gerald F. Hill.

(Plates xxiii.-xxv. and forty-one Text-figures.)

[Read 31st May, 1922.]

The present paper contains descriptions of four new species and two hitherto undescribed castes of North Australian Termites of the genera *Eutermes* and *Hamitermes*, in addition to miscellaneous references to other and better known species.

In my studies of termites I have been fortunate in enlisting the cordial assistance of several well-known authorities in this group to whom I wish to extend my grateful thanks. Professor Sjöstedt has very kindly presented me with a nearly complete set of Dr. Mjöberg's Australian species and many papers. The former has been almost indispensable in working out closely allied species. To Professor Nils Holmgren I am indebted for literature and a very large collection of termites, including many species from the Malayan and Australian Regions. I am further indebted to him for the identification of many specimens. From Professor S. F. Light, Dr. T. E. Snyder and Reverend Father Wasmann I have received valued assistance in the form of literature and specimens.

The types of new species are in the writer's collection. Measurements and colours are recorded as in earlier papers.

Eutermes vernoni, n.sp. (Pl. xxiii.; xxiv., fig. 1; Text-figs. 1-9.)

Imago. (Text-figs. 1-4.)

Colour: Head very dark brown, postclypeus and labrum buckthorn brown, a little paler than basal half of mandibles; pronotum auburn, blotched with buckthorn brown, anterior margin darkest, meso- and metanotum buckthorn brown with middle and posterior margin suffused with auburn; wing-veins and tergites of abdomen auburn; wing-membrane brown with anterior margin suffused with yellow ochre.

Head (Text-fig. 1) large, hemispherical behind, front concave, clothed rather densely with long and short setae. Fontanelle large, forked anteriorly, in line with the middle of eyes. Eyes very large (.650 x .517) and prominent, finely faceted, their lower margin very near lower margin of head (.094). Ocelli very large (.188) circular, very close to the eyes. Postclypeus short and wide, more than twice as wide as long, convex, posterior margin hemispherical, anterior margin truncate. Anteclypeus large, hyaline, nearly straight in front. Labrum small, about one-third longer than wide, narrow at the base, swollen on the sides to the conical apex, exposing the two apical teeth of each mandible. Mandibles very large, the teeth black, dentition of usual type. Antennae (Text-fig. 2) 16-jointed, first joint very broad, second nearly cylindrical, a little more than half as wide as first, third as long as second but much narrower, fourth a little shorter and wider than third, fifth longer than third and shorter than fourth, sixth and seventh equal, eighth to sixteenth about equal in length, narrower at base, turbinate at apex.

Thorax (Text-fig. 3): Pronotum nearly as wide as head, anterior margin slightly bent up, behind which there is a deep depression on either side midway between the pale median suture and lateral margin, antero-lateral areas rounded, sides sloping to the slightly sinuate posterior margin, clothed as in head. Posterior margin of meso- and metanotum more markedly sinuous than that of pronotum.

Legs moderately long, very setaceous, claws and spurs slender, spurs 2:2:2.

Wings: Wing-stumps short, equal, moderately densely clothed with short and long setae, showing rudiment of subcosta, suture straight. Wings very long, costa and radius very distinct, the former more setaceous than the latter; median vein dark at the base but soon becoming indistinct, with several branches beyond the middle; cubitus with about 12 branches in the forewing and 10 in the hindwing, most of them well-defined and unbranched. Membrane (Text-fig. 4) densely clothed with minute setae and densely and minutely sculptured.

Abdomen large, tergites narrow, clothed with long and short golden setae, sternites yellowish, with greyish blotch at either end of the first six segments; cerci very short and broad.

Measurements:

Length with wing: ♀ 23.00 mm., ♂ 20.50.
Length without wings: ♀ 12.00, ♂ 10.50.
Head: long 2.44; wide 1.97; deep 0.80.
Antennae (16-jointed) 3.29.
Pronotum: long 1.12; wide 1.88.
Wings: forewings, long 19.00, wide 4.75; hindwings, long 18.00, wide 4.75.
Tibia iii., long 2.29.
Abdomen, wide 3.00 mm.

Queen,

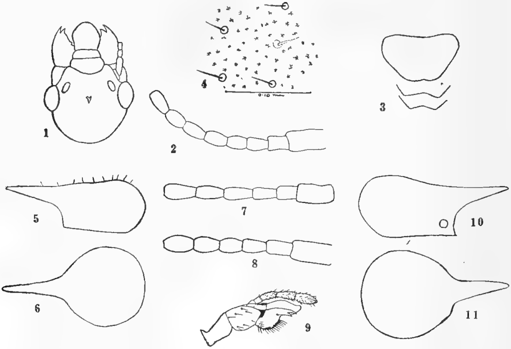
Total length 33 mm., width of abdomen 7.9 mm.

Soldier. (Text-figs. 5-7.)

Colour: Head very dark castaneous, distal two-thirds of snout, back of head and an obscure dorso-median line lightest, proximal one-third of snout darkest (in dried specimens from alcohol the head generally appears uniformly dark); antennae nearly as dark as tip of snout, anterior half of pronotum as dark as head, remainder of thorax and tergites of abdomen brown, the latter giving the body a distinctly banded appearance.

Head (Text-fig. 5 and 6): Posterior part large, nearly round, snout nearly as long as rest of head, clothed with scattered long reddish setae. Antennae (Text-fig. 7) 14-jointed, long, third joint equal to, or a little longer than, second, fourth always longer than third and fifth, fifth as long as third, sixth to fourteenth elongate, slender.

Pronotum saddle-shaped, the anterior half bent up sharply and narrowed to the emarginate anterior margin, bearing very few long reddish setae.



Text-figs. 1-9. *Eutermes vernoni,* n.sp.

1-4. Imago.—1. Head; 2. Antenna, proximal segments; 3. Pronotum and posterior margin of meso- and metanotum; 4. Wing-membrane.
5-7. Soldier.—5. Head in profile; 6. Head, dorsal surface; 7. Antenna, proximal segments.
8-9. Worker.—8. Antenna, proximal segments; 9. Maxilla.

Text-figs. 10-11. *Eutermes nigerrimus* var. *queenslandicus* Mjöb.
Soldier.—10. Head in profile; 11. Head, dorsal surface. Drawn from a cotype.

Legs very long and slender, clothed scantily with long and short reddish setae; tibial spurs 2:2:2.

Abdomen short and broad, bluntly rounded at the apex, tergites with scanty fringe of long reddish setae as on thorax.

Measurements:
Head: long 1.74—1.83 mm., wide 1.00.
Thorax and abdomen, long 2.72—2.91.
Antennae (14-jointed) 2.40.
Tibia iii. 1.50—1.60.
Abdomen, wide 0.85.

Worker. (Text-figs. 8, 9.)

Colour: Head mummy brown above and behind, genae and postclypeus cream, frontal and transverse sutures (Light, 1921) very distinct, pronotum brown, not as dark as head, but darker than tergites of abdomen; remainder of insect whitish yellow.

Head very large, longer than wide, widest at the insertion of the antennae, with very few setae. Labrum large, convex, narrow at the base, wide on the sides and rounded in front. Postclypeus large, convex, twice as wide as long, a dark brown spot at either end; anteclypeus hyaline with yellow suffusion on either side of the middle line, anterior margin produced in the middle. Antennae (Text-fig. 8) 15-jointed, joints long and slender, second shorter than third, fourth longer than third. Maxillae as in Text-fig. 9.

Pronotum similar to that of soldier; margin with a few long stout setae.

Legs long and slender, with scattered reddish setae.

Abdomen large, widest in the middle, clothed with scattered long and short setae; cerci short and stout.

Measurements:

Total length 6.00 mm.

Head: long 2.00; wide 1.73.

Thorax and abdomen, long 4.00.

Antennae (15-jointed) 2.35.

Pronotum: long 0.47; wide 0.90.

Tibia iii. 1.75.

Abdomen, wide 1.70.

Affinities.—The imago is distinguished from *E. palmerstoni*, to which it is evidently closely related, by its much larger eyes and ocelli, proximity of the latter to the former, differently shaped antennae, shorter abdominal tergites (the third segment being 0.61 as against 0.71 in *palmerstoni*), markedly emarginate posterior border to meso- and metanotum (much straighter in *palmerstoni*), and less deeply emarginate posterior border to pronotum. The soldier appears to be nearest *E. nigerrimus* var. *queenslandicus* Mjöb. (Text-fig. 10 and 11) and *E. magnus* Frogg. From the former (alate form not known) it differs chiefly in having smaller and less rounded head, longer and more slender snout and straighter dorsal surface in profile. These differences are slight, but they are at least as well marked as those which separate soldiers of certain allied species which are very distinct in the alate form. The termitaria of these two are so dissimilar that it is not at all likely that they are constructed by individuals of the same species. I have not had authentic examples of *E. magnus* Frogg. for examination, but from the description of the soldiers and Dr. Mjöberg's remarks upon them, they are evidently very similar to *E. vernoni*. The termitaria, too, are evidently very much alike, but the difference in the alate forms is very marked indeed.

Biology.

The termitarium and its occupants.—The termitaria are to be found in immense numbers on the low treeless or nearly treeless country in the vicinity of Townsville (Pl. xxiv. fig. 1), where they are associated with the mounds of two other very common species, *Hamitermes wilsoni* Hill (H. perplexus Hill) and *Drepanotermes silvestrii* Hill. In shape they are more or less rounded domes, circular at the base and sloping on the sides to the broadly rounded or flattened apex. The sides are often symmetrical, but generally undulating as a result of accretions made from time to time to meet the needs of the increasing colony. The average dimensions of these termitaria are about 2 ft. 6 inches in diameter at the base by 2 feet in height, but they are sometimes more than twice this size. The walls are composed entirely of heavy loamy soil, moulded into a close-textured mass free from the short lengths of grass found in the structures of some other *Eutermes*, e.g., *E. palmerstoni*, n.sp. Although thick and compact, the walls may be easily broken down with a light pick, and are often pierced by small animals (? Bandicoots) presumably in search of food. A small bird (*Pardalotus* sp.) also occasionally tunnels into these termitaria for nesting purposes. Within the walls there is a maze of irregular passages and tunnels, some of which are generally tightly packed with short lengths of dried grass, while others are occupied by members of the community (Pl. xxiii., fig. 2). Nearer the middle the passages are more numerous and the dividing walls less substantial. The "nursery" is generally large and occupies the whole of the lower-middle portion of the nest (Pl. xxiii., fig. 1). In it the chambers are more or less horizontal and separated from each other by very thin layers of fragile, brown matter almost entirely vegetable in origin. There is no well-defined queen-cell, the mother termite occupying one of the undifferentiated chambers composing the "nursery" or, very often, one of the large cells near those in which grass is stored (Pl. xxiii., fig. 1). The roofs of the "nursery" cells are generally dotted over with small white spots of fungus growth, which may possibly be used as food. Dejecta are stored in the cells outside the lower part of, and below, the "nursery." Additions to the nest appear to be made generally during the dry season and, when undertaken, are generally extensive. An increase of about 50% in the size of a nest has been observed to take place within a week in one instance, but such rapid building is unusual.

The earthy material used in building is gathered very largely on, or near, the surface, since there are no extensive excavations below it and no trace in the walls or elsewhere of the yellow-coloured subsoil, which underlies the locality in which the nests have been investigated. The main passages from the nest all trend towards the lower part of the walls, under which they pass at a depth of 3 to 4 inches and then divide into numerous radiating passages communicating with the surface, where they are closed excepting at "harvesting" time.

The parents of a new colony live for some time in underground passages, in which they rear a fairly large brood of workers and soldiers only; then, when the community is strong enough, a termitarium is built, and, later (probably 2 years) the first brood of nymphs is reared. I have seen still soft and moist termitaria of about 15 inches in height where none existed a few weeks earlier and, on breaking these mounds open, found them to contain a large number of workers and soldiers only, the king and queen being located in chambers excavated in the soil below. There is no "nursery" in these young termitaria, in fact, this part of the structure is well-defined only in the older ones.

The community invariably consists of an immense number of soldiers and workers, the former approximating the latter in numbers. These castes are associated with vast numbers of young forms in all stages of development, the larger of which may be differentiated as being destined to become workers, soldiers or imagos. A king and queen are nearly always found in some part of the nest, but the former is easily overlooked unless a careful search is made. The queen is not imprisoned within a cell, as is often the case with other species, but wanders through, and oviposits in, any of the larger passages. Of five queens captured on 7th July, only two were located in the "nursery," the others being in passages near the top of the nest and within a few inches of the walls. In each case masses of fresh eggs were found in close proximity, and others not far distant. The eggs hatch in the chambers or passages in which they are laid, but the resulting larvae appear to be carried, or migrate, to the "nursery." Ecdysis has been observed only in the larger worker larvae and nymphs undergoing their final moult; in these the quiescent stage is passed within the "nursery." The larvae which are destined to develop into imagos, moult about the middle of September, after which the wing rudiments are evident to the naked eye. After passing through another moult, about the middle of November, there is a considerable increase in the size of the body and wing-rudiments. The latter grew rapidly at first, but after attaining a length of 3.0-3.25 mm. there is little further external development in this stadium. Just before the final ecdysis, which occurs between the end of the first and the last week of January, the wing-rudiments, now 3.50 mm. long, lose their creamy colour and become brownish yellow, and the abdomen becomes distended owing to the great increase in the fat-body. The moult which follows is not simultaneous throughout the colony. From the middle of January to about the middle of February there will often be found large nymphs with unpigmented wing-rudiments and others in all subsequent stages of development, up to apparently mature insects. I believe that the latter await the further development of the former and that all subsequently leave the colony together during the first two weeks of February. "Swarming" has not been observed but almost certainly takes place at night. The number of imagos reared by a colony of this species is comparatively small. Probably 50% of the termitaria examined between the months of September and February will be found to contain no nymphs or alate imagos, whilst in the remainder, the complement will range from three to twenty, or an average of about 12 per colony. These figures have been found to agree fairly closely for three successive seasons, with the exception that in one termitarium examined this year (13th January) about 100 nymphs and developing imagos were found.

Neoteinic royalties, or the immature forms destined to develop into them, have not been found in this species. I have frequently noted that termitaria from which I had removed the queen were always repaired to a certain extent and then abandoned, whilst those in which the queen was not discovered were soon rebuilt and as prosperous as before. This indicated the inability of these *Eutermes* to exist as a community after the death of the original female parent. In order to decide this question, the queens were removed from three large termitaria on 17th July, 1920, while at the same time three other nests were similarly broken into but not orphaned. About a month later all were found to be sufficiently repaired to protect the inmates from the attacks of predaceous animals and from other dangers. When next visited on 13th January, 1922, the three orphaned nests were found to be quite abandoned, while the others contained prosperous communities. In the case of *Drepanotermes silvestrii* Hill which is found in the same locality, I have been able to show that the loss of the true queen is not such a serious matter, since the survivors thereafter substitute one or more neoteinics which are capable of producing sufficient young to maintain a colony of considerable, if not of average, numerical strength.

Associated with *E. vernoni* are two other species of termites whose relationship with the host species and with each other is not clear. As a rule when a termitarium is occupied by more than one species, each occupies a definite part of the structure and there is, apparently, no fraternising. In the present instance, however, there are two species living (in the alate form) in the same galleries, and, as far as is known, in perfect amity with their hosts. The smaller of these, a species of *Hamitermes,* has been found twice in occupied nests of *E. vernoni,* and on each occasion associated with the larger species, and once in an abandoned nest—one of the orphaned nests examined on 13th January. The latter were accompanied by their own soldiers and workers,—castes which I could not find with the two series of imagos previously taken in nests occupied by *E. vernoni.* The larger species, the generic position of which I have not determined, is of much commoner occurrence in the nests of *E. vernoni* than is the smaller *Hamitermes.* During the period September-February of the years 1919-20 and 1920-21 the nymphs or the alate forms only of this species were taken in many of the nests examined. In most instances they were found with the nymphs or imagos of the host species, according to the period, but in numerous cases they were found in termitaria which contained no other nymphs or imagos. In fact, during those seasons the nymphs or the imagos of the unidentified guest species were more often found than those of the host species and in only two instances were the latter unaccompanied by the former. All attempts to find the soldier and worker castes proved unsuccessful. During the present season (1921-1922) with more leisure at about the "swarming" period and with the assistance of an energetic companion I was able to examine a large number of termitaria, only to find a complete absence of all castes of the unidentified species.

The grass stored in these termitaria is nearly always infested with the larvae, pupae and imagos of a small beetle, which Mr. A. M. Lea has described under the name *Palorus eutermiphilus.* From the same nests Mr. Lea has also identified *Mandalotus geminatus* Lea which, he informs me, is not a true inquiline. The partially abandoned upper parts of the nests often harbour the larvae, pupae and imagos of the Carabid beetle *Gigadema sulcatum* Macl. (identified by Mr. T. G. Sloane) and an unidentified Scarabaeid and Elatrid. The most remarkable inhabitants of these mounds are, however, large Coleopterous larvae which are enclosed by the termites in closely fitting cells in which they are fed and attended by their hosts. I have examples measuring from 15 to 60 mm. in length, but I have not yet succeeded in rearing them to the pupal or adult stage, although I have at the present time living specimens which have been in captivity for two years without food or the attendance of termites. It is intended to publish some notes elsewhere on these insects.

EUTERMES PALMERSTONI, n.sp. (Text-figs. 12-14.)

Eutermes triodiae Hill (*nec* Froggatt), Proc. Linn. Soc. N.S.W., xl., 1915, p. 107.

Queen.

Colour: Head very dark brown; antennae, clypeus, and legs buckthorn brown; labrum yellow; thorax, wing-stumps and tergites of abdomen auburn.

Head large, posterior margin semicircular to the hind margin of the eyes, front concave; fontanelle large, shaped like a key-hole, in line with ocelli; dorsal surface covered with fine short hairs; ocelli moderately large and well separated from the eyes; eyes large (diam. 0.470 x 0.564) and prominent, finely faceted, the lower margin less than one-third the short diameter from the lower margin of head; post-clypeus moderately large, arcuate behind, truncate in front, with fairly distinct median suture; anteclypeus hyaline, large, produced anteriorly in the middle; labrum strongly convex, narrow at the base, swollen on the sides, rounded in front. Antennae 16-jointed, first joint long and stout, second half as long as first and much narrower, third one-fourth longer than second, fourth as long as second, oval.

Thorax: Pronotum with anterior margin concave and bent up, lateral areas rounded, sides narrowed to the deeply emarginate posterior border, the whole surface densely clothed with short fine setae, as on head. A clear depression on each lateral area and a larger angular patch behind the anterior margin. Wing-stumps small, equal, covering about half the notum, posterior margin of meso- and metanotum slightly sinuate.

Legs moderately long and stout.

Abdomen with very distinct tergites, clothed with dense short setae, remainder of abdomen creamy white, glabrous.

Measurements:

Total length 33.00 mm.

Head wide 1.97; long 2.35; deep 1.17.

Thorax and abdomen, long 31.00.

Pronotum: long 1.17; wide 1.88.

Tibia iii. 2.82.

Abdomen, wide 9.00.

Soldier. (Text-figs. 12-14.)

Colour: Head very dark chestnut, base of snout a little darker than rest, a little lighter behind; antennae fuscous; thorax, legs and abdomen lighter, anterior margin of pronotum very dark.

Head (Text-figs. 12, 13) large, wide, round behind, snout moderately long and stout, clothed with scattered fine pale setae. Antennae (Text-fig. 14) 14-jointed, very long and slender, first joint long and moderately stout, as long as fifth, second short, about half as long as first and much narrower, shortest of all; third very long and slender, equal to or very little shorter than fourth; fourth, fifth and sixth progressively longer, seventh and eighth equal in length to sixth; ninth shorter than eighth, equal to fourth; tenth to thirteenth inclusive a little shorter than ninth and a little longer than fourteenth.

Thorax: Pronotum saddle-shaped, anterior half bent up sharply, very dark, anterior margin rounded, slightly emarginate in the middle, lateral areas narrow and bluntly pointed, posterior margin rounded and slightly emarginate. Mesonotum much narrower than pronotum.

Legs long and slender, clothed with short fine setae.

Abdomen much narrower than head, tergites with scanty, long reddish setae; cerci long and slender.

Measurements:

Head: long 1.88 mm.; wide 1.22.

Thorax and abdomen, long 2.53.

Pronotum: long 0.25; wide 0.65.

Tibia iii. 1.84.

Abdomen, wide 0.95.

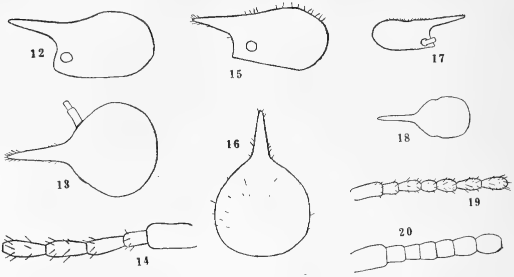
Note: In some of the tubes there are a few soldiers with smaller and less rounded heads, but otherwise similar. These have heads 1.74 long x 0.98 wide.

Worker.

Colour: Head dark chestnut, with pale sutures; clypeus, legs and prónotum pale yellow, antennae paler.

Head large, rounded, clothed with pale setae; post clypeus convex, about twice as wide as long, arcuate behind, truncate in front; anteclypeus hyaline, with middle of anterior margin strongly produced forward. Antennae 15-jointed, first joint long and moderately stout, second about half as long and much narrower, third very long and slender, fourth long and narrow, but shorter than third.

Thorax: Pronotum saddle-shaped, anterior half bent up, emarginate in middle, lateral areas rounded, posterior border rounded, bearing a few stout red setae; mesonotum narrower and shorter than pronotum; metanotum one-fourth wider than mesonotum, both with a few stout, red setae.



Text-figs. 12-14. *Eutermes palmerstoni,* n.sp.
Soldier.—12. Head in profile; 13. Head, dorsal surface; 14. Antenna, proximal segments.

Text-figs. 15-16. *Eutermes triodiae* Froggatt.
Soldier.—15. Head in profile; 16. Head, dorsal surface. Drawn from a cotype.

Text-figs. 17-20. *Eutermes mareebensis,* n.sp.
Soldier.—17. Head in profile; 18. Head, dorsal surface; 19. Antenna, proximal segments.
Worker.—20. Antenna, proximal segments.

Legs long and moderately slender, not markedly setaceous; abdomen with a few reddish setae on tergites.

Measurements:
Total length 6.00 mm.
Head: long 2.00; wide 1.64.
Thorax and abdomen, long 4.00.
Antennae (15-jointed) 2.35.
Pronotum: wide 0.70; long 0.51.
Tibia iii. 2.16.

Affinities.—The alate form of *E. palmerstoni* is unknown, but the measurements of the queen indicate that it is one of the large species, possibly as closely allied to *E. vernoni,* n.sp. as any other. From the latter it is distinguished, *inter alia,* by the pronotum and size of the eyes. From *E. triodiae* Frogg. it is easily distinguished by its much greater size, darker colour and fewer joints in the antennae. The measurements of Froggatt's species (from a co-type) are as follows:—diameter of eyes .304 x .288, length of head 1.27, width of head 1.08, length of pronotum 0.70, width of pronotum 1.03.

The soldier is similar to *E. triodiae* but the head differs in shape and is much darker in colour (Text-figs. 15 and 16).

In an earlier publication (1915) I described and figured the termitaria and discussed the habits of this species under the name *Eutermes triodiae* Frogg., a species which it resembles only in the soldier caste.

The immense termitaria erected by these termites entitle them to rank as one of the most remarkable of the Australian species, sharing with *Eutermes pyriformis* Frogg. the distinction of building the highest nests of any known species. The latter species is of further interest owing to the fact that, since its discovery by the late N. Holtze over 20 years ago and its subsequent description by Froggatt, it appears to have remained unknown to naturalists. With Froggatt's excellent photographic reproduction of the termitarium and its discoverer's direction to the locality (near Darwin) for guidance I anticipated little difficulty in learning more of the habits of this interesting insect, but all efforts to locate another colony have so far failed. The termitarium figured by Froggatt is evidently very similar, outwardly at any rate, to those of *E. palmerstoni,* which are very common in the vicinity. The possibility that Holtze's specimens were occupants of a part, or whole of a nest originally built by *E. palmerstoni* cannot be overlooked, but his description of the interior of the nest, if correct, indicates a species possessing feeding habits quite distinct from those of the latter species.

EUTERMES MAREEBENSIS, n.sp. (Text-figs. 17-20.)

Imago.

Not known.

Soldier. (Text-figs. 17-19.)

Colour: Head very dark, nearly black; antennae and anterior half of pronotum fuscous, remainder of pronotum and tergites of abdomen lighter; legs yellowish.

Head: In profile (Text-fig. 17) long and slender, with long slender snout; viewed from above (Text-fig. 18) the posterior part of the head is moderately wide and rounded with a marked constriction behind the antennae. Antennae (Text-fig. 19) 13-jointed, long and slender, longer than head, first joint long and slender, twice as long as second and fourth, second and fourth equal in length and shortest of all, fourth oval, third long and narrow, seven-tenths the length of first and a little longer than fifth, sixth and thirteenth elongate, sixth a little longer than seventh, eighth to tenth and thirteenth a little longer than sixth, nearly as long as first, eleventh and twelfth shorter than thirteenth, equal to seventh.

Thorax: Pronotum more than twice as wide as long, saddle-shaped, anterior half very dark, bent up and fringed with short stout hairs, lateral margins narrow and rounded, posterior margin semicircular; mesonotum narrower, shorter and more flattened than pronotum.

Legs very slender, not markedly long, moderately setaceous.

Abdomen elongate, clothed similarly to legs, cerci long and slender.

Measurements:

Total length (when axis of head is parallel with axis of body) 3.75 mm.
Head: long 1.22—1.30; wide 0.56; deep 0.37.
Thorax and abdomen, long 1.90—2.00.
Antennae (13-jointed), long 1.60.
Pronotum: long 0.18; wide 0.42.
Tibia iii. 0.84.
Abdomen, wide 0.80.

Specimens in alcohol may be roughly distinguished from other described Australian species by the following obvious characters:—small size, long, slender, nearly black head and snout, long antennae, dark pronotum and brown banded abdomen.

Worker. (Text-fig. 20.)

Colour: Head light yellowish-brown with two broad parallel dark-brown stripes on either side of the whitish frontal suture and posterior to the transverse suture; labrum stramineous; antennae, mouth parts, thorax, legs and abdomen pale yellowish-white.

Head moderately broad, rounded behind; clypeus rather convex, without distinct longitudinal suture, sides straight, sloping to the broadly truncate apex; labrum very short and broad, less than half as long as wide, widening on the sides to the very broadly rounded apex. Antennae (Text-fig. 20) 15-jointed, third joint shortest, fourth and fifth equal, sixth a little longer than fourth and fifth.

Thorax: Pronotum saddle-shaped, as in soldier, but lateral margins are markedly produced.

Legs slender and rather short, moderately setaceous.

Abdomen with scanty clothing of fine setae of unequal lengths.

Measurements:

Total length 4.50 mm.

Head: long 1.40—1.60; wide 1.08—1.13.

Thorax and abdomen, long 3.33.

Pronotum: long 0.30; wide 0.70.

Affinities.—The nearest allies to the new species (soldiers) are *E. pulleinei* Mjöb. and *E. tyriei* Mjöb. From the former it is easily distinguished by its much darker head (dark reddish-orange in *E. pulleinei*) and by having only one form of soldier. From *E. tyriei* it is distinguished also by the colour of the head (dark reddish-orange in Mjöberg's species), smaller size and very distinctly different antennae. It is the smallest of the very dark headed species yet described from Australia and the only one of such colour with constricted head.

Locality.—North Queensland: Mareeba (G. F. Hill, 23.5.21). Described from soldiers and workers found in a small, pointed mound of an undetermined species of *Hamitermes* in open Eucalyptus forest.

EUTERMES YARRABAHENSIS Mjöberg. (Text-figs. 21-27.)

Arkiv for Zoologi, xii., No. 15, 1920, p. 53.

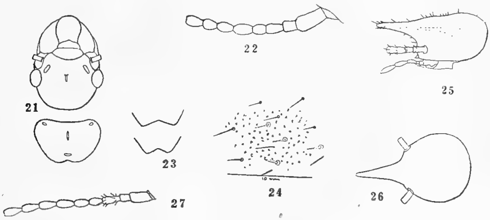
Imago. (Text-figs. 21-24.)

Colour: Head very dark brown, postclypeus and mandibles (excepting teeth) buckthorn brown, anteclypeus white, membranous; labrum yellow ochre; antennae and thorax buckthorn brown; wings brown, veins darker, anterior margin yellowish; tergites of abdomen brussels brown; first five sternites with obscure greyish spots at each end; legs buckthorn brown.

Head (Text-fig. 21) rather small, rounded behind to the posterior margin of the eyes, moderately densely setaceous. Eyes large (.517 x .400) and prominent, finely faceted, their lower margin close (.141) to lower margin of head. Ocelli oval, moderately large, inserted near eye (.047). Fontanelle large, elongate, forked anteriorly. Postclypeus a little more than twice as wide as long with scattered reddish setae. Anteclypeus as long as postclypeus, anterior margin produced in the middle. Labrum narrow at the base, as wide as postclypeus in the middle, rounded in front and just reaching the apex of the mandibles. Antennae (Text-fig. 22) 16-jointed, the first joint large, longest of all, second half as long as first and much narrower, third as long as second, a little narrower at the apex and much narrower at the base, fourth shortest of all, fifth noticeably longer than third, sixth and seventh, the remaining joints not exceeding the fifth in length.

Thorax: Pronotum (Text-fig. 21) small, a little narrower than head, not notched, but slightly concave and bent up in front; antero-lateral areas rounded, sides sloping to the narrowed and slightly sinuate posterior margin, clothed as in head and wing-stumps. Meso- and metanotum (Text-fig. 23) with posterior margin deeply emarginate.

Legs short, moderately stout and setaceous, claws long and slender, spurs 2:2:2.



Text-figs. 21-27. *Eutermes yarrabahensis* Mjöberg.

21-24. Imago.—21. Head and pronotum; 22. Antenna, proximal segments; 23. Meso- and metanotum, posterior margin; 24. Wing-membrane.

25-27. Soldier.—25. Head in profile; 26. Head, dorsal surface; 27. Antenna, proximal segments.

Wings: Wing-stumps small, equal, clothed with long and short setae, suture straight; costa and radius very distinct at the base but soon becoming obscure, with three or four branches beyond the middle; cubitus with nine or ten branches, the first six only very distinct. Wing-membrane (Text-fig. 24) minutely and densely sculptured, clothed densely with minute setae.

Abdomen large, clothed as in pronotum; cerci short and stout.

Measurements:

Length with wings: ♂ 16.00 mm., ♀ 18.50; without wings: ♂ 8.00, ♀ 10.50.

Head: wide 1.60—1.69; long 1.88—2.00; deep 0.70.

Antennae (16-jointed) 2.60.

Pronotum: long 0.84—0.94; wide 1.50—1.55.

Wings: fore, long 15.00, wide 4.60; hind, long 14.50, wide 5.00.

Tibia iii. 2.00.

Abdomen, wide 3.00—3.50.

Affinities.—The imago of this species is very similar to that of *E. vernoni*, n.sp., but is easily separated by its smaller size, much smaller wings and eyes, light coloured thorax, etc.

Identification.—A comparison of a long series of soldiers and workers from several localities near Townsville with co-types kindly placed at my disposal by Professor Sjöstedt, leaves little doubt in my mind as to the correctness of the identification of the imago described in the preceding pages. In the colour, size and form of the heads of soldiers I can find no differences whatever, but there is a marked tendency in nearly all of my specimens to a coalescence of joints three and four of the antennae. This is rare in Palm Island examples, but, with few exceptions, it is the rule in all others. The workers appear to agree in every detail.

Biology.

Termitaria.—The termitaria are generally conical in shape, circular at the base, sloping symmetrically on the sides to the bluntly pointed or rounded apex. An average size nest measures about 15 inches in diameter at the base and about 18 to 20 inches in height. Larger nests, up to about 2 feet in height, are sometimes found. They appear to be constructed invariably on sandy, well-drained open forest or scrub country, or on low sandy rises near the margin of plains subjected to inundation. In the latter localities they are commonly found amongst the stumps of *Pandanus*. The material used in the construction of these nests appears to be composed entirely of sand firmly cemented together. In the older nests the walls are fairly hard and solid, but in the majority the whole mass is rather fragile and easily crumbled. The interior is composed of a multitude of small passages and cells, which sometimes contain eggs and small stores of grass, but are generally occupied exclusively by the insects. There is no well-defined "nursery," and no queen cell in the superstructure. A queen has not been found, but it is certain that she is not domiciled above ground-level. Below the termitarium the earth is tunnelled out to a depth of about 18 inches, forming galleries and cells similar to those above, and, doubtless, others for the accommodation of the queen and young larvae.

Prosperous colonies have been found in the walls of nests of *Coptotermes acinaciformis* Frogg. on Magnetic Island, and, on many occasions, under logs and in the soil on treeless grazing land near Townsville. The presence of the latter are generally easily detected by numerous short covered-ways which are constructed on the surface of the ground by foraging parties in search of food (grass). An exit is first made by cutting a curved slit in the surface soil about 3 mm. wide by 10 mm. long which is then covered with an arched roof of particles of sand cemented together. The covered-ways branch out in all directions to a distance of a foot or more and afford protection for the working party. Food appears to be gathered only at night. The underground nests of these colonies have not been examined, but it is probable that they are extensive, since it is definitely known that imagos are reared in them.

Swarming.—Nymphs with well-developed wing-pads, and also some mature imagos, were found in many nests on Magnetic Island on 26th November, 1920, and near Pentland on 1st December, 1921, whilst many imagos were captured at a lamp indoors in Townsville on 24th and 26th December, 1920, 15th and 21st January, 26th, 29th, and 31st December, 1921. The nests which contained nymphs and imagos on 26th November, 1920, contained none of these forms on 10th February, 1921.

Locality.—The type locality is Yarrabah, near Cairns, N. Queensland. The following additional N. Queensland localities may be added:—Palm Island, Magnetic Island, Cape Cleveland, Townsville (G.F.H.) Proserpine (J. F. Illingworth), Pentland (G. F. Cook), Prairie (J. R. Chisholm).

EUTERMES LONGIPENNIS Hill. (Plate xxiv., fig. 2.)

Proc. Linn. Soc. N.S.W., xl., 1915, p. 104.

The type locality for this species is Koolpingah Station, about 30 miles S.E. of Darwin, N.T. A recent examination of a large number of nest-series shows that it occurs commonly in the vicinity of Darwin and Stapleton (69 miles south of Darwin), generally on low-lying, stiff grey or black soils. It is a pest of considerable importance, since it readily attacks fence-posts, house-blocks and bridge piles in badly-drained heavy soils. In such localities one frequently finds fence-posts and dead stumps of trees felled by timber-cutters encased in a hard clayey sheath, which is carried over the top to form a conical apex (Pl. xxiv., fig. 2). As the work of destruction proceeds, the entire mass of wood is replaced by a column of hard clay and triturated wood, which is easily pushed over but not readily crumbled. I have not found a queen in any of the nests examined. Fully developed alate forms were found in the nests from 6th to 21st November, when there were generally present a number of nymphs in the stage preceding the final moult. The latter doubtless mature rapidly, as is known to be the case in many other species, and leave the colony with the earlier developed winged individuals soon after the first heavy rains.

"Swarming" has not been observed, nor have the imagos been captured in the free-living state.

HAMITERMES DARWINI, n.sp. (Text-figs. 28-33.)

Imago.

Not known.

Soldier. (Text-figs. 28-31.)

Colour: Head xanthine orange with broad ochraceous orange area extending from the front posteriorly; labrum mustard yellow; mandibles mahogany, shading at base to the colour of head; mouth parts, antennae, legs and pronotum yellow ochre; abdomen greyish, due to contents of stomach.

Head (Text-figs. 28, 29) large, broadly rounded behind, slightly rounded on the sides, widest about the middle, bearing very few stout reddish setae, chiefly on the front. Clypeus large, about two-fifths as long as wide, slightly emarginate in front, divided by a deep and wide median furrow, which passes into the frons. Labrum large, wide at base, slightly rounded on the sides to the broadly rounded apex, which hardly covers the mandibular teeth, bearing about 14 long reddish setae. Mandibles very long, falciform, broad at the base, each with a large tooth in line with the apex of the labrum. Gula at narrowest part about one fourth the width of head. Antennae (Text-figs. 30, 31): First joint very large, second about half as long as, and much narrower than, first, both without setae, third half as long and about as wide as second, shortest of all; fourth very little larger than fifth, sixth a little larger than fourth, seventh to fourteenth elongate.

Prothorax very small, much narrower than head, anterior half bent up, front margin semicircular, with faint indication of notch in middle; antero-lateral area narrowed, sides sloping into the truncate posterior margin; margin with scanty fringe of long reddish setae.

Legs moderately short, femora and fore-tibiae slightly thickened, with few setae; apical one-third of tibiae with long stout setae on posterior margin, tibial spurs 3:2:2.

Abdomen small, widest in the middle, pointed towards the apex, with scanty pale long setae.

Measurements:

Total length 4.25 mm.

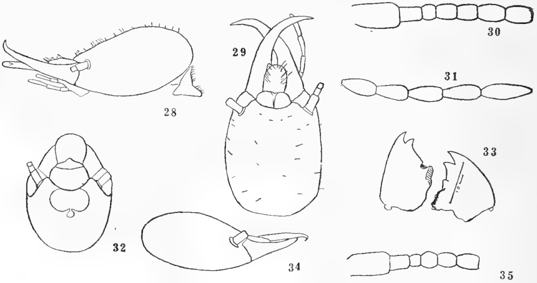
Head: with jaws, long 2.35; from base to apex of labrum 1.88; wide 1.22—1.36; deep 0.89.

Antennae (15-jointed) long 1.88.

Pronotum: long .37; wide .70.

Tibia iii., long 1.22.

Abdomen, wide 1.17.



Text-figs. 28-33. *Hamitermes darwini*, n.sp.

28-31. Soldier.—28. Head in profile; 29. Head, dorsal surface; 30. Antenna, proximal segments; 31. Antenna, distal segments.
32-33. Worker.—32. Head; 33. Mandibles.

Text-figs. 34-35. *Hamitermes meridionalis* Froggatt.

Soldier.—34. Head in profile (to same scale as fig. 28); 35. Antenna, proximal segments (same scale as fig. 30).

Worker. (Text-figs. 32, 33.)

Colour: Head yellow ochre, suffused with ochraceous orange on sides; clypeus and labrum yellow ochre; frons cream; remainder of insect buff yellow.

Head (Text-fig. 32) small, semicircular behind, widening slightly on the sides to the base of the mandibles, antennal fossae wide and shallow, foviolae much closer to the postero-lateral angle of the clypeus than to the lateral margin of the head, the surface with very few, moderately long, reddish setae. Post-clypeus large, half as long as wide, convex, broadly rounded behind, truncate in front, with a distinct suture. Labrum short and wide, rounded in front. Antennae 15-jointed, third joint shortest. Mandibles as in Text-fig. 33.

Pronotum as in soldier, but without notch in anterior margin.

Legs short and stout, femora and fore-tibiae thickened, long stout setae on the posterior margin of the apical one-third of tibiae; tibial spurs 3:2:2.

Abdomen short and broad, nota with scattered moderately long setae.

Measurements:

Total length 4.25 mm.

Head: long 1.55; wide 1.22.

Thorax and abdomen, long 3.80.

Antennae (15-jointed) 1.64.

Pronotum: long .42; wide .70.

Tibia iii., long 1.03.

Abdomen, wide 1.78.

This species is described from three series of soldiers and workers, (*a*) from amongst the surface roots of grass (1st April), (*b*) in an abandoned nest of *Eutermes pastinator* Hill (1st January), (*c*) in heavily manured garden soil (16th October). It is probably a common species in the type locality, but owing to its cryptic habits it is likely to be found only by chance.

Affinities.—In colour the soldier is very like that of *H. meridionalis* Frogg., but it is a much more robust species (compare Text-figs. 28 and 34, which are drawn to same scale) with distinctly different mandibles. From *H. germanus* Hill it is easily distinguished by its greater size and the form of the mandibles, especially the relative proximity of the mandibular tooth to the base of the jaw. *H. kimberleyensis* Mjöb. is much nearer to *H. germanus* Hill than to the new species, with which it cannot be confused.

Locality.—Northern Territory: Darwin (G. F. Hill).

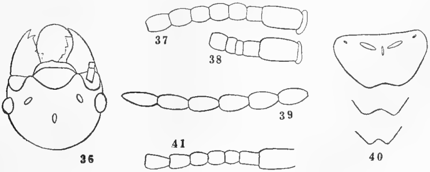
HAMITERMES GERMANUS Hill. (Plate xxv., fig. 1; Text-figs. 36-41.)

Termes germana, Hill, Proc. Linn. Soc. N.S.W., xl., 1915, p. 88.
Hamitermes germanus, Hill, Bull. Ent. Res., xii., No. 4, 1922.

Imago. (Pl. xxv., fig. 1; Text-figs. 36-40.)

Colour: Head dark auburn, thorax and tergites of abdomen argus brown; labrum yellowish; postclypeus, mouth-parts, antennae, legs, and under-surface yellow ochre; pleurae brown; wings dark fuliginous with dark brown veins.

Head (Text-fig. 36) small, rounded behind to the posterior margin of the eyes, flattened in front, densely setaceous. Labrum rather small, swollen on the sides to the semicircular anterior margin, setaceous. Anteclypeus small, hyaline;



Text-figs. 36-41. *Hamitermes germanus* Hill.

36-40. Imago.—36. Head; 37. Antenna, proximal segments; 38. Antenna, proximal segments of another form; 39. Antenna, distal segments; 40. Pronotum and posterior margin of meso- and metanotum.
41. Soldier.—Antenna, proximal segments.

postclypeus large, about twice as wide as long, semicircular behind, truncate in front, setaceous. Eyes small (.208 x .272), projecting very little, separated from the lower margin of the head by a space equal to about half their short diameter. Ocelli small, oval, separated from the eyes by a distance equal to that separating the eye from the lower margin of head. Fontanelle large, elongate oval. Antennae (Text-figs. 37-39) 15- or 16-jointed, variable in segmentation, sometimes differing markedly in the same individual, the first always short and stout, second always very short and narrow, sometimes shortest of all, third generally shortest and narrowest but often equal to second and fourth.

Thorax (Text-fig. 40): Pronotum small, narrower than head, straight in front, with an oblique, elongate depression on either side near the median line and a smaller one in each antero-lateral area, sides rounded to the emarginate posterior margin, densely setaceous. Meso- and metanotum with posterior margin markedly sinuate.

Legs short, moderately stout and setaceous; tibial spurs 3:2:2.

Wings: Wing-stumps clothed with long and short setae, suture straight. Wings long and narrow, veins distinct to the wing-margin, margin very setaceous; membrane setaceous and densely sculptured. Venation slightly variable but generally as shown in Plate xxv., fig. 1. Rudiment of subcosta visible beyond cross suture.

Abdomen widest in the middle, rounded at the apex, densely clothed with long and short pale setae; cerci very small.

Measurements:

Length: with wings 12.5—13.0 mm.; without wings 6.5—7.0.

Head: long 1.50; wide 1.08; deep 0.47.

Antennae (15- 16-jointed) 1.88.

Pronotum: long .61; wide .98.

Wings: fore, long 10.00, wide 2.63; hind, long 9.50, wide 2.77.

Tibia iii, long 1.17.

Abdomen, wide 1.41.

Identification.—The identification of the alate form described above is based on the comparison of soldiers and workers associated with them, with the types of these castes (from the same locality).

Biology.

On the 17th and 20th November, 1914, immense numbers of alate termites were seen to rise from the ground during and just after a driving rainstorm, which swept over the town about 2.30 p.m. The "swarm" was found to be issuing from many small, circular openings in the surface of the soil over an area of about 20 feet in diameter. Soldiers and workers poured out with the winged forms and, like them, soon became a prey to ants and lizards, which had appeared with their customary promptness. The exit holes were guarded by other soldiers and workers as long as "swarming" lasted, after which the latter closed the openings with cement-like material, leaving many of their fellows to perish in their struggles with their enemies. Examples of all castes were collected at the exit holes only to obviate the possibility of confusing them with another species (*H. darwini,* n.sp.) which was known to infest the same allotment. An attempt was made to follow the underground tunnels back to their nest, but this was found impracticable. This species, like *H. germanus* Hill and *H. darwini,* n.sp., appears to feed exclusively on decaying vegetable matter. None of them, as far as known, build termitaria.

Locality.—Northern Territory: Darwin (G. F. Hill).

HAMITERMES WILSONI, nov. nomen.

Hamitermes perplexus Hill (*nec* Banks) Bull. Ent. Research, xii., No. 4, 1922; Proc. Linn. Soc. N.S.W., xlvi., 1921, p. 453.

Dr. T. E. Snyder, Bureau of Entomology, Washington, has been kind enough to point out to me that the name given to this species is preoccupied, having been used by Banks (1920) for a species from Texas. I now propose to name it after Mr. F. E. Wilson, to whom I am indebted for many examples of the termite fauna of Victoria.

COPTOTERMES ACINACIFORMIS Froggatt. (Plate xxv., figs. 2, 3.)

Proc. Linn. Soc. N.S.W., xxii., 1897, p. 740 (Termes); Hill, *op. cit.*, xl., 1915, p. 92.

I have examined a large number of nest series, many of which include queens or alate imagos, or both, from North Queensland, Northern Territory, and adjacent islands, and have compared them with co-type soldiers and imagos of *C. acinaciformis* Frogg. (imago de-alated) and *C. lacteus* Frogg. Mr. Froggatt had previously identified Northern Territory specimens for me as *C. acinaciformis* and I am now satisfied that this is the common, if not the only, species of this genus found in the northern (coastal) region of the Territory. I have previously described the habits of this species in the Northern Territory (Hill, 1915), but I may add that later investigations show that neoteinic queens are produced as substitutes for "first form," or true queens, if the latter be removed from prosperous termitaria.

Since the above paper was written I have been fortunate enough to secure complete nest series of *Coptotermes* from Bathurst Island (N.T.) and Moa Island (Torres Strait), which show clearly that the island species is quite distinct in the imago from any of the described mainland species. Whether or not the Melville Island specimens, previously referred to *C. acinaciformis*, are conspecific with those from the islands mentioned, must remain in doubt until imagos are available for study. A number of soldiers and workers from a house-pile at Membare River (New Guinea) represent still another species, while a similar set from Mitchell River (N.Q.) appears to differ from other N. Queensland specimens. From Townsville (N.Q.) I have complete series, including alate imagos and queens, which I refer to *C. acinaciformis* Frogg. Other sets from North Queensland (Malanda, Port Douglas, Palm Island and Magnetic Island) appear to be referable to the same species, but in the absence of imagos, specific determination cannot be made with confidence. *C. michaelseni* Silv. which has been recorded by Mjöberg (1920) from Cedar Creek and Herberton (N.Q.) is unknown to me from N. Australia, as is *C. lacteus* Frogg. recorded by Mjöberg from Millaa Millaa, Laura, and Alice River (N.Q.). To the latter species I provisionally refer soldiers and workers from Pikedale, S.Q.

In the paper previously referred to, I have described the termitaria and habits of this species, which appear to be very similar to those of *C. lacteus* as described by Froggatt. The mounds are very characteristic in the genus, inasmuch as they consist of a clayey outer wall covering a compact mass of comminuted woody matter moulded into a curiously complicated form reminding one of the familiar jig-saw puzzles (Pl. xxv., figs. 2, 3).

This species is undoubtedly the most destructive of all to standing timber, and in many localities few Eucalypts escape attack. Fortunately only the centre of the tree suffers for many years, so that the actual loss in timber felled for splitting is not great. I have, however, seen some very fine timber rendered valueless for bridge-building and other heavy work, which was otherwise suitable for the purpose. Although capable of doing so much damage to the hardest woods, I have rarely found them destroying fences or buildings.

Coptotermes raffrayi Wasmann.

Proc. Linn. Soc. N.S.W., xxv., 1900; Hill, *op. cit.*, xlvi., 1921, p. 263.

In a recent paper (1921) I described the alate form of the above species from a nest series collected in the type locality (S.W. Australia), the identification having been made from the original descriptions of the soldier and worker castes. This identification has since been confirmed by Rev. Father Wasmann after comparison of my material with the types.

In referring to the affinities of this species, I stated that the alate form of *C. michaelseni* Silv. is unknown, whereas a full description appears in Professor Silvestri's paper (1909). The differences in both the alate and soldier caste are so marked that the two species cannot be confused.

Reference in addition to those quoted in the text.

Light, S. F., 1921.—Notes on Philippine Termites, ii. *Philippine Journ. Sci.*, xix., No. 1, pp. 23-61.

EXPLANATION OF PLATES XXIII.-XXV.

Plate xxiii.

Eutermes vernoni, n.sp.

Fig. 1. Termitarium opened to show "nursery" in the middle, and position of queen (at point of forceps). The scale in middle of "nursery" is 4 inches long.

Fig. 2. Close view of a similar termitarium. Queen in the "nursery," below left end of scale. Stores of grass near outer walls.

Plate xxiv.

Fig. 1. A group of termitaria of *Eutermes vernoni*, n.sp., *Hamitermes wilsoni* Hill and *Drepanotermes silvestrii* Hill.

Fig. 2. Termitarium of *Eutermes longipennis* Hill built over stump.

Plate xxv.

Hamitermes germanus Hill.

Fig. 1. Fore- and hind-wings.

Coptotermes acinaciformis Froggatt.

Fig. 2. Termitarium on side of hill (Townsville, N.Q.).

Fig. 3. Interior of termitarium, showing partly destroyed tree stump (Darwin, N.T.).

THE GEOLOGY AND PETROGRAPHY OF THE CLARENCETOWN-PATERSON DISTRICT. Part i.

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(Plate xxvi., and six Text-figures.)

[Read 31st May, 1922.]

Introduction.

The last ten years have witnessed quite a considerable amount of detailed geological investigation upon the Carboniferous rocks of New South Wales. Prior to 1911, the literature on the Carboniferous System, with the exception of numerous important palaeontological papers (*see* Benson, 1921, pp. 12, 13, 14, 26), was chiefly of economic and commercial interest (*cf.* Jaquet, 1901, p. 63 and Sussmilch and David, 1919, p. 249), and investigations into the detailed stratigraphy were only pursued in so far as it was necessary to make possible the determination of the mode of occurrence, horizon and extent of economic deposits. But from 1911 to the present time, pure research has been carried on to such an extent that there is now a firm foundation for further work upon either the type areas or other districts of Carboniferous rocks.

Without giving a detailed historical account of the work performed on the Carboniferous System during the decade in question, it is necessary to consider briefly the progress of this work as a preliminary to the discussion in the following pages.

The main workers in this connection during the past ten years have been Prof. Benson, Mr. W. R. Browne, Prof. David, Messrs. W. S. Dun and C. A. Sussmilch, and Dr. A. B. Walkom. Prof. Benson described, in 1913 and 1917, the Carboniferous succession along the western slopes of the New England Plateau instituting the term "Burindi Series" for the lower marine portion of the Carboniferous (Benson, 1913, pp. 503-508, and Benson, 1917, pp. 264-270) and later, in collaboration with Messrs. Dun and Browne, discussed in greater detail the geology of the Carboniferous rocks of the Currabubula District (Benson, Dun and Browne, 1920).

A. B. Walkom, in addition to some work at Pokolbin (Browne and Walkom, 1911), made observations on the stratigraphy of the Carboniferous Series in the Glendon Brook district (Walkom, 1913), and has recently discussed the age of the Carboniferous rocks of the Hunter Valley, on the evidence of their fossil flora (Sussmilch and David, 1919, Appendix 1).

Besides some work on the stratigraphy of certain areas (Browne and Walkom, 1911), W. R. Browne has studied the petrology of the Carboniferous Series, particularly the rocks of the upper terrestrial division (Sussmilch and David, 1919, Appendix II., and Benson, Dun and Browne, 1920, Section C), but many of the results of the research have not yet been published.

The most important step in the development of our knowledge of Carboniferous geological history took place as a result of the investigations by Mr. Sussmilch and Professor David of the Carboniferous Series in the Paterson-Dungog region, which followed on the discovery, in 1914, by the latter geologist, of the occurrence of tillite at Seaham. These authors (Sussmilch and David, 1919) proposed the name "Kuttung Series" for the terrestrial strata which, in New South Wales follow the Lower Carboniferous Burindi Series, and which they regarded as representing the Middle Carboniferous and Upper Carboniferous (in part).

The outcome of the work done in the past decade is that the Paterson-Clarencetown district must now be looked upon as the type-area for the Kuttung Series, as it is from evidence collected in parts of this region that Sussmilch has established the general sequence of that Series.

In view of the geological importance of the Kuttung Series, especially on account of the development of volcanic rocks in great variety, together with a wonderful series of glacial beds, the suggestion was made by Professor Sir Edgeworth David, and supported by Messrs. Sussmilch and Browne, that the writer should begin an investigation of the type area, paying particular attention to the petrographic aspect of the work.

Accordingly, five weeks of 1920 and three months of 1921 were spent in field work. During these periods a detailed geological and topographical survey was made of an area bounded by a line running from Wallarobba past Hilldale south-west to Vacy, south to Mt. Johnstone and Paterson, east-south-east to Seaham, across to the Limeburner's Road about six miles from Clarencetown, and west along that road through Clarencetown back to Wallarobba, a region of about 200 sq. miles. Observations in adjacent districts, chiefly to the north, were also made in order to render more simple the interpretation of certain features in the limited area.

It is proposed in the present paper to describe the detailed stratigraphical succession and regional geology, leaving matters connected with tectonic geology, physiography and petrology for later communication.

The General Sequence of the Carboniferous Rocks in the Lower Hunter District.

The broad succession, as determined by Mr. Sussmilch, is as follows:

I. *Burindi Series.*—The chief units comprise limestones, sometimes oolitic and often impure, tuffs of acid and intermediate composition, conglomerates and massive lava-flows. There is some indication that the limestones occur low down in the series and that the lavas may be near the top. A minimum thickness of 5000 feet is suggested.

II. *Kuttung Series.*

(i.) Wallarobba Beds.—Basal conglomerates and tuffs with the conglomeratic material predominating. Thickness, 2500-3000 feet.

(ii.) Martin's Creek Beds.—Lavas and tuffs with intercalated conglomerates. Thickness, about 2250 feet at two localities, viz. Martin's Creek and Eelah.

(iii.) Mt. Johnstone Beds.—A series of tuffs, cherts and conglomerates containing remains of the *Rhacopteris* flora and impure coal seams, these beds being capped by an acid lava flow of toscanite (Paterson type). Thickness: Tuffs, conglomerates, etc., 1950 feet; Toscanite, 300 feet.

(iv.) Glacial Beds of Seaham and Paterson.—Fluvioglacial conglomerates, tillites, varves and tuffs. Thickness, 1840 feet.

DETAILED STRATIGRAPHY OF THE CLARENCETOWN-PATERSON DISTRICT.

PRELIMINARY.

In connection with the present work, more detailed observations were made upon the Kuttung than upon the Burindi Series, the main igneous portion of the Kuttung Series being the subject of the most careful attention. Definite "indicator" horizons were surveyed in detail, in order that the geological structure might be made apparent, and this method afforded excellent opportunities for observing the distribution of the various horizons in the Series. It was soon evident that the succession at any one locality was not in detail the same as at any other, and for this reason detailed sections have been prepared to show the variation in the degree of development and order of the various units. After consideration of the statement that the sequence is different in different localities, one might argue against the policy of mapping any particular horizon to delineate the geological structure. However, the only units used in this connection were the hornblende-andesite (Martin's Creek type) and the biotite-toscanite (Paterson type), which were sufficient to provide the evidence for interpreting the broad tectonic features of the area. In addition, other junctions, and three well-defined horizons in the main igneous portion of the Series have been mapped to show the distribution of the latter and to supply collateral information as to structure.

The two first-mentioned horizons form limits to the portion of the Kuttung Series in which stratigraphical variation occurs, and experience has shown that each of these two units occupies a constant stratigraphical horizon.

The question as to whether some of the massive igneous rocks are flows or intrusive bodies may be considered here. (There are some definitely intrusive rocks in the area, possibly of age later than Carboniferous, which will be described later). The massive igneous rocks in the Kuttung Series comprise rhyolites, toscanites, dellenites, keratophyres, dacites, andesites and andesitic pitchstones. There is no doubt as to the nature of the acid and sub-acid types except the Paterson type of toscanite and dellenite, which are considered below (p. 181). But the following evidence supports the contention that the acid types in the main igneous portion of the Kuttung Series (hereafter called the Volcanic Stage) are extrusive: There occur in the area tuffs of similar general composition to these massive rocks, and in the coarser fragmental material, some of the inclusions are identical with certain of the massive rocks. In many cases spherulitic and axiolitic structures abound in the base of the porphyritic types and, in some instances, the rocks may still come under the category of "massive rocks," but on account of a subordinate content of fragmental material should be termed tuffaceous rhyolites, tuffaceous toscanites and so on. Then, it would be scarcely feasible, in a section such as the Langlands Section (Text-fig. 3), to postulate that the massive rocks are intrusive, on account of the very small interval separating one horizon from the other, the absolute absence of transgression, and the apparent absence of contact metamorphism or the visible effects of marginal assimilation which might reasonably be expected from such acid rocks.

Thus the only horizons about which any doubt remains are the more basic and those which elsewhere in the State appear to be sometimes definitely intrusive and which, in the area under consideration, are not accompanied by tuffs of similar composition.

A number of exposures of the hornblende-andesite show its junction with the adjacent sediments, and no signs of intrusion are in evidence. The thickness of this unit varies abruptly from point to point, and the change is in direct sympathy with the variation in the degree of development evidenced by the volcanic series as a whole. The hypersthene-andesite and andesitic pitchstone also give no indication of an intrusive nature where junctions with adjacent strata are observed.

The Burindi Series.

A considerable amount of difficulty is experienced in determining the detailed succession in the Burindi Series, owing to the lack of persistent horizons and the complexity brought about by faulting.

Some idea of the chief features of the lower portion (in a comparative sense) of the rocks of the Hilldale district has been obtained. At this locality the beds are developed in a plunging anticline which pitches to the south-south-east and, as one proceeds north-east, the mudstones which outcrop in portion 100, Parish of Barford, and form the lowest beds exposed, are followed by red gritty tuffs, which outcrop very poorly for a considerable distance and appear to pass into slightly different tuffs, which are more acid and mica-bearing and form a mass about 500 feet thick, in turn passing into the Basal Stage of the Kuttung Series.

On the south-western side of the anticlinal axis a better section is seen and, proceeding upward stratigraphically, we have:

(i.)	Green Mudstones and Shales	40 feet
(ii.)	Impure Limestones with marine fossils	70 ,,
(iii.)	Fine-grained Tuffs with fossils	25 ,,
(iv.)	Medium-grained Tuffs containing jasperoid fragments	20 ,,
(v.)	Shales or fine Tuffs	20 ,,
(vi.)	Coarse Tuffs	80 ,,
(vii.)	Mudstones	30 ,,
	Total Thickness	285 ,,

The mudstones (i.) and (vii.) are those characteristic of the Burindi Series, and contain quite a quantity of indeterminate plant remains. The limestones are made impure by quite a large proportion of tuff, in places passing into tuffs. On account of the conditions which obtained during the accumulation of the coarse material which helps to make up the limestones, many of the fossils are only imperfectly preserved. This horizon, together with the next (iii.) which is characterised by an abundance of the remains of *Orthis resupinata*, forms a well-known hunting ground for fossil collectors; crinoid calyxes have often been found, but the state of preservation is such that the identification of many is unfortunately impossible.

The marine fossils recorded from Hilldale (late Greenhills) are given in the following list, prepared from Professor Benson's Census and Index to the Burindi Fauna (Benson, 1921):

Zaphrentis sp. indet.
Lophophyllum corniculum
Actinocrinus sp. indet.
Periechocrinus sp. indet.
Fenestella sp. indet.
Leptaena (*Strophomena*) *rhomboidalis* var. *analoga*
Orthotetes crenistria
Productus scabriculus
muricatus
(?) *subquadratus*
sp. indet.
Orthis (*Rhipidomella*) *australis*
resupinata
Dielasma sacculum var. *hastata*
Spirifera lata
cf. *ovalis*
sp. indet.
Syringothyris exsuperans
Actinoconchus planosulcatus
Athyris cf. *expansa*
sp. indet.
Leptodomus duplicostata
Nuculana sp. indet.
Aviculopecten sp. indet.
Entolium sp. indet.
Gosseletina australis
Yvania koninckii
Bellerophon sp. indet.
Bucania sp. indet.
Euomphalus sp. indet.
Naticopsis, n.sp.
Loxonema rugifera
Orthoceras sp. indet.
Griffithides sp.
Phillipsia dungogensis

To this list must be added the following six forms, collected by the writer at Hilldale, which have not hitherto been recorded from that locality, although they have all been found elsewhere in the Burindi rocks of New South Wales. The determinations of all the author's specimens were kindly made by Mr. W. S. Dun.

Cladochonus tenuicollis (?)
Productus pustulosus
Reticularia crebristriata
Retzia ulotrix
Bellerophon hiulcus
Murchisonia sp.

The fine and coarse tuffs (iv.) and (vi.) appear to differ only in grainsize and not in composition, although no thin sections have been prepared. In hand-specimens they are seen to be composed of felsitic fragments, pieces of jasper and occasional grains of quartz. The remaining tuffs call for no special remark, except for the mention that they may locally become very calcareous and grade into fine-grained limestones.

Near Wallaroo Hill, portion 152, Parish of Uffington, tuffs of Burindi age containing fossil remains are well developed, the fossils being poorly preserved. To the south-east of this locality a thin band of felsite occurs amongst the marine rocks.

About two and a half miles to the east of Mt. Gilmore there is an area of marine rocks, trending north across the Limeburner's Road between the mile-pegs on that road distant from Clarencetown four and five miles respectively.

In this area the chief rocks are tuffs, always acid, hard grey cherts, silicified (?) mudstones and a lava flow about 20 feet thick, which is exposed in Portion 56, Parish of Wilmot, but which can not be traced very far along the strike. This type proves, under the microscope, to be an andesitic pitchstone which has experienced a certain amount of devitrification, the porphyritic constituents being a little plagioclase, hypersthene, biotite and hornblende (?). This is undoubtedly the equivalent of a similar rock occurring in the Burindi rocks near where the road to Wallarobba leaves the Clarencetown-Dungog road. The occurrence of this flow to the east of Mt. Gilmore, in a stratigraphical position undoubtedly near the base of the Kuttung Series, supports the opinion expressed by Sussmilch that the lava-flows in the Burindi Series occur towards the top of that Series.

The Passage of the Burindi Series into the Kuttung Series.—The relation of the Burindi Series to the Kuttung Series in the area under discussion is one of conformity, as announced by C. A. Sussmilch, but the actual line of demarcation between the marine and freshwater beds is hard to determine. In many places where one would hope to find definite evidence as to the nature of the transition, heavy and complex faulting causes confusion.

Along the road leading from Hilldale up the Wallarobba Ridge, there are in the road cuttings, exposures of tuffs of Burindi age. In them there are small bands of conglomerate, greatly subordinate to the tuffs until just near what appears to be the top of the Burindi Series. However, just at the top of the ridge the base of the Basal Stage of the Kuttung Series is encountered, but the occurrence of the tuffs similar to the underlying Burindi tuff, interstratified with these basal conglomerates, and the existence of conglomerate towards the top of the marine series, makes it difficult to place the dividing line.

At Clarencetown, on the outskirts of the town in the cuttings on the Dungog road, and in the water-tables of the Maitland road, there occurs, just below the conglomerates of the Basal Stage of the Kuttung Series, a fine-grained cherty mudstone or shale in which, it is stated, plant remains have been found. This horizon is unlike any of the Kuttung strata and has been regarded in the present work as belonging to the Burindi Series. It was considered as the topmost bed of the marine series during the mapping, and conglomerates and tuffs occurring beneath it must be referred to the marine Carboniferous. Further along the strike of this unit one comes upon similar but more compact rocks (e.g., on the Glen William Road) carrying a varied marine Burindi fauna, and as experience has shown that many of the minor horizons of both the Burindi and Kuttung Series do not persist for any great distance along the strike, one feels confident in regarding the unit mentioned above as being the top of the Burindi Series.

Kuttung Series.

As a result of the careful consideration of the stratigraphical details exhibited in the region under investigation, the writer suggests the following subdivision of the Kuttung Series in the type area, viz. the Paterson-Clarencetown district, such classification being substantially the same as that proposed by C. A. Sussmilch, with suggested modifications resulting from the writer's more recent work.

(i.) *Basal Stage.*

All the strata from the base of the conglomerates which, following on the Burindi Series, occur at Wallarobba and elsewhere, to the base of the hornblende-andesite and andesite-glass (Martin's Creek type). This stage corresponds with Sussmilch's Wallarobba Beds.

(ii.) *Volcanic Stage.*

The strata from the base of the hornblende-andesite to the base of the tuffs and conglomerates formerly known in the Paterson Valley as the Mt. Johnstone Beds.

The rocks of this stage form a distinctive set of lavas and tuffs with subsidiary conglomerates. Whilst igneous material occurs throughout the Kuttung Series (and tuffs of primary deposition are just as important units as the massive flows), the succession from hornblende-andesite through hypersthene-andesitic pitchstone to a series of keratophyres, toscanites, and sodi-potassic rhyolites, with associated fragmental rocks, has now been shown to be a recognisable and distinct assemblage all through the Southern Carboniferous areas.

The Paterson flow, a toscanite in most places, although somewhat similar under the microscope to the toscanites of the Volcanic Stage, is not grouped with this stage since, as it may be extrusive, its inclusion would involve also the inclusion of some 2000 feet of strata occupying the interval represented by the Mt. Johnstone Beds of the Paterson Valley: a procedure that would not be satisfactory for reasons made apparent below.

(iii.) *Glacial Stage.*

The strata from the top of the Volcanic Stage to the base of the so-called Permo-Carboniferous System.

The grouping of the 2000 feet of tuffs, arkoses and conglomerates with the Paterson toscanite and the Main Glacial Beds is necessary on account of the discovery of a horizon of varves near Glenoak, a village four miles N.N.W. of Seaham. These varves occur in the equivalents of the so-called Mt. Johnstone Beds, some 1800 feet below what was previously considered to be the base of the glacial beds at Seaham. It seems desirable to group together all the strata containing definite evidence of glacial origin, or of deposition during glacial conditions, even though they embrace a lava flow and tuffs; also, it must be remembered that, sandwiched in among the varves and tillites at Seaham and elsewhere, there occur tuffs and tuffaceous sandstones. Further support is given to the establishment of the "Glacial Stage," in the occurrence, at its base, over most of the region investigated, of a coarse conglomerate—particularly so near "Oakendale"—with a maximum thickness of 100 feet, which indicates that, following the eruptions of lava of the Volcanic Stage, a decided uplift occurred, rejuvenating the streams which brought down coarse gravels and deposited them on the surface of the last felsite, the outpouring of which closed the epoch represented by the Volcanic Stage.

It is difficult to arrive at a scheme of classification suitable for all requirements. The method of employing local names has certain merits, but the scheme used by Mr. Sussmilch was not sufficiently general for the whole area, especially in view of the fact that there is a greater development of the Volcanic Stage at Mt. Gilmore than at Martin's Creek. Also the separation of the Mt. Johnstone Beds from the Main Glacial Beds is not now advisable on account of the occurrence in both of glacially-produced rocks.

Observations upon Kuttung rocks in other parts of the Southern Carboniferous areas show the existence of the three well-defined stages. Thus in the neighbourhood of Gosforth and Lamb's Valley, north-west of Maitland, W. R. Browne has found the sequence to be basal conglomerates, followed by a series of volcanic rocks of the same general facies as the Volcanic Stage, succeeded by conglomerates, varves, a flow of toscanite and more glacial beds.

Our knowledge of the Kuttung Series generally, and of its time-relations to associated series in particular, is still incomplete and for this reason no terms have been used in the classification which indicate geological time. Attention may be drawn to the fact, that although the base of the Kuttung Series is well defined in a broad sense, the upper limit is by no means so clearly fixed, and from the results of research by Professor David in this connection, it is very probable that in the future some of the strata now referred to the Permo-Carboniferous System will have to be regarded definitely as Carboniferous in age.

Therefore it is hoped that the present scheme will prove useful in that it is suitable for the whole of the type area and lends itself to application, by comparison and correlation, to other areas.

It is pertinent here to mention the relation of the proposed scheme of subdivision to that used by Professor Benson in his work on the Currabubula District. The three stages described here cannot in any way be correlated with the three "portions" of the Kuttung Series described by him. In fact, it is fairly clear, that the representatives of the Kuttung Series at Currabubula belong chiefly to the upper Glacial Stage of that series, and that the Volcanic and Basal Stages are poorly, if at all, represented in the succession of volcanic rocks and sediments in that district.

We now proceed to a detailed description of the stratigraphy of the Series.

(i.) *Basal Stage.*

The thickness of this division varies from 1800 feet at Wallarobba to about 2300 feet in the vicinity of Clarencetown. The stratigraphy of the Basal Stage does not require much description.

The tuffs show current bedding in many places, of the type indicating deposition by water. The whole of the strata in this Stage give evidence of rapid accumulation for the most part, and exhibit many features characteristic of continental deposits. The matrix of the conglomerates, when fresh, is very hard and of a uniform medium grainsize, and much of it contains fresh grains of orthoclase felspar, so that it presents some of the characteristics of an arkose.

About fifty feet from the top of the Basal Stage there is a horizon containing plant remains. As the matrix is in most cases a pebbly tuff, the plants are not very well preserved as a whole, but good examples of *Stigmaria* and of *Lepidodendron veltheimianum* have been collected on this horizon from Clarencetown and Martin's Creek. Former records only indicate the finding of indeterminate species of *Lepidodendron* in the Kuttung Series, but there is in places quite an abundance of *L. veltheimianum,* the identification of the specimens being kindly confirmed by Dr. Walkom. There is no possibility of the host of these remains being large fragments of rock derived from pre-Kuttung units.

This horizon has proved of distinct stratigraphical value, as it has been found at a number of localities between Martin's Creek and Clarencetown, where large areas of conglomerate and tuff occur, the stratigraphy of which, but for the occurrence of this plant-bearing horizon, would have been very obscure.

(ii.) *Volcanic Stage.*

A considerable amount of detailed work has been done upon this Stage. A number of sections have been carefully measured and of these five have been drawn to scale and are given as Text-figures.

In the following discussion of the stratigraphy concise descriptions of the essential features of the various rock types will alone be given, as the detailed and final consideration of the identity and petrography thereof will form the subject of subsequent work.

The basal group in the Volcanic Stage consists of andesites and andesitic pitchstones, in general called the Martin's Creek type. At Wallarobba, in a railway cutting about half a mile to the north-east of the railway station, both the hornblende-andesite-glass and the lithoidal andesite are found in association. The sequence is, lithoidal andesite 6ft., andesitic pitchstone 2½ft., and lithoidal andesite 12ft. The junctions between all the types are quite sharp. The lithoidal phases are similar to those found at Martin's Creek, descriptions of which are given below. The pitchstone is of a general black body-colour with a number of red veins of iron-stained material, possesses a resinous lustre and, under the microscope, shows phenocrysts of andesine and hornblende set in a glassy base which contains a number of microlites, and patches which have been produced by devitrification.

In portions 99 and 141, Parish of Barford, near Tumbledown Creek, one finds three varieties of hornblende-andesite. The first is the glassy phase found at Wallarobba, and this, being not more than 20 feet thick, is followed by a thin band of a dark greenish-black rock possessing a greasy lustre and uneven fracture. This contains phenocrysts of biotite, hornblende, hypersthene, augite, and occasionally plagioclase set in a glassy base. It is succeeded by 50 feet of the normal lithoidal hornblende-andesite.

At Martin's Creek three large quarries have been opened in the hornblende-andesite, which has here its maximum development for the region under consideration. The writer had the opportunity of visiting all the quarries, and was able to study in detail the property of The State Metal Quarries, Ltd., where there occur at least four distinct phases of hornblende-andesite. These are (i.) a pale blue rock with phenocrysts of plagioclase and subordinate hornblende, (ii.) a lighter coloured rock, hornblende dominating over plagioclase, (iii.) a deep blue rock with equal amounts of hornblende and plagioclase as phenocrysts, and (iv.) a felspathic rock with very little hornblende.

The Mt. Gilmore Section. (A-B on Map). Text-fig. 1.

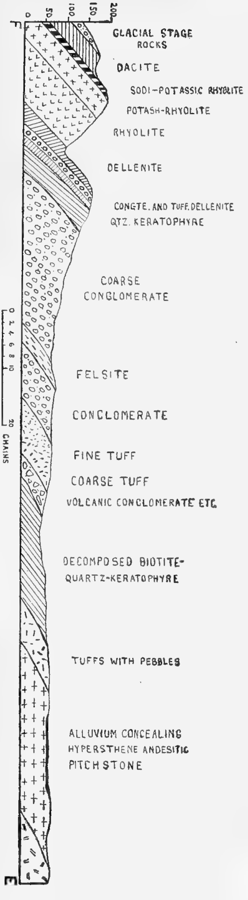
The maximum thickness of the rocks of the Volcanic Stage is found in the Mt. Gilmore area. A detailed section is to be obtained along the line A-B, as follows:

Starting with the base of the hornblende-andesite exposed on the left bank of the Williams River opposite Clarencetown and going south-east over the dip-slope of andesite, one passes on to tuffs containing sporadic pebbles up to one foot in diameter. These tuffs give poor outcrops, but some of the few exposures exhibit current bedding. Above these is the hypersthene-andesitic pitchstone, the rock being for the most part decomposed. Here and there small shatter zones occur in which cementation of the fragments of pitchstone has occurred, the nature of the binding material being indeterminate on account of the weathered state of the whole. Above the pitchstone are tuffs and conglomerate similar to those below it, and these end under a thin band of sodi-potassic rhyolite which has an abundance of biotite, imparting to the rock a spangled appearance. Above this is a conglomerate formed of well-corroded pebbles, with an intercalation of fine red tuff. This is succeeded by an important flow of biotite-quartz-keratophyre, which is developed to a greater extent a little to the south on the right bank of the river. The line of section is now continued from this point, where there are two flows of keratophyre separated by 25 feet of conglomerate. Particularly good opportunity of examining fresh material is afforded by the quarry which is opened upon the larger of the flows, and the rock is seen to be more or less homogeneous, of a blue colour, and possessing an abundance of quartz, biotite and plagioclase felspar. On the surface of the smaller flow there lies a thick mass of conglomerate and tuff which is succeeded by a lava of the nature of a type transitional between soda-rhyolite and dacite. This rock is distinctly spherulitic and may be obtained in a very fresh state. It is overlain by conglomerate, in which there is an intercalated band of quartz keratophyric tuff, containing angular fragments of quartz and clear albite, together with inclusions of glassy rocks and patches of secondary silica. Following this is the most important unit in the sequence. It appears in the majority of cases to be a dellenite, but in some places is a toscanite. It has a maximum thickness of 400 feet, and occurs as a thick capping to most parts of the Mt. Gilmore ridge. The variations in the lithological features seen in hand-specimen would lead one to expect greater differences than are apparent under the microscope. The distribution and chemical variation of this rock are indicated in the account of the Regional Geology.

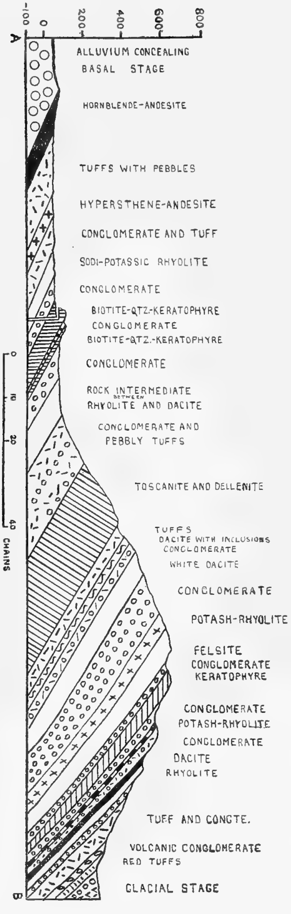
Above the dellenite there are tuffs containing a thin band of red felsite which may be intrusive. These are succeeded by a very characteristic cream or white lava, which shows an abundance of stumpy felspar phenocrysts, and peculiar spherulitic and axiolitic inclusions set in a dense base, examination in thin section proving the rock to be a dacite. After an interval of 45 feet of red tuffaceous conglomerate, a similar white rock occurs, probably also a dacite. Above it there is a mass of conglomerate which is quite persistent along the ridge. It contains well-rounded pebbles of quartzite, felspar-porphyry and aplite in abundance, and is followed by a very distinctive lava, which here and elsewhere in the area always exhibits a deep reddish-purple colour. This colour is due to iron staining of the base, the origin of the iron in all probability being connected with devitrification. It possesses phenocrysts of felspar, and in addition a large number of flat amygdules, sometimes filled with carbonates. Examination under the microscope shows the rock to be a potash-rhyolite. It does not occur very far along the strike, but has been found at Martin's Creek. It is overlain by a white felsite which is succeeded by a normal conglomerate. This is followed by a thin flow of biotite-quartz-keratophyre, which has much in common with the main keratophyre occurring near the base of the section. The flow here possesses a more finely-grained phase towards its upper surface, in spite of its small thickness, and in this upper phase the felspar is less sodic and less abundant. Heavy conglomerates succeed this horizon, and the repeated succession of lava and conglomerate hereabouts gives rise to a series of small escarpments and dip-slopes which are somewhat unique in appearance.

The next unit is a thin flow of potash-rhyolite, the quartz being very abundant in well-formed hexagonal crystals, the orthoclase having a less regular development. Upon the rhyolite lies a distinctive conglomerate in which the sorting of the pebbles, which in places are subangular, has not been as complete as in the lower horizons. There is also a lack of continuity along some horizons, and this feature, together with the presence of current bedding, points to rapid accumulation of these rocks. The top portion of this horizon is really a coarse sandstone or grit, and the contact effect of the overlying dacite has been to convert this into a quartzitic rock. The dacite is an oligoclase type with a devitrified groundmass. It weathers slowly and forms a resistant unit, in one place preserving the main ridge by its opposition to erosion. Immediately upon it lies another massive rock which contains phenocrysts of quartz and felspar, the identity of the latter being very difficult to determine, the results of examination suggesting orthoclase.

This is the last massive horizon coming into the section, and from here through the rather rough country at the back of the Gilmore Ridge, the rest of the Volcanic Stage is followed with difficulty. Tuffs with bands of small pebbles follow the last-mentioned horizon, and carry on down a long dip-slope where a peculiar horizon is encountered. This appears to be a volcanic conglomerate, which has resulted from the pouring out of a lava upon some unconsolidated gravel or shingle. There is a fair variety of type among the pebbles, but the



Text-fig. 2. The Glenoak Section. (Line E–F on map.)



Text-fig. 1. The Mt. Gilmore Section. (Line A-B on map.)

matrix, which is only found unweathered in a few instances, is seen in thin section to be a potash-rhyolite.

Just to the east of the line of section in portion 52, Parish of Wilmot, this unit is underlain by a reddish tuff, which consists of fragments of quartz, albite and orthoclase and pieces of pitchstone and keratophyre, the whole modified by secondary silica.

The volcanic conglomerate, described above, is then succeeded by normal red tuffs, which unfortunately are unfit for microscopic examination. These form the topmost member in the long series detailed above, and following them one can trace the sequence into the Glacial Stage, the distinctive conglomerate at the base of that Stage being met with in the headwaters of McManus' and Caswell's Creeks.

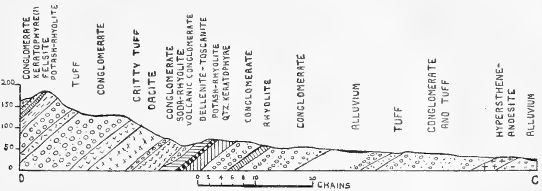
The Mt. Gilmore Section shows the following succession:

	Thickness in Feet
Hornblende-andesite	80
Tuffs with occasional pebbles	150
Hypersthene-andesitic pitchstone	50
Conglomerates and tuffs	80
Sodi-potassic rhyolite	45
Conglomerate	75
Biotite-quartz-keratophyre	150
Conglomerate	25
Biotite-quartz-keratophyre	30
Conglomerate and tuff	105
Lava intermediate between rhyolite and dacite	150
Conglomerate with a band of keratophyric tuff	320
Dellenite-toscanite lava	400
Tuffs with a band of felsite	80
Dacite with spherulitic inclusions	60
Tuffaceous conglomerate	45
Dacite	70
Conglomerate	150
Red amygdaloidal potash-rhyolite	60
White felsite	100
Conglomerate	50
Keratophyre with fine-grained upper surface	90
Conglomerates	90
Potash-rhyolite	40
Conglomerate with quartzitic contact margin	80
Dacite	50
Potash (?)-rhyolite	50
Tuffs with conglomerate bands	130
Volcanic conglomerate	50
Tuffs	45
Total Thickness	2900

The Langlands Section. (C-D on Map). Text-fig. 3.

The succession of volcanic rocks on the Langlands Estate may be most completely studied along the line C-D. A few of the horizons shown in Text-fig. 3 do not occur on the actual line of section, but their stratigraphical positions have in all cases been clear, and they are therefore incorporated into the section, which is therefore somewhat generalised.

The hypersthene-andesite-glass may be seen amongst the alluvium of Tumbledown Creek, on its right bank, the flow being apparently thin. A thick mass of conglomerate with some important bands of tuff overlies the pitchstone, the outcrops being in places obscured by alluvium. The first lava to succeed the pitchstone is then a lavender-coloured rhyolite in which the phenocrysts are scantily developed, the ground-mass being pumiceous and devitrified. This is overlain by a conglomerate composed of small pebbles, which is followed by a thin horizon of a tuffaceous sodic rock, the fragmentation apparently having occurred during the solidification of the rock. Quartz, biotite and albite are



Text-fig. 3. The Langlands Section. (Line C–D on map.)

present, the rock being a keratophyre. This is immediately succeeded by a dark purple rock which shows an abundance of free quartz in large crystals, and subordinate felspar set in a fine-grained base. The rock, which is a potash-rhyolite, breaks with a very uneven fracture. Following this horizon is the equivalent of the thick mass of dellenite in the Mt. Gilmore Section. Here the composition of the rock is just about on the border-line between dellenite and toscanite, the plagioclase being basic oligoclase and in about the same proportion as the orthoclase. The lava forms a distinct ridge which can be followed from the Williams River to the Maitland Road.

Succeeding this is one of the most interesting groups of rocks in the area. They may for the present be referred to as tuffaceous volcanic conglomerates and flow-breccias. They present a variety of characters, but the general features consist of the occurrence of rounded and partially rounded inclusions of soda-felsite with phenocrysts of quartz, together with numerous angular chips of glassy and pumiceous rocks and an odd piece of felspar, all compacted together by felsitic material of similar composition to the corroded inclusions which has been very much altered by secondary silica replacement, so that the appearance in hand-specimen is that of a number of rounded inclusions and angular fragments set in a subordinate matrix of interstitial strings of quartz. In places the rounded inclusions decrease or even disappear, and the rock becomes an even-grained tuff or breccia. A considerable amount of investigation will have to be made upon these rocks before their significance is fully appreciated, but it seems probable that they have originated in the following manner. The rounded and partially rounded pieces of soda-felsite have resulted from the breaking up of portions of the crust of an acid alkaline lava during cooling, subsequent corrosion of the fragments being effected by the unconsolidated and still fairly mobile magma. Simultaneously, tuffaceous material was being showered in varying amount over an area more extensive than that occupied by the lava, the latter incorporating the tuff in many places, and the residuum of magma consolidating as interstitial felsitic material. Post-dating these processes, siliceous solutions have altered portions of the rocks, especially the ground-mass, effecting replacement. The association of rounded fragments of sodic rock, and foreign tuffaceous material in a base of composition essentially similar to the former, and the presence of secondary silica are thus explained.

Succeeding these peculiar rocks there is about 70 feet of a pale pink soda-rhyolite carrying some felsitic fragments. Albite is the chief constituent among the phenocrysts, which are set in a pumiceous groundmass which has been impregnated by secondary silica. Conglomerate succeeds the rhyolite and then there follows a dark purplish rock, recalling the potash-rhyolite lower down in the sequence. Phenocrysts of felspar dominate over fine-grained quartz, both being set in a dense base; the rock is a dacite. This is overlain by a band of gritty-looking tuff, which possesses a characteristic appearance in thin section, fragments of albite and quartz and patches of spherulitic material being cemented together into a fairly compact mass. Following the tuff is a thick band of conglomerate containing one well-defined band of medium-grained tuff, which consists of quartz and felspar chips and pieces of glassy and dacitic rocks. The next horizon is a potash-rhyolite, in which a certain amount of brecciation during consolidation has occurred. This is not well-developed, fresh outcrops being rare, and it is succeeded by a tuffaceous felsite, which has resulted from the showering of quartz, felspar and pitchstone fragments into a flow which solidified as a pumiceous groundmass to these fragments. This rock ends under the last unit in the Volcanic Stage, which is a fine-grained rock with quartz, felspar and biotite showing in hand-specimen, its microscopic characters not yet having been investigated.

Summarising the Langlands Section we have:

	Thickness in Feet
Hypersthene-andesite-glass	50
Conglomerate and tuffs	550
Rhyolite	36
Conglomerate	90
Quartz-keratophyre	55
Potash-rhyolite	18
Dellenite-toscanite	40
Tuffaceous volcanic conglomerates and flow-breccias	35
Soda-rhyolite	70
Conglomerate	18
Dacite	108
Gritty tuff	70
Conglomerate with well-defined tuff band	292
Potash-rhyolite	50
Tuffaceous felsite	20
Fine-grained lava (Possibly a keratophyre?)	18
Total Thickness	1520

The Glenoak Section. (E-F on Map). Text-fig. 2.

The Volcanic Stage rocks developed along the line E-F from Glenoak to the south, present many interesting features.

We commence immediately to the north of the Post-Office upon the base of the hypersthene-andesite-glass, which is fairly well-developed here, the dip being flat to the south. Overlying it are red tuffs with pebbles here and there. They are followed by a decomposed biotite-quartz-keratophyre, the outcrop of which has a considerable extent on account of the low angle of dip mentioned above. In the weathered state the biotite shows up very well. To the west of the line of traverse the rock is found in a fresh state. Above it comes the peculiar volcanic conglomerate described in the Langlands Section. Here there are abrupt changes from the type of rock containing many rounded inclusions to that in which fine-grained angular fragments are abundant, and the cognate inclusions almost absent. The general body colour of both types is a dark buff. Following this unique horizon there are two varieties of tuff differing in texture, the coarser having some features in common with the breccia-portion of the last-mentioned unit. A band of coarse conglomerate is found above these, and after the intervention of a thin flow of decomposed felsite, there is a thick mass of conglomerate. The constituent pebbles of this horizon often attain to a considerable size, a number measuring 2½ft. in diameter, and some rarely 3ft. There is an abundance of pink aplite pebbles, while quartzite and acid porphyries rank next in importance. On the surface of this conglomerate has been poured a flow of fine-grained biotite-quartz-keratophyre, in which a little brecciation has occurred during crystallisation. This is immediately overlain by a tuffaceous dellenite about forty feet thick at its maximum, the extent beside the line of section being small. Conglomerate is found above this and then an important flow of dellenite containing plenty of free quartz, potash and soda-lime felspar set in a devitrified pumiceous groundmass.

This horizon is succeeded by a variety of massive igneous rocks, the first being a mauve-coloured type with a subconchoidal fracture, very fresh specimens being obtainable in Wattle Creek, the rock outcropping in the bed, and on a steep hillside to the south. The rock is a rhyolite and has been almost wholly glassy except for free quartz and a few acicular felspar crystals. Devitrification has been universal, secondary silica and iron-oxides having replaced original glass. The next type is a potash-rhyolite which has been stained locally in such a manner as to give it a blotched appearance. It caps the hill to the south of Wattle Creek, the next horizon leading down the dip-slope to the south. This rock is either a sodi-potassic rhyolite or a soda-rhyolite, microscopic examination being difficult. It is not very thick, and ends under the last unit in the Volcanic Stage, which is an andesine-dacite, in which a certain amount of biotite occurs, the cryptocrystalline base being strongly stained in places by iron-oxides. Overlying this horizon is the basal conglomerate of the Glacial Stage.

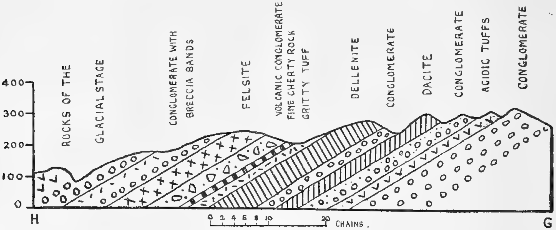
The Glenoak Section shows the following succession:

	Thickness in Feet
Hypersthene-andesitic-pitchstone	200
Tuffs with pebbles	100
Biotite-quartz-keratophyre	180
Volcanic conglomerate, etc.	60
Coarse tuff	100
Fine tuff	60
Conglomerate	180
Felsite	60
Conglomerate	450
Fine-grained quartz-keratophyre	90
Tuffaceous dellenite	40
Conglomerate	45
Dellenite	80
Rhyolite	250
Potash-rhyolite	130
Sodi-potassic rhyolite	45
Dacite	120
Total Thickness	2190 Feet

The Oakendale Section. (G-H on Map). Text-fig. 4.

The chief interest in the Oakendale Section lies in the fact, that while close to the Glenoak Line, the number of units developed is much smaller, the massive igneous rocks being very poorly represented.

Rocks of the Volcanic Stage are well exposed in a series of dip-slopes running down to Tumbledown Creek. The section starts upon a thick mass of conglomerate overlying the biotite-quartz-keratophyres which all through the area are the first important flows to succeed the hypersthene-andesite. The rocks following the thick conglomerate are as follows:



Text-fig. 4. The Oakendale Section. (Line G–H on map.)

(*a*) Acid tuffs. These rocks vary a little in texture from point to point, but in general have an average uniform grainsize, and a general rusty-red colour. The constituents are angular quartz in abundance, biotite-pitchstone, pumice and felsite fragments, all cemented together by a matrix, which has now been completely stained by iron. Thickness, 50 feet.

(*b*) Conglomerate. Pebbles of great variety up to nine inches in diameter set in a reddish gritty matrix. Thickness, 80 feet.

(*c*) Dacite. This rock forms a pronounced bump on the line of ridges traversed by the section. It is fairly fresh and shows an abundance of quartz in hand-specimen. The microscope reveals large corroded quartz crystals and some ragged oligoclase-andesine in a partially glassy base. Thickness, 70 feet.

(*d*) Conglomerate. This is similar to the preceding conglomerate (*b*), but the size of the constituent pebbles is somewhat less. Thickness, 50 feet.

(*e*) Dellenite. This is the most important massive rock, outcropping from the line of section down to Tumbledown Creek, and along the right bank, west of the section. It is very well exposed artificially on a road nearby, fresh specimens having a fawn colour, and displaying the existence of porphyritic quartz, orthoclase and acid plagioclase in an extremely fine-grained groundmass. Thickness, 40 feet.

(*f*) Tuff. This is not very thick, being very weathered and possessing a yellow colour and a gritty nature. Thickness, 35 feet.

(*g*) Fine-grained cherty rock. These rocks, although only 20 feet thick, deserve careful notice. They show many lithological features identical with the varves of the Glacial Beds. The hard porcellanous appearance of many of the latter is a characteristic of the rocks here, and irregular alternation of fine and coarse layers is to be noted. Nevertheless, there is no evidence of contemporaneous contortion, nor of associated glacial rocks, so that one cannot assign to them a definite origin. Thickness, 20 feet.

(*h*) Volcanic conglomerate, etc. This is the horizon described in detail in the Langlands Section. Here there are some features which are unique, particularly the occurrence of bands of coarse breccia, many of the fragments simulating the appearance of varves. It is just possible that these fragments have been derived from the underlying cherty rocks (*g*). The secondary quartz is abundant, and much of the interstitial matrix is stained a bright green colour, due to infiltration of iron compounds. Thickness, 90 feet.

(*i*) Felsite. This is the third and last massive rock in the section. It is best developed a little to the west of the line of traverse, forming part of the rough timbered hill near the Black Rocks. The rock is porphyritic in tiny red felspars, probably orthoclase, and a little free quartz, the dense groundmass predominating. Thickness, 60 feet.

(*j*) Conglomerate, etc. This unit is composed of a series of bands of gritty pebbles and some brecciated material similar to that observed with the agglomerates. Thickness, 130 feet.

The total thickness of the rocks described in the Oakendale Section, omitting the conglomerates mentioned in the preliminary paragraph, is 620 feet.

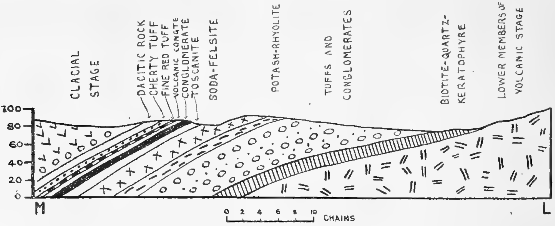
The Volcanic Stage at Martin's Creek.

The basal portion of the Volcanic Stage at Martin's Creek, has already been described (p. 168). There is a variety of rocks of the Volcanic Stage outcropping around the village of Martin's Creek, and between that locality and Paterson. The description of these rocks given by Mr. Sussmilch (Sussmilch and David, 1919, pp. 262-266) can only be regarded as of a general nature. Of the four distinct flows referred to by the field names of dacite and rhyolite, the lowest, considered stratigraphically, is an important biotite-quartz-keratophyre. This is identical with the rocks from about the same levels in the other sections, but is not repeated in the sequence at Martin's Creek, as is the case in most of the other localities. The nature of the second flow is hard to discern under the microscope, but albite is certainly present in a devitrified base, and it is possible that the rock is a soda-rhyolite. The third flow, outcropping on the road between Gostwick Bridge and Mt. Johnstone, is a dacite, but elsewhere to the south-east becomes a toscanite. The fourth unit has been described by W. R. Browne (Sussmilch and David, 1919, Appendix ii.), the dacitic nature of the massive portions of the flow being demonstrated. Associated with this dacitic flow there is developed in the Martin's Creek district an important type of rock, somewhat tuffaceous, but not by any means a true tuff. It proves in thin section to be a tuffaceous soda-rhyolite; it is pale green in colour, albite phenocrysts being seen in hand-specimen. The rocks present features almost identical with those of the group of similar rocks occurring at Currabubula, described by W. R. Browne (Benson, Dun and Browne, 1920, Section C, p. 408).

Just east of the road near Mt. Johnstone, close to the outcrop of these sodic rocks, there is an interesting section of the underlying strata, down to the next massive flow, which is a toscanite. Immediately following the toscanite is an outcrop of the rocks described elsewhere as volcanic conglomerates; there is abrupt variation along the strike, the rock in some places possessing all the characters of the volcanic conglomerates in the Langlands Section, and elsewhere being more of the breccia type which is predominant in the Glenoak Section. Here this phase is very hard, consisting of cherty-looking fragments and the usual secondary quartz which, in places, is itself replaced by crystals of a red mineral having some of the properties of stilbite. The identity of this interstitial material has not yet been finally determined. Following these rocks is a fine-grained tuff, which in hand-specimen reminds one of a normal basalt. It is made up almost entirely of tiny angular fragments of quartz and subordinate felspar set in an unresolvable groundmass. Upon this tuff lie the dacitic rocks and the soda-rhyolites.

East of the Railway Line and the Martin's Creek fault, there is an interesting area of Volcanic Stage outcrops. Here and there local types of tuffs and lava occur, and it would be almost impossible to incorporate the details of all these occurrences in a general section, but the most inclusive traverse is that along the line L-M on the map, description of which is given below (*see* Text-fig. 5).

Starting a chain or two to the north of the point where Martin's Creek flows under the Railway line, east of the Martin's Creek fault, one passes immediately on to the decomposed outcrop of the quartz-keratophyre flow, which trends east up the valley of Martin's Creek. Then crossing into portion 25, Parish of Barford, a coarse tuffaceous conglomerate is found. In this paddock some very large boulders occur, quite a number exceeding three feet in dia-



Text-fig. 5. The Martin's Creek Section. (Line L–M on map.)

meter. These conglomerates are continued in the cuttings of the Railway, and just at the first overhead bridge south of Martin's Creek the chief features of these rocks can be examined. Current bedding occurs among the tuff bands, and there are rapid changes in the average size of the pebbles in various bands. Towards the top of the mass the tuffs are very much weathered, and they end under a flow of potash-rhyolite, which is very restricted in extent, the only other place of outcrop being at Mt. Gilmore. This is succeeded by the equivalent of the soda-felsite occurring near the Gostwick Bridge, forming flow No. 4 in the section described by Sussmilch. The rock here is well developed and forms a bare hill to the east, no further extension being observed. It is overlain by the toscanite (Mt. Gilmore type), which in the account of the Regional Geology is shown to be very widespread and important. There is an abundance of large quartz crystals with subordinate orthoclase and plagioclase in a base which has a very rough feel. Following this there is a group of tuffs and conglomerates including the flow-breccia type, already sufficiently described. The final rock of the Volcanic Stage is a dacitic type, the extension of which, to the east, is singular on account of some remarkable inclusions made up entirely of spherulites and axiolites. Although the green soda-rhyolites are not exposed in the Railway cutting, they are well developed in portion 154, Parish of Barford, a little to the east, there resting on the dacite just mentioned.

About 150 feet below the top of the Volcanic Stage, there is a tuff which presents some interesting characters. It is exposed a little to the east of the line of section described above. In thin section it is seen to contain a lot of fragmental quartz, chips of orthoclase and oligoclase, and fragments of a spherulitic rhyolite and pitchstone, the whole being compacted by an iron-stained matrix. This tuff is like many of the other types in the Volcanic Stage in possessing a distinctly felspathic nature.

The thicknesses for the Martin's Ck. section are given in the following summary:

	Thickness in Feet
Biotite-quartz-keratophyre	50
Coarse conglomerate and tuff	300
Red potash-rhyolite	25
Soda-felsite	100
Toscanite	50
Conglomerate	15
Volcanic conglomerate	10
Fine-grained tuff	15
Cherty tuff	25
Dacite	50
Total Thickness	640 Feet

Preliminary discussion of the Stratigraphy of the Volcanic Stage.

It is premature to discuss in any detail the variation in the stratigraphy of the Volcanic Stage, as such will only be possible after an exhaustive petrographical and chemical study of the rocks has been made. The names given to the various units will in all probability stand after such study, but at present one is not able to say what are the relations between the various types of potash-rhyolite, or between the tuffaceous soda-rhyolites on the one hand and the biotite-quartz-keratophyres on the other.

From the data to hand one can generalise as to the sequence. The only sequence of lavas maintained through the area is the following: hornblende-andesite and andesitic pitchstone (Martin's Ck. type), hypersthene-andesite and andesitic pitchstone, biotite-quartz-keratophyre (Williams River type—in some places one flow, and in some places two), biotite-toscanite—dellenite (Mt. Gilmore type), potash-rhyolites and dacites. This succession may be looked upon as the framework of the sequence, which is modified at various localities by the existence of additional sets of less important flows, respectively more or less peculiar to those localities. Some details with regard to the overlapping of flows from adjacent vents are to hand, and these are withheld until full petrographic work is done, but one can state that there is evidence of the former existence of a centre of supply towards the Martin's Ck. end of the area, one possibly near Glenoak and Langlands, and a third in the Mt. Gilmore district. As a result of the position of these, there is a poor development of the Volcanic Stage along the Oakendale Section, and overlapping appears to have occurred at Mt. Gilmore and in the Langlands area. Whether these eruptive centres were of the strictly central type, or existed as a series of local centres along a dominant fissure-line or set of fissure-lines, there is little direct evidence to decide. On account of the uniformity of the petrological features and, to some extent, the stratigraphical positions of the various lavas over large tracts of land in the

State, and also in view of the fact that at the close of the Burindi epoch and during the Kuttung epoch pronounced upwarping (not folding) affected the area, it seems likely that the eruptions were of the fissure type.

The question now presents itself as to how far the Mt. Gilmore Section may be regarded as typical for, and indicative of the maximum thickness of the Volcanic Stage. The overlapping of flows in a volcanic series must be looked upon as a factor making for complexity and masking the truth concerning the details of thickness, analogous to the factor of strike-faulting in achieving similar effects. And while strike faulting often presents difficulty, the problem of the stratigraphical variation caused by overlapping of flows may be more subtle. In spite of this, one can be sure that there is a repetition, and therefore an increased thickness from this cause, of no more than 300 feet in the Mt. Gilmore Section.

(iii.) *Glacial Stage.*

The general sequence of the Glacial Stage is as follows: Basal conglomerates overlain by red pebbly tuffs, the Glenoak varves, some thin bands of arkose, and a thick mass of tuffs, grits, tuffaceous sandstones with conglomerate bands, and local developments of volcanic breccia. Towards the top of the main mass of tuffs (the equivalent of the Mt. Johnstone beds of the Paterson Valley) there are fine-grained shales and tuffs carrying the remains of the *Rhacopteris* flora. The Paterson toscanite follows this thick clastic mass, and in its turn is succeeded by the Main Glacial Beds. The basal unit is a coarse conglomerate consisting of pebbles up to two feet in diameter, granites, aplite and porphyries occurring in abundance, with other types in less amount, all fairly well rounded, but not showing evidence of long transportation. The best development of this horizon is in Tumbledown Creek, just near Oakendale Homestead. This conglomerate is followed by tuffs with thin pebbly bands for about 200 feet, when the Glenoak varves are reached. These are forty feet in thickness and present all the features of the classic deposits at Seaham and elsewhere. The colour varies greatly, the alternating bands of coarse and fine material sometimes being red and white, as in the rocks west of the Seaham Hotel, and at other times brown and yellow. Contemporaneous contortions are quite frequent, having produced some beautiful structures.

The varves are succeeded by the main tuffs which, on the whole, have a very uniform grain-size, and here and there contain bands of conglomerate. Mr. Sussmilch has given a section of these rocks as seen on the eastern face of Mt. Johnstone, where there is probably more conglomeratic material than anywhere else in the area. In the valley of Tucker Ck., to the north of Hungry Trig. Station, the tuffs grade into sandstones which suggest accumulation as continental deposits. In some places the main tuffs are very fine-grained, this applying to the strata which yield the Rhacopteris fossils. Although the plant remains are not restricted to one horizon, the strata in which they occur form a zone which occupies in general a constant stratigraphic level, this zone extending from 50-300 feet below the base of the Paterson toscanite. Arkoses occur in among the main tuffs in rather restricted bands, as well as some interesting felspathic grits. The latter have an abundance of orthoclase, possibly some plagioclase, both fragmental, and numerous chips of felsitic rocks all cemented by a ferruginous matrix. These felspathic grits are exposed in a quarry on Reserve 112, Parish of Uffington, about a mile to the west of Glenoak, the stratigraphical level being about 500 feet above the top of the Volcanic Stage. About 100 feet above the base of the Glacial Stage there occurs in the central part of Portion 39, Parish of Seaham, a characteristic volcanic breccia, consisting chiefly of uniform fragments of dacitic and rhyolitic rocks, set in a matrix of volcanic dust with which is associated a certain amount of secondary quartz. Fossil wood is abundant in the main tuffs near Red Hill.

An extremely detailed section of about 500 feet of the main tuffs, prepared from the records of a diamond-drill bore, put down $1\frac{1}{2}$ miles to the north of Seaham, has been given by Prof. David (David, 1904, pp. 111-112). There is no need to reproduce the minute details of this section, except to point out that the rocks passed through were entirely clastic, comprising tuffs of many kinds, shales, tuffaceous sandstones, arkoses, etc.

In places, particularly to the west of Paterson, the top layers of the main tuffs have been altered into siliceous rocks by contact metamorphism from the overlying toscanite.

A summary of the stratigraphy of the Lower Portion of the Glacial Stage is as follows:

	Thickness in Feet
Basal conglomerates	100
Volcanic Breccia of limited extent	30
Red tuffs with pebbly bands	200
Varves	40
Fine tuffs	200
Tuffs with arkose bands	50
Tuffs with pebbles	320
Conglomerate	80
Tuffaceous sandstones	700
Conglomerate	80
Tuffs with fine-grained strata carrying *Rhacopteris* fossils	250
Tuffs, with silicified upper surface	50
Total Thickness	2100

It has not been possible to say beyond all doubt whether the rocks constituting the Paterson type of toscanite and dellenite are entirely extrusive or intrusive. In some places there are features indicating extrusion, in others evidence suggesting intrusion. For instance, tuffaceous phases occur, the fragmental material not having originated within the mass during crystallisation. Also in the glacial beds overlying the toscanite in Dunn's Ck., there are numerous boulders identical with the underlying igneous rock, and there is nothing in the whole area examined to suggest that the present position of the basal glacial beds was occupied by a former, now eroded, series, into which the toscanite was injected. On the other hand one has to consider the following particulars. In a number of exposures of the igneous rock one can see rounded pebbles firmly embedded in it. It does not seem likely, in view of the fact that the mass of toscanite is thick, that these pebbles represent loose material picked up by the igneous rock when poured out as a lava, and transported to the surface by reason of a difference in specific gravity of host and inclusion, or by other mechanical means, although such must be regarded as possible. Also in places as, for example, along the course of Dunn's Ck., there are fine-grained strings of igneous material found among the glacial beds, just at their junction with the toscanite, and these *seem* to originate from the toscanite, although this point is not clear. If these strings are continuous with the main igneous mass, it is difficult to explain their present positions, except as being due to forces of intrusion. In the case of a unit being a sill in one place and a flow in another, one would expect to find the sill in a different stratigraphical position from the extruded portion, but the fact remains that the Paterson rock is found at a constant level all through the area.

Thus the matter must be left an open question for the present. From general impressions and experience in the field, the writer is inclined to view the whole of the rocks as extrusive, feeling that the discrepancies described above will eventually be explained; but no definite pronouncement will be given in the present state of knowledge.

Whatever the mode of occurrence of the rocks under discussion, there is a definite variation in the chemical composition from place to place. To the west of Paterson there are two varieties, the lower one being a buff-coloured rock of the nature of a spherulitic toscanite, and overlain by a type transitional between potash-rhyolite and dellenite, this being purple in colour, and showing an abundance of free quartz. At Paterson Station where the mass has decreased in thickness to about 90 feet, there is only one definite variety, in which the quartz is not so abundant megascopically, but is probably in the groundmass. Under the microscope the plagioclase is seen to be andesine of basicity less than that in the rock on Mt. Johnstone, while biotite and orthoclase are present in fair amount, the rock being either a dellenite or a toscanite. The maximum development of these rocks occurs at Hungry Hill, where they attain a thickness of 290 feet. Here the mass is of a threefold nature. The first 200 feet is composed of a handsome toscanite with a general brown body-colour, and well-formed phenocrysts of quartz, orthoclase and plagioclase. Above it lies a small band, probably 30ft. thick, of a felspathic phase, the rock being intermediate between toscanite and andesine-dacite. The third variety is a pale-blue toscanite, somewhat similar to the first type. Between Hungry Hill and the east side of the Williams River, these rocks vary considerably in lithological features, and the thickness never exceeds 100 feet. Examination has been made of slides of the rock in Felspar Creek, just west of the main road, which is a dellenite, and of the rock a little to the east of this, which has a distinctive greyish-green colour and proves to be less acid and almost a dacite.

Opposite Porphyry Point, on the left bank of the Williams, the Paterson type of rock occurs as a mass 150 feet thick. From a careful examination of fresh hand-specimens there appear to be three phases present. The first is grey rock with few phenocrysts of quartz and felspar, followed by a fluidal purple rock with abundant phenocrysts, which passes into a blue rock which weathers to a buff colour. No microscopic examination of these rocks has been made, but W. R. Browne states (Sussmilch and David, 1919, p. 289) that dellenite and rhyolite occur hereabouts.

The only important area, other than Paterson and Seaham, where the Main Glacial Beds are well-exposed, is the Dunn's Creek district. Here they are developed in an asymmetric pitching syncline. A generalised section obtained from data collected in Dunn's Ck. and its tributaries is as follows:

On the eastern side of the syncline the basal rocks are tuffs, containing bands of nondescript material, clearly of glacial origin. Here and there groups of pebbles occur, and in one of these a faintly-striated boulder was found. These tuffs which have a thickness of 350 feet are found again at Seaham. On the western side of the syncline, the basal unit is a thick mass of fluvio-glacial conglomerate and tillite. These rocks are exposed all along the course of Dunn's Ck. from portion 50 to portion 14, Parish of Butterwick. In places they are almost true tillites, but on the whole consist of badly-sorted rounded and subrounded boulders of variable size, including representatives from the underlying toscanite, all aggregated together in a gritty matrix which contains patches of varve-like material. The absence of bands of contiguous pebbles, and the general facies, put beyond all doubt a glacial origin for these rocks. Some puzzling structures are seen in the outcrops of these rocks in the first gully east of the Dunn's Creek road. Here there are, amongst the tillitic mass, patches of banded rock showing contortions and characters identical with varves, which are cut across by similar rocks just in the manner in which a dyke cuts across some country rock. The direction of the banding in the pseudo-trangressive material is, in many cases, at right-angles to that in the main mass, the bands in the former sometimes standing vertically. (The explanation of these features is deferred till a microscopic examination of the material from the different portions is made).

The main fluvio-glacial conglomerates are the equivalents of those occurring at Felspar Creek, near Seaham, and are about 300 feet in maximum thickness. They are followed by 50 feet of varves, which carry small erratics, and have suffered contortions while unconsolidated. In places the varves pass into coarser material, which may be tuff. Overlying the varves there is about 120 feet of fluvio-glacial conglomerate containing numerous striated pebbles. This horizon may be seen to the north-east of the Paterson-Seaham road along the banks of Dunn's Creek. The next unit is a fine-grained flaggy rock, not unlike quartzite in appearance, being in all probability a tuff. It is about 25 feet in thickness and is associated with a thin band of varve not more than 10 feet thick. Succeeding these one comes upon a dark olive-green mudstone containing some odd plant stems and possessing a characteristic subconchoidal fracture. This horizon is about 35 feet thick, and is very similar to a dark mudstone which occurs associated with varve-rock near Webber's Creek, north of Gosforth (Osborne and Browne, 1921). These rocks are succeeded by 150 feet of conglomerate which has no special features. The total thickness of the beds, which show an overlap in their disposition, is 1040 feet.

At Seaham, to the west of the line of section described by Mr. Sussmilch, there is a local development of tuff, 350 feet thick, being the equivalent of the basal unit in the Dunn's Ck. section. The tuffs at Seaham are overlain by varves and, close to the junction, there is a zone consisting of an intermingling of tuff and varve, the constituents, in places, being entirely angular. Nearby the varves have been altered by metamorphism of some kind, and the fragments in the zone mentioned are also changed. The general features of the structures here displayed remind one of the effects set up by the intrusion of tuffs into claystones and cherts, to be seen in the Devonian rocks at Tamworth; but pending detailed microscopic examination, one hesitates to regard the tuffs as intrusive, realising that the structures may possibly be explained by considering the effect of differential movement (gliding) upon a series of partially consolidated sediments.

General Summary of the Stratigraphy of the Kuttung Series.

The detailed examination of the whole of the type area has made it possible to speak with certainty as to the maximum thicknesses of the various divisions of the Kuttung Series. The results obtained for the maximum thickness of the whole of that Series accords very well with the results published by C. A. Sussmilch, although there is some adjustment necessary in connection with the individual divisions and subdivisions. Thus the thickness of the Basal Stage goes up to 2300 feet, the former estimate having been placed at 3000 feet, and on account of the greater development of the Volcanic Stage at Mt. Gilmore than elsewhere the maximum thickness of this Stage (allowing for overlapping of flows) is 2600 feet, while of the Glacial Stage the Lower Portion (equivalent of the Mt. Johnstone beds) has a thickness of 2100 feet, the Paterson type of dellenite and toscanite, 290 feet, and the Main Glacial Beds, 1840 feet as measured at Seaham by Sussmilch.

Maximum Thicknesses of Stages of the Kuttung Series.

Basal Stage		
Conglomerate chiefly	1500	Feet
Tuffs with conglomerate bands	740	,,
Tuffs with *L. veltheimianum*	10	,,
Tuffs with pebbles	50	,,
Volcanic Stage	2600	,,
Glacial Stage		
Lower Portion (equivalent of Mt. Johnstone Beds)	2100	,,
Toscanite (Paterson type)	290	,,
Main Glacial Beds	1840	,,
Total	9130	,,

An excellent summary of the geological history of the Carboniferous Period has already been given by Mr. Sussmilch.

REGIONAL GEOLOGY.

The Burindi Series.

The representatives of this Series at Hilldale are delimited to the south by a fault which has in part determined the scarp of Mt. Douglas on the northern side. The individual horizons in the Series are not very persistent, but the mudstones and shales outcropping in portion 100, Parish of Barford, can be traced through to the north-west and may be seen in the railway cuttings just west of Hilldale Station. The Burindi outcrops are then continued beyond the limit of the map towards Gresford on the Allyn River. The fossiliferous limestones and calcareous tuffs of portions 100 and 102, Parish of Barford, do not persist as far west as the railway line, because here, on the strike of these rocks, sandstones are found. It is not possible that faulting is responsible for these features, since the mudstones which underlie the limestones show no evidence of displacement.

The Burindi rocks west and north of Clarencetown occupy a large area. About half-way between Clarencetown and Wallarobba, small strike faults have been responsible for some repetition of the units of the Burindi beds, while larger faults occurring near these two localities have caused apparent interbedding of the Burindi with the Kuttung Series. Thus, on the Limeburner's Road, a little to the east of the Clarencetown Bridge, one finds a small occurrence of marine mudstones striking meridionally and accompanied by Kuttung conglomerate to the west and east. Of the Burindi rocks to the west and north-west of Clarencetown, the Glen William fossiliferous claystones and the andesite crossing the Dungog Road in portion 206, Parish of Uffington, are the most important.

The former rocks strike north and outcrop all the way along the road from Clarencetown to Glen William village, maintaining their individuality for about four miles. The igneous horizon can also be traced about the same distance to the north, disappearing in portion 21, Parish of Wallarobba, while its extent to the south-west is little beyond the Dungog Road.

It is interesting to note that the stratigraphical interval between the lava and the marine claystones is occupied by rocks which are not homogeneous for any distance along their strike. The persistence of the two horizons precludes the possibility of dip-faults, and here the lenticular and local nature of some of the beds in the Burindi Series is again well exemplified.

The Burindi rocks to the east of Mt. Gilmore owe their position to heavy strike faulting (*see* Plate xxvi.). They outcrop over an area of about two square miles in the region mapped, their extent to the north being unknown. The plan of the outcrop is triangular, with the apex in portion 55, Parish of Wilmot. One can not make out very clearly the distribution of the individual horizons in this area, but there is undoubted evidence of only local development of the various types. Thus the pitchstone outcropping in portion 56, Parish of Wilmot, can be followed for about three chains, and then is not encountered until one comes to the northern end of portion 59. This flow is interbedded with tuffs and conglomerate bands which pass into claystones as one travels north into portion 52, Parish of Wilmot, and the outcrop of these claystones, which are locally silicified, is continued for about ten chains, when coarse gritty tuffs and tuffaceous sandstones obtain. These in turn decrease in extent going northwards and then one finds acid tuffs which outcrop on the Limeburner's Road, just east of the five-mile peg. These latter are clearly of primary deposition, and in places of the nature of "flow-breccias," but the former have to some extent been redistributed, and are mixed with a certain amount of arenaceous sedimentary material. It is possible that some of the abrupt changes along the strike which characterise many of the Burindi clastic units may be due to partial contemporaneous erosion of one series and subsequent accumulation of another series.

The Kuttung Series.

(i.) *Basal Stage.*

The basal conglomerates of the Kuttung Series form part of the Wallarobba Ridge (incorrectly called a range), and are exposed on the northern fall of that ridge, and artificially in the cuttings of the Railway. On account of the plunging syncline at Wallarobba, which is clearly indicated by the outcrop of the hornblende-andesite of the Volcanic Stage, the conglomerates swing off to the North-east, and are seen on the road to Sandy Creek. The chief "tuff-portion" of the Basal Stage forms the rocks in the southern end of portion 1, Parish of Wallarobba, and then is lost in the alluvium of Sandy Creek.

The next place of distinct occurrence of Basal Stage rocks is to the east-south-east of Wallaroo Hill, forming an eminence in State Forest No. 178 (Uffington); the strike of the sediments here is more or less east and west, so that the conglomerates are exposed on the Maitland Road about three and a half miles from Clarencetown. With a changing strike the rocks then curve round till they assume a north and south trend and appear in the paddocks lying to the west of the Williams River. Ultimately they cross through the western outskirts of the town, showing up well on the Dungog Road and near Clarencetown Bridge, while a small area to the east of the river is also occupied by the outcrop of these rocks.

The failure of the conglomerates and tuffs to appear between the eminence in State Forest 178, and Wallarobba may be due to faulting, but it seems more likely that these rocks occur as large lenticular masses, not forming a continuous unit between the localities cited.

On the Limeburner's Road, near the locality known as "The Gap," conglomerates occur underlying rocks of the Volcanic Stage. These are undoubtedly the faulted equivalents of those outcropping in the vicinity of Clarencetown. They can be easily traced south to Caswell's Creek and the cross-road from East Seaham to Raymond Terrace, forming the densely wooded slopes which lie west of a well-marked ridge formed of rocks of the Volcanic Stage, running from "The Gap" four miles south-south-west.

One of the most interesting areas of these basal conglomerates and tuffs is that extending from Mt. Douglas towards Martin's Creek. The high cliffs of Mt. Douglas, so conspicuous from the North Coast Road near Hilldale, are composed of these rocks dipping at 13° in a direction S 20° W, and capped in places by Cainozoic basalt. Following on in the direction of dip one comes upon a small outcrop of hornblende-andesite (whose position is difficult to account for) and then, from this point to the south side of the valley of Shingle-Splitter's Creek, the rocks of the Basal Stage are found. Their limit to the west seems to be a line of faulting and to the east they are definitely cut off by a large fault (*see* map). If strike-faulting be absent along the line of dip just mentioned, a thickness of 3500 feet is indicated, since the general dip steepens somewhat as one proceeds south, but on account of local changes in the strike and dip, and the definite existence of a series of oblique faults encircling the region in question, one feels sure that the thickness is apparent, and due to strike-faulting having taken place in addition to the faulting on the margins of the Basal Stage outcrop.

Within 50 feet of the base of the Volcanic Stage there occurs a plant fossil horizon, details of the fossil content of which have been given above. In portions 107 and 118, Parish of Barford, on the slopes of the Valley of Shingle-Splitter's Creek, this stratum is encountered, and can be followed to the east for some distance.

Owing to faulting these rocks should next be found at the back of the heavy brushes cloaking the steep valleys of the tributaries of Tumbledown Creek in portions 105 and 113, Parish of Barford. Although no leaf and stem impressions or casts occur as at the other locality, chalcedonic replacements of tree trunks are quite frequent at this place. Beyond portion 54, Parish of Barford, this plant-bearing horizon is not traceable any further to the east until one reaches the Williams River, a little below the township of Clarencetown. In two spots the fossil plants are again observed. The first is in portion 153, Parish of Uffington, towards its south-eastern corner, on the riverbank, where a rather good example of *Stigmaria* was obtained. The other occurrence is in a small washout of a creek draining through portion 16, Parish of Uffington, and just west of the lane running from the Limeburner's Road to Seaham.

(ii.) *Volcanic Stage.*

As is apparent from the stratigraphical discussion, one finds that some units in this portion of the system do not persist for any great distance, others appear in different relative positions at different districts, while others have a wide distribution and preserve a uniformity of position in the sequence.

The hornblende-andesite (Martin's Creek type) is developed to its greatest extent at Martin's Creek Township, where it gives rise to a curving dip-surface extending from portions 107 and 118, Parish of Barford, south to where Martin's Creek passes under the railway line. Starting in portion 107 the strike is about north-west and changes quickly to N. 15° W. which carries on till just near the extremity of the andesite, where a slight bend toward the south takes place. The dip-surface is broken by a number of cross-cuts made by small tributaries of Martin's Creek, so that when viewed obliquely to the dominant strike the topography has the appearance of a series of dip-slopes arranged somewhat *en échelon*. The termination of the andesite on the south is certainly due to a fault, and it is probable that the north-western extremity is close to a fault-line.

The andesite at the locality under description is in every case of the variety that comes under the general category of "lithoidal phase," and the most widespread variety of that phase is the one described above in the stratigraphy section as Variety I.

A development of the andesite, almost as important as the Martin's Creek occurrence, is that in Mr. A. J. Vogele's property, portions 113, 104, 28, 21 and 99, Parish of Barford. Limited to the west, near Mt. Douglas, by a heavy fault (*see* map), the rocks trend easterly for some distance and then the strike changes to north-north-west in portion 28. Here the flow is faulted to the east and forms a bare ridge in portion 99, with a steep slope directed to the west. This ridge of andesite does not extend very far to the south, as it soon ends against a heavy fault which has placed higher members of the Volcanic Stage against the andesite.

The slopes of andesite in portion 113 carry heavy masses of talus, and are cut into by a number of very youthful streams flowing south. The glassy phase of the rock is only scantily developed in portion 28, but a larger amount of the two varieties of the andesitic pitchstone, together with the lithoidal phase makes up the rocks occurring in portion 99.

It is difficult now to follow the andesite from here to the outcrops near Clarencetown and the Williams River. If one traverses across the strike northwards towards Welshman's Creek from near portion 99, Parish of Barford, where the hornblende-andesite is terminated by a fault, the majority of the lower beds of the Volcanic Stage are passed over,—some are missing but certain distinct types occur. On account of the strata assuming a flat dip in a general south-south-west direction, a considerable horizontal distance has to be covered before one arrives at the stratigraphical position where the hornblende-andesite should occur. In portions 66 and 67, Parish of Barford, the biotite-quartz-keratophyre which has been shown to be the first important flow following the hypersthene-andesitic pitchstone is observed, and then the absence of the latter is apparent, and only tuffs and conglomerates of almost undoubted Volcanic Stage identity intervene between the keratophyre and an outcrop, in portion 217, Parish of Wallarobba, of lithoidal hornblende-andesite identical in hand-specimen with that at Martin's Creek. Immediately to the north of this occurrence is a very much disturbed area, comprising outcrops of both Burindi and Kuttung rocks, but the andesite appears to be without the zone of disturbance and is here viewed rather as the directly-faulted equivalent of that forming the ridge in portion 99, Parish of Barford, than as a lava of Burindi age, which has suffered almost complete devitrification, for in all the Burindi hornblende-andesites occurring elsewhere, devitrification has not proceeded to any great extent.

The outcrop of andesite at Welshman's Creek does not proceed far to the south-east, which is the direction of its strike, and from the point of its disappearance in portion 217, Parish of Wallarobba, to a spot near the Maitland Road, three and a half miles from Clarencetown, no evidence of its existence has been found, the stratigraphy between the two localities mentioned being in fact somewhat obscure. From the Maitland Road just near the northern boundary of portion 160, Parish of Uffington, where the andesite, now very thin, appears, one can follow the outcrop with ease across to the Williams River and the foot of the Mt. Gilmore Ridge, the rock failing temporarily at the cross-road to Seaham (*see* map).

The distribution of the hypersthene-andesite and andesite-glass is in general agreement with that of the Martin's Creek type, but the former is not so widespread. It is found in the paddocks west of the railway near Martin's Creek Station and in the railway cutting a little to the north of the Station, where it has been brought up against the hornblende-andesite by a small overthrust fault. While its thickness hereabouts is 100-150 feet, a short distance to the east it is hard to discover, and in portions 16 and 29, Parish of Barford, it has a limited extent, being about 15 feet thick. Near the upper part of Tumbledown Creek, two outcrops are seen, viz., in portions 22 and 57, and 34 and 59 respectively. These appear to be the result of a small branch fault. The hypersthene-andesite is not seen again until one comes to the village of Glenoak, where about 200 acres are occupied by its outcrop. This occurrence is bounded on both the west and east by faults, the eastern fault being responsible for displacing the andesite some distance to the north, its outcrop being seen on the main road about 1½ miles from Glenoak. From here, intermittent exposures occur towards the Williams River, but east thereof the rock is only found at the foot of the northern end of Mt. Gilmore, in portion 16, Parish of Wilmot.

The biotite-quartz-keratophyre (Williams River type), of which there are in most places two flows separated by a little conglomerate, has its maximum development in the eastern part of the area. In portion 10, Parish of Wilmot, on the Williams River it is exposed in a large quarry, and must here be about 150 feet thick in the larger flow and 30 feet in the subsidiary one. With the exception of the districts of Martin's Creek, the Langlands Estate and the northern end of Mt. Gilmore, one finds over all the area the two flows which microscopic examination shows to be almost identical.

Passing west from the Williams River quarry, the keratophyre abruptly decreases in extent and is poorly developed between the river and Glenoak. At the latter place it is decomposed and, on account of its flat dip, occupies a comparatively large area just south of the Post Office. Heavy faulting then intervenes, and it is next found in the fields to the north-east of Oakendale homestead. The exact relationships of the outcrops here to the surrounding rocks are not clear. However, to the north-west of "Oakendale," one finds the two flows with their usual stratigraphical relationships, as on the cleared hills north of Tumbledown Creek. The large fault which runs through this locality, passing the hornblende-andesite ridge of portion 99, Parish of Barford, terminates the keratophyres on the west, and they are not found till one comes to a tributary creek in portion 137, from whence the main flow (the subsidiary one having died out) can be traced westwards past the Martin's Creek school to the railway line, where it is adjacent to the hornblende-andesite. To the west of the railway the rock is found in Priestley's paddock (S.E. division of portion 131, Parish of Barford), the outcrops being for the most part decomposed.

Some idea of the distribution of the remaining lavas of the Volcanic Stage has been given in the discussion on the stratigraphical variation, but something must be said of the important unit which has been termed the Mt. Gilmore biotite-dellenite. This rock displays very well the manner in which some of the lavas change their facies from place to place. At the Gilmore area this unit has a maximum thickness of 400 feet, forming in most places the capping to the ridge. The rock in almost every case is a dellenite, but one specimen, under the microscope, proved to be a toscanite. At the northern end of the ridge the maximum development occurs, the field relations not being very clear; one is almost inclined to regard the mass as intrusive on account of its irregular extent, but the extrusive nature shows up in thin section, and the westerly continuations of the unit can only be viewed as volcanic occurrences. On account of the plunging anticline between Mt. Gilmore and Glenoak, this flow swings round to the Williams River, gradually decreasing in thickness, and on the right bank has a somewhat different appearance in hand-specimen, the rock proving under the microscope to be a phase on the border-line between dellenite and toscanite. From here it is traced to the Maitland Road, where this crosses Tumbledown Creek, and the outcrop is only continued for a few chains to the north-west when faulting occurs, large horizontal displacement placing the rock south of Glenoak, where it is developed on the timbered hills in portion 29, Parish of Seaham. In this outcrop the rock is more potassic than elsewhere, being more of a potash-rhyolite than a dellenite. In order to follow it we start again in portion 189, Parish of Uffington, where it runs north-north-west to a small creek in that portion, suffers a small displacement by faulting, and then continues through the Oakendale paddocks along Tumbledown Creek to the large fault near portion 99, Parish of Barford. Along the line of outcrop just mentioned it has a marked effect on the drainage and, near the fault plane, is tilted up, dipping at an angle of 40° to the S.S.W. The fault in question has the effect of sending this horizon to the south, where it outcrops in portion 142, Parish of Barford. From here it forms a pronounced ridge which runs west, reaching the railway line by a gradual decrease in height, which is due to the pitching nature of a broad earth-fold, of which structure the lava forms a part. From this ridge the rock spreads out in a dip-surface to the south, forming much of the area drained by the headwaters of Tucker's Creek. The most westerly outcrop of this portion of the flow is in the railway cutting, just south of the first overhead bridge south of Martin's Creek, the rock being a toscanite. About here it is intersected by a large fault, and is then found appearing at intervals through the alluvium and recent wash in portions 27 and 28, Parish of Houghton, striking N. 15° W., finally crossing the Paterson River and outcropping in the southern end of portion 132. In these occurrences along the right bank of the Paterson River the rock shows a decrease in the content of phenocrystic orthoclase, and in portion 27 it is a dacite, unless the potash molecule be retained in the cryptocrystalline base.

Of the upper members of the Volcanic Stage, the dacites are perhaps the most important. These in general have a glassy base and in some occurrences contain fragments of foreign felsitic rocks. They are poorly developed on the plain to the east of Mt. Johnstone, and outcrop also in the valley of Tucker's Creek. Near Glenoak and Langlands Estate their extent is limited, but in the Mt. Gilmore area they attain a considerable aggregate thickness. In one part of the Gilmore ridge the main dacite, due to faulting, forms the ridge-capping, which elsewhere is composed of the Mt. Gilmore dellenite. From the slopes to the south-east of the main Gilmore ridge in portions 51 and 52, Parish of Wilmot, to near the Williams River in portion No. 2, the outcrops of the dacites are quite distinct.

There still remain the more tuffaceous types of rock and the intercalated conglomerates, of which some mention must be made. The soda-rhyolite tuffs and tuffaceous soda-rhyolites appear to be confined to the western portion of the region surveyed. They are seen on the North Coast Road at the foot of Mt. Johnstone, and in the paddocks immediately to the east of the road. They also outcrop in portion 154, Parish of Barford, near its junction with portion 156. The rocks are always associated with dacite,—in the latter locality with a dacite carrying a multitude of peculiar inclusions which are made up almost entirely of spherulitic structures. The soda-rhyolites in question have never been found to the east of the Tucker's Creek locality.

The somewhat remarkable rocks described as volcanic conglomerates, etc., can be traced almost continuously from the base of Mt. Johnstone to near the Langlands Estate. As was pointed out above, there are in general two types of rock, and in this connection there seems to be a distinct change in nature between the outcrop in portion 154, Parish of Barford, and that near Tumbledown Creek in portion 147, Parish of Uffington, where the rock contains rounded inclusions of felsite up to the size of an egg. Near Glenoak the outcrop is brown in colour, and can be seen just at the junction of the main road and a settler's road leaving the former near the western boundary of portion 155, Parish of Uffington. Here the rock is adjacent to a fault plane and its displaced equivalent to the east is found on the Langlands Estate, beyond which it is not known to occur.

The majority of the other true tuffs are fairly limited in extent, but those which contain sandy and conglomeratic sediment have a wide areal distribution. Thus the tuffs both underlying and succeeding the hypersthene-andesite are well in evidence all the way from Martin's Creek to Clarencetown, particularly so to the east of Martin's Creek Station and to the north of the school, where the conglomerate content is very predominant. The conglomerates overlying the biotite-quartz-keratophyres outcrop extensively in portions 54 (Barford) and 147 (Uffington), and to a less degree near the railway line just south of Martin's Creek (*see* map).

At Mt. Gilmore the development of these rocks is also considerable, but the average size of the constituent pebbles is much less than in the western districts. At the northern end of the ridge the conglomerates become still less coarse in texture and there is a local intercalation of a felspathic grit or tuff which does not occur elsewhere.

Sugar Loaf Hill, a conspicuous landmark in portion 148, Parish of Uffington, is composed of conglomerates which appear to belong to the series under discussion, the stratigraphical relationship of the Sugar Loaf outcrop to the surrounding rocks being undetermined.

(iii.) *Glacial Stage.*

The widespread nature of the rocks forming the lower portion of the Glacial Stage can be appreciated when one realises that, in spite of the effects of heavy faulting involving pronounced meridional displacement in most cases, it is possible to draw a line in a direction east 20° south, from a point a little to the south of Mt. Johnstone right across the area mapped, to Caswell's Creek, distant 13 miles, the line traversing almost entirely the outcrops of these rocks, the exception being a small area of Volcanic Stage rocks near Glenoak, alluvium, of course, not being considered.

Starting at Vacy, at the confluence of the Paterson and Allyn Rivers, rocks of the lower portion, with the exception of the varves, are strongly developed and form, for the most part, the ridge which stands up 1000 feet above the valley of the Paterson River, and trends south to Johnstone Trig. Station. They also compose the hills south and south-east of Mt. Johnstone, which gradually decrease in height as one comes to Paterson Township. In addition they form a considerable portion of the drainage area of Tucker's Creek.

A well-marked depression in the timbered hills to the east of Paterson is due to the existence of an area of these comparatively soft rocks, which have been faulted so as to be surrounded by the harder toscanite. Further to the east these tuffs and conglomerates cover an extensive area between Tumbledown Creek and the headwaters of Wattle Creek, being concealed just at Red Hill by a flow of Tertiary basalt. The heavy fault passing through a little to the west of Glenoak can be traced right down to the Paterson-Seaham Road near Butterwick, and is thus responsible for placing the tuffs and conglomerates close to this road, where they form the greater part of a long whale-back outcrop known as Little Brandy Hill. Big Brandy, close by, is also composed of these sediments.

Further extensive areas of these rocks occur in the rough country in the northwestern corner of the Parish of Seaham, where a number of the small tributaries of the Williams River have their rise; and a trapezoidal area, south of Glenoak, bounded on the east by the river and on the west by a large fault, is also occupied by the outcrops of these fragmental rocks. The continuation of the last-mentioned outcrops to the east of the River is obscured by alluvium, but the rocks are again well seen further eastwards, forming much of the country at the feet of the slopes to the south-east of the Gilmore ridge, and ultimately being cut off by a heavy strike-fault which places them against the Burindi Beds. An effect of this fault, also, is to duplicate the outcrop of the tuffs and conglomerates, causing them to appear overlying the ridge of Volcanic Stage rocks running from The Gap south towards Raymond Terrace.

The conglomerate which forms the basal unit in the Glacial Stage is not found on the western portion of the area surveyed, but from near portion 99, Parish of Barford, across to the country east of Mt. Gilmore, it is a constant feature, having its maximum development near Oakendale, where it outcrops in huge boulders in portions 164 and 167, Parish of Uffington, and forms a flat pavement in the bed of Tumbledown Creek, and a vertical cliff rising therefrom, the general locality of these occurrences being called the "Black Rocks."

It forms a small, but marked hill, just east of the residence of Mr. Adamson, schoolmaster at Glenoak, where there is an abundance of quartzite and aplite pebbles, and maintains these features right to the outcrop on the Limeburner's Road.

The varves near Glenoak occur in portion 138, Parish of Uffington, on a hillside immediately to the north-west of a small branch fault (*see* map). They constitute a small saddle, which effects a physiographic break in the otherwise simple profile of a hill of tuff and tuffaceous conglomerate, and this feature can be followed round to a creek in portion 131, and also north-west into portion 99. The rocks have been found not *in situ*, in the bed of the creek in portion 109, Parish of Barford, but the parent rock was not located.

It is to be noted here that to the east of the Williams River in portion 35, Parish of Wilmot, there is a white cherty rock associated with the conglomerate at the base of the Glacial Stage, which has some features in common with glacial varves, but in the absence of confirmatory evidence, one hesitates to assign to it a glacial origin.

The thin cherty shales carrying remains of the *Rhacopteris* flora have a wide distribution. They have been noted in the talus upon the slopes of Mt. Johnstone and are to be found in a well-preserved state in two small quarries on the roadside a few chains west of the railway line at Paterson on the way to Gresford. Towards the base of the northerly-directed scarp of Hungry Hill, good fossils from this horizon can be obtained, and particularly fine remains are seen on a track leading from the northern point of portion 150, Parish of Barford, down to Dunn's Creek. A little to the east of the crossing of the creek by this track, in a tributary gully, the plant-remains are associated with impure coal seams. In the areas between here and the Williams River the plant-bearing shales and tuffs are always found in the same stratigraphical position. Thus one sees an abundance of this material just to the south of the Paterson-Glenoak Telegraph Line in portion 108, Parish of Barford, and excellent specimens of *Rhacopteris* species occur in the central part of portion 39, Parish of Seaham, and at the foot of the hills close to the Williams River near the junctions of portions 39 and 40. The most southerly occurrence of this horizon is upon the top of Big Brandy Hill in portion 38 where the rock containing the plant-remains is of coarser texture. The horizon cannot be followed very far, either to the east or west, on account of the presence of faults.

To the east of the Williams River one has no difficulty in locating this horizon, as it outcrops at intervals along the cross-road from East Seaham to Raymond Terrace, particularly near portion 22, Parish of Wilmot.

On account of the slight change which takes place in the composition of the igneous rocks developed at Paterson as toscanite, it will be convenient in the description of their regional distribution, to use the term dellenite, when dealing with a locality where such is the identity of the rocks, and the term toscanite in other cases. It has not been possible to say definitely whether the rocks in question occur as a composite sill, as a single flow, or as a series of two or three flows, but for present purposes they may be considered as one unit.

The toscanite outcrops at the summit of Mt. Johnstone and is developed in a long dip-slope on the western fall of the ridge, spreading out westward towards the head of Webber's Creek. On account of the effect of erosion upon the dome-like structure hereabouts, the junction of the lava with the underlying tuffs swings away to the west, but the toscanite is again encountered along the southern margin of the hills south of Mt. Johnstone, here having an easterly strike. About one mile from the town of Paterson the rock dips at a high angle, the result of an oblique fault, which, although possessing a considerable throw, has effected practically no horizontal displacement of the visible outcrops. (The peculiarity of this feature will be fully discussed in a later chapter). From here the rock passes down into the town of Paterson, outcropping in the railway and road cuttings and, after being cut through by the Paterson River and temporarily lost in the alluvium, is found strongly developed to the east between the Paterson and Dunn's Creek, the dip-slope on which Hungry Trig. Station stands being duplicated to the south by strike-faulting. The junction of the toscanite with the overlying glacial beds is continually exposed along the course of Dunn's Creek, and towards the headwaters of that stream there are a number of small disconnected outcrops, their lack of continuity being the result of erosion upon a locally flatly-dipping series. Then on the road from Dunn's Creek to Red Hill there is a decomposed outcrop, and some dip-slopes of dellenite occur in the rough country comprising portions 18, 21, 22, and 23, Parish of Butterwick. The dellenite may then be traced down through the Water Reserve, portion 39 (Butterwick), and becoming very thin, it swings away to the south, possibly owing partly to the dragging effect of a large fault. The decrease in thickness eventually brings about the disappearance of the rock, and there is, therefore, an overlap of the Main Glacial Beds upon the lower portion of the Glacial Stage in the district to the east of Butterwick. Beyond the region of overlap the eruptive rock again occurs, as in portion 52, Parish of Seaham, but the extension to the east is small, owing to the intervention of a heavy fault, by reason of which the dellenite is next found along the course of Felspar Creek, eventually coming out upon the Seaham-Clarencetown Road just at its sharp bend above Felspar Creek. Alluvium now conceals the dellenite to the east, until the Williams River is crossed, and on the left bank, immediately opposite Porphyry Point, dellenite and potash-rhyolite are exposed on the hillside, partly artificially in a small quarry. From here the rock forms the capping and southerly-directed slopes of a distinct ridge which trends E. 30° N. to Caswell's Creek.

Good sections of the Main Glacial Beds are to be seen at various places in the area, but the individual horizons do not outcrop over large areas in such a way as to make it possible to trace them from place to place with ease. Furthermore, local development is a feature of some of the strata, especially the true tillites.

At Paterson the Main Glacial Beds outcrop in the Park and in the paddocks west thereof, and form a considerable amount of the low-lying land occupied by Webber's Creek, some distance further west. Passing east from Paterson Park they form the foundation of much of the southern portion of the town, and can be seen near Douribang Village, on the Paterson-Seaham Road, and outcropping continuously along this road to within a mile of Butterwick. To the south of this road they extend little, but on the north and north-east gradually increase in width of outcrop from Douribang towards Dunn's Creek, where they are developed in a plunging syncline. In Dunn's Creek and its main tributaries, excellent sections are exposed, and the stratigraphy is clear, while the record, in the main stream, of a dip of 40° at E. 30° S., and in the first tributary to the east of a dip of 30° at N. 60° W. establishes the existence of the syncline mentioned.

Fluvio-glacial conglomerates, varves and glacial muds form part of the ridge running from the western boundary of portion 18, Parish of Butterwick, to Big Brandy Hill, as well as much of the lowlands to the south-west of this ridge. On the east of the large fault near Butterwick, tillites and conglomerates are to be seen on the southern slopes of Big Brandy, and also along the banks of Bartie's Creek. Hereabouts, the direct passage from the tuffs and conglomerates of the lower portion to the Main Glacial Beds may be observed.

The most characteristic tillite in the whole area of the Main Glacial outcrop, occurs on a small rise in the south-eastern corner of portion 38, Parish of Seaham, the extent being limited. From here on to Seaham the glacial beds appear to be mostly conglomerate and tillite, varves not being conspicuous. Nearer Seaham they may be seen in the road cuttings, and to the north outcrop right to the right bank of Felspar Creek.

The occurrences in the Seaham Cemetery and along the Maitland Road have been fully described by Mr. Sussmilch. The base of the Main Glacial Beds occurs at Felspar Creek, just near the point where the road crosses the creek. Here they are very bouldery indeed, and owing to the strike coinciding in general with the trend of the road to the south, they outcrop right along to the Seaham Hotel. They also extend to the west of the road and are overlain by tuffs which have their maximum development in portions 62 and 63. These are the equivalent of the tuffs occurring along the ridge which stands to the east of the main tributary of Dunn's Creek. The varves outcropping within the village of Seaham, and excellently described by Sussmilch, may be followed from the main road some distance to the west, the lower and more important horizon being the more persistent.

On the northern side of the Williams River, in the region mapped, the Main Glacial Beds do not form important outcrops, much of the area where one should expect to find them being occupied by swamps and alluvium. However, they occur in a band about 30 chains wide, from the Punt Crossing to Caswell's Creek, the representative of the series being conglomerate, the appearance of which suggests a fluvio-glacial origin, although no striated pebbles have been found.

Intrusive Igneous Rocks.

The eruptive rocks which are definitely intrusive form a very subordinate group, occurring as sills and dykes. Three distinct types are comprised in this group.

Firstly, there is a dyke of quartz-bearing gabbro-porphyrite, occurring in portion 114, Parish of Barford. It forms a small knoll just to the east of Mr. Vogele's cottage, and can be traced about half a mile to the north and half that distance to the south. The dyke strikes N. 10° E. and has an inconstant width, varying from 10 to 30 feet, but no particulars could be obtained as to the dip. On the margins of the outcrop the rock is distinctly fine-grained. The main mass is a grey rock of very compact nature, weathering spheroidally, and giving surfaces which it is almost impossible to spawl. The rock is porphyritic in plagioclase in hand-specimen, and under the microscope one sees large labradorite crystals set in an ophitic groundmass of medium grain-size, composed of augite, ilmenite, plagioclase and interstitial quartz.

Secondly, we consider a group of intrusions in the railway cutting in portion 2, Parish of Wallarobba, just south-west of the Station. Here there is a sill and three dykes of basic material intruding the hornblende-andesite (Martin's Ck. type). Two of the dykes are about one foot in thickness, and the third eight inches, while the sill has a width of 10 feet. Unfortunately the rocks are almost completely decomposed, but there is no doubt of the material being basic and originally probably basaltic or doleritic.

Thirdly, there is a dyke of felsite intruding Burindi Beds in a railway cutting between Martin's Ck. and Hilldale, just north of the 40 mile-peg, which strikes N. 50° E. and has a width of 4 feet. The microscopic characters of this rock are not yet known.

The question arises as to the age of these minor intrusions. The felsite is post-Burindi and might reasonably be regarded as connected with the eruption of the felsitic lavas of the Volcanic Stage of the Kuttung Series, and all that can be said of the quartz-bearing gabbro-porphyrite and the basic rocks is that they are post-Volcanic Stage. They are essentially similar to the material forming some of the minor intrusions of Tertiary age in Eastern New South Wales, and in view of the occurrence of Cainozoic basalt flows at Mt. Douglas and elsewhere in the area, the possibility of the large dyke of quartz-gabbro-porphyrite having been a feeder to the basalt sheets produced by fissure eruptions, must be recognised. However, it is also to be pointed out that at Currabubula there are rocks of the nature of quartz-dolerites among the Carboniferous rocks, and also at Pokolbin some small occurrences of dolerite and basalt, possibly of Palaeozoic age.

Cainozoic Basalt.

Flows of Cainozoic basalt occur on Mt. Douglas and to the east thereof, and at Red Hill, near the head of Dunn's Creek. The thickness of the basalt varies from 200 feet to 60 feet, the maximum being at Mt. Douglas, and its occurrence as residual cappings to the highest hills points to the existence of former widespread flows, which were poured out upon a peneplain surface, this being evident from the record of the aneroid barometer readings, which showed that the base of the basalt was essentially level. In all localities the rocks are considerably decomposed, furnishing excellent land for orchardists. At Red Hill the basalt has existed in columnar form, large prisms being found amongst the red soil. At this place also, the underlying tuffs have been changed by ferruginous material derived from the basalt. In hand-specimen the basalt is aphanitic and almost black in colour, the microscope showing equal amounts of well-formed laths of felspar and irregular augite, together with magnetite and an occasional grain of olivine, the fabric being radiate and ophitic.

Cainozoic Detrital Deposits.

In addition to the silts and alluvium along the banks of the creeks and rivers, and the recent wash and unconsolidated talus elsewhere, there occur some interesting rocks, of the nature of conglomerates, boulder beds, and grits, which are clearly of Pleistocene or Recent age. In places these are surrounded and partially concealed by alluvium, and thus are mentioned in the legend of the map (Plate xxvi.), but otherwise they have not been mapped, in spite of their widespread occurrence, since the placing of them upon the map would have further concealed the already obscured plan of the Palaeozoic rocks, as given on the map. These rocks are found on the highest hills and in the lowest valleys. The best development generally occurs as a cloaking to the slopes of small-stream valleys, and at the mouths of streams. They have, in these cases, been formed as talus masses and alluvial fans, cemented together, and subsequently cut into by the streams during further periods of degradation. But they are not confined to stream valleys. On almost any gentle slope, masses of the rocks may be found, often in the process of formation. It was interesting to find that a conglomerate consisting of fragments of toscanite had developed on the dip-slope on which Hungry Trig. Stn. stands, where the angle of dip is 18°. The boulders are sometimes well rounded, but in the majority of cases only partially so, while some rocks are composed of completely angular fragments. The size of the constituents varies, the larger being the more angular, and there is no evidence of sorting. The cementing material must differ in detail from place to place, but essentially it is of an argillaceous nature. The extensive character of the deposits has to a large extent been determined by the fact that there is a notable felspathic content in most of the Palaeozoic rocks in the whole area, whether igneous or sedimentary. The types referred to as grits are free from boulders and seem to be confined to relatively high localities. A typical outcrop of the conglomerates is to be seen immediately south of the road half a mile from Paterson towards Gresford. They also occur on the top of Mt. Gilmore and in the Valley of Tucker's Creek and in a large number of other places. The boulder beds are best developed in the creeks to the east of the Gilmore Ridge, while the gritty rocks may be seen round about the Dunn's Creek Road a little south of Red Hill.

Concluding Remarks.

In the foregoing is given a detailed account of the stratigraphical and regional geology of the Carboniferous System in the Clarencetown-Paterson area, together with descriptions of certain intrusive rocks of uncertain age, and Cainozoic igneous and sedimentary units.

A classification of the Kuttung Series is proposed, consisting of a Basal Stage, a Volcanic Stage and a Glacial Stage. This subdivision, it is pointed out, is one suited to the stratigraphical features exhibited in the area, and in basic nature, differs little from that given by Mr. Sussmilch, but has been deemed necessary on account of an advance in our knowledge of the details of the succession in the district, which was only possible from a close examination of the rocks in the field over an extended field-season, which the author, fortunately, was able to conduct. The Volcanic Stage has been treated in full detail and a preliminary discussion of the stratigraphy of that Stage is given.

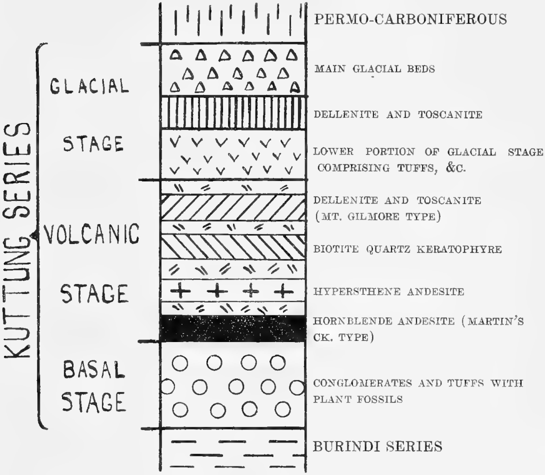
The whole outcome of the work, which is meant to be a contribution to a fuller knowledge of the Carboniferous System, especially the Kuttung Series, has been to confirm the general sequence determined by the pioneering work of Mr. Sussmilch, to whom, on this account, the author, like all workers in the Carboniferous, is much indebted.

Acknowledgments.—To Prof. Sir Edgeworth David the writer is deeply indebted for his many kind actions of encouragement. In the initial stages of the work he conducted the writer over some of the ground described in these pages, and has constantly interested himself in all the subsequent field and laboratory work, supplying helpful advice on numerous occasions. Mr. W. R. Browne spent a few days in June, 1921, in the Paterson area confirming the writer's conclusions and making helpful suggestions as to field problems. He has also been most willing at all times and under all circumstances to confer with the writer on various matters connected with the stratigraphy and petrology and, by his knowledge of the Carboniferous, has been able to offer valuable opinions on numerous points. The writer has derived benefit from discussions on the geology of the area with Mr. C. A. Sussmilch, on account of his first-hand knowledge of the sequence, and in the field was assisted by Mr. H. G. Raggatt who, as a student of the Geology Dept., spent a week with the writer at Clarencetown. In connection with the office work thanks are due to Mr. W. S. Dun and Mr. L. L. Waterhouse, especially the latter for advice during the preparation of the map. For characteristic hospitality and local scientific information the author has to thank Mr. W. J. Enright, of Maitland.

With regard to the activities in the field he wishes to place on record his appreciation of the generous hospitality extended to him by the residents of the area. In this connection he cannot speak too highly of the service rendered by Mr. W. Parker, Quarry Master, Martin's Creek, and family, from whom he received every kindness throughout the whole of his sojourns in the area. Also he has to sincerely thank Mr. and Mrs. G. McD. Adamson of Glenoak Public School, Mr. and Mrs. J. W. Boag and family, of "Burnbrae," Seaham, Mr. and Mrs. A. J. Dransfield of Paterson, Mr. and Mrs. L. S. Holmes of "Oakendale," and Mr. and Mrs. W. A. Holmes of "Langlands," Mrs. W. Ripley and her mother Mrs. Hackett, and Mr. Ben. Robards and his parents of "Hollydene," Clarencetown, Mr. John Tucker of Paterson and Mr. A. J. C. Vogele of Mt. Douglas, whose exact knowledge of the rocks on his property was of distinct value, and others who, in various small ways, contributed towards the success of the work.

EXPLANATION OF MAP (PLATE XXVI.).

The map (Plate xxvi.) requires some remarks. On account of the impracticability of indicating on the legend the characters of all the units shown, a supplementary key has been prepared, which is given in Text-fig. 6. The map is entirely original, except for the following details: The boundaries of the alluvium round about Seaham have been taken from Professor David's Map of the Hunter River Coal Measures, as well as the junction-line between the Kuttung Series



Text-fig. 6. Supplementary key to the Geological Map. (Plate xxvi.).

and the Permo-Carboniferous System from Seaham to the south-west, which itself is not intended to be absolutely accurate. The extent of the Carboniferous Series in the Dunn's Creek district has been changed from what was shown previously, but the base of the Permian Beds near Butterwick has again been obtained from Prof. David's map. The band of dellenite running from The Gap on the Limeburner's Road south-south-west and the boundaries of alluvium near Clarencetown have been copied from Jaquet's map.

On account of the writer having mapped different units from those surveyed by Jaquet, no reproduction of any of the details (with the exception of the alluvium mentioned) of his Clarencetown map has been made.

At Dunn's Creek there is a small outcrop of Permo-Carboniferous rocks which is liable to be overlooked. It owes its preservation to the existence of a syncline. In the mapping, the lowest bed of the so-called Permo-Carboniferous traced was a fine-grained conglomerate containing an abundance of quartz pebbles, with which was associated a yellow plant-bearing sandstone, both horizons being utterly different from any of the Kuttung rocks.

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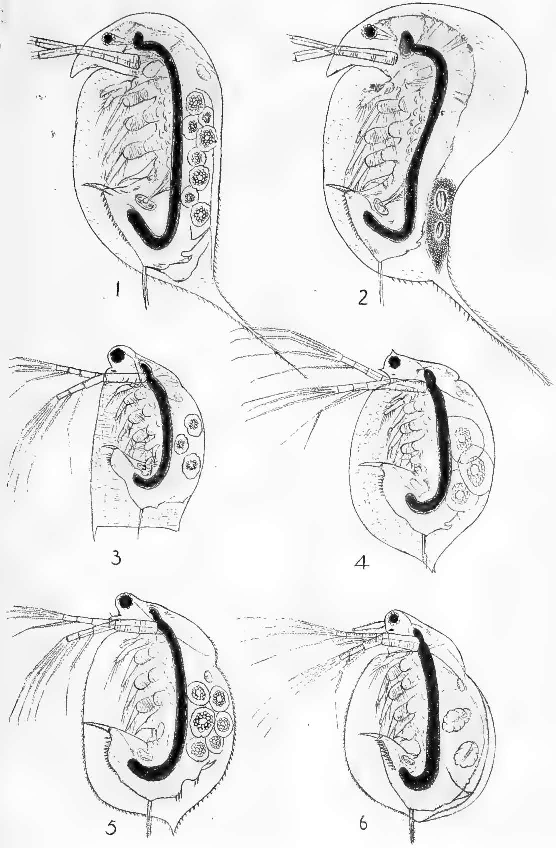
[Printed off, 9th June, 1922.]



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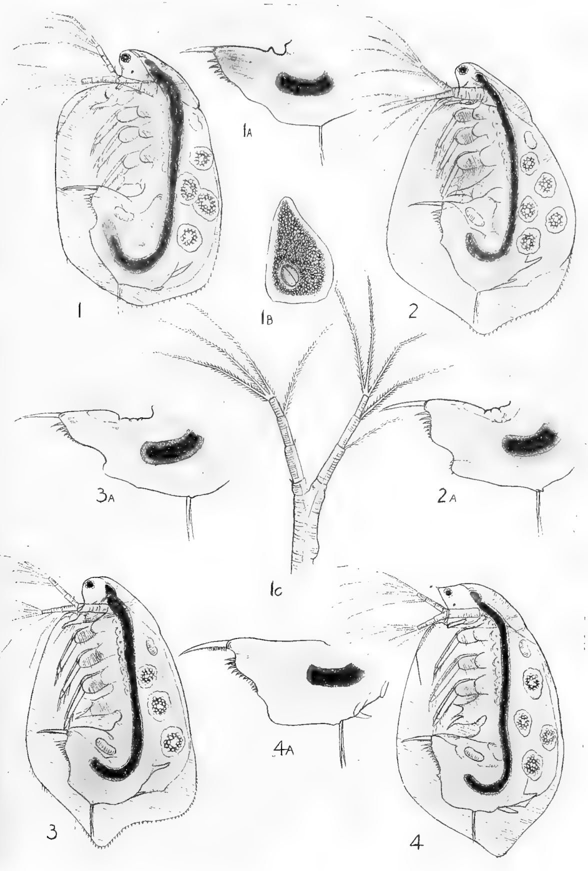

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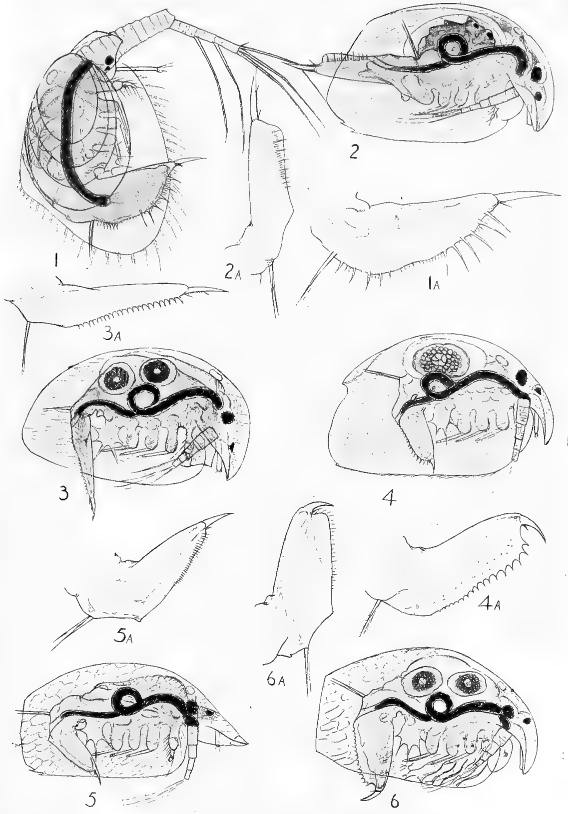

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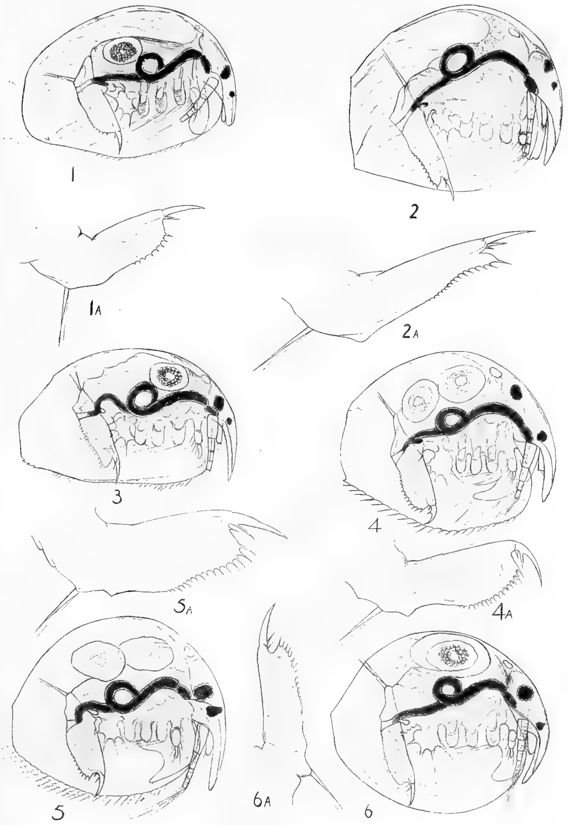

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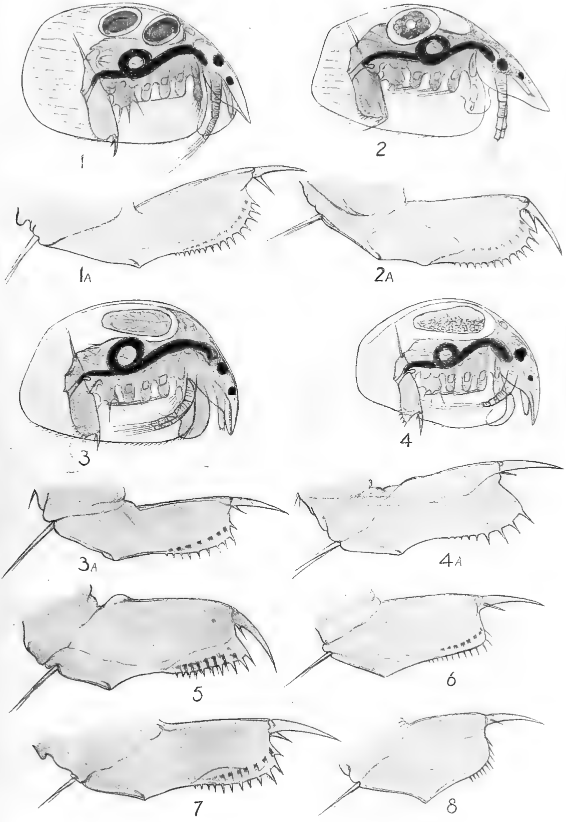

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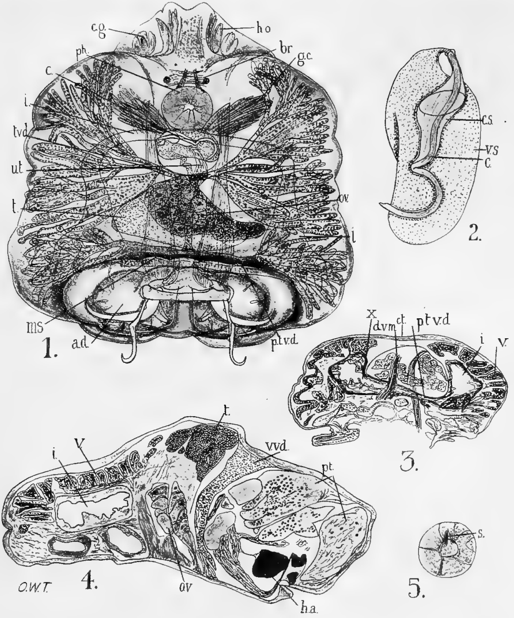
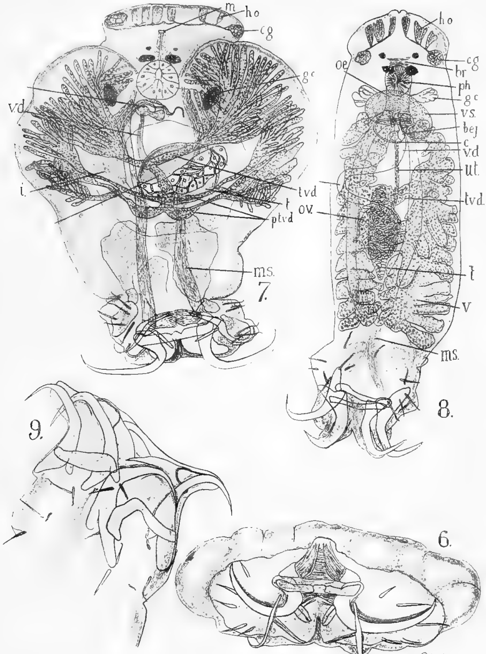


Gyrodactyloid Trematodes from Australian Fishes.



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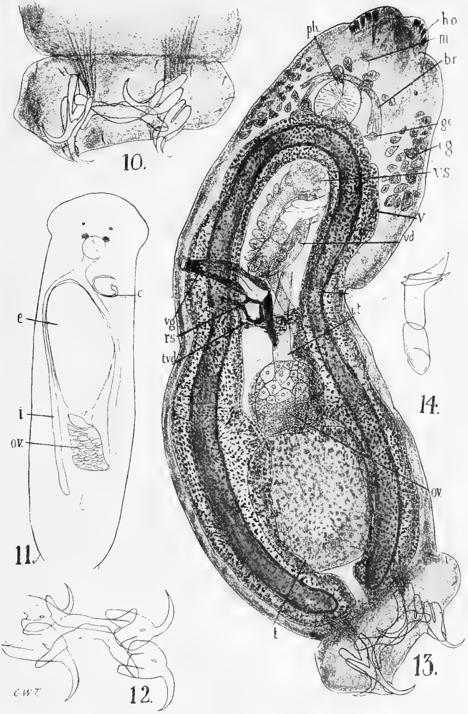

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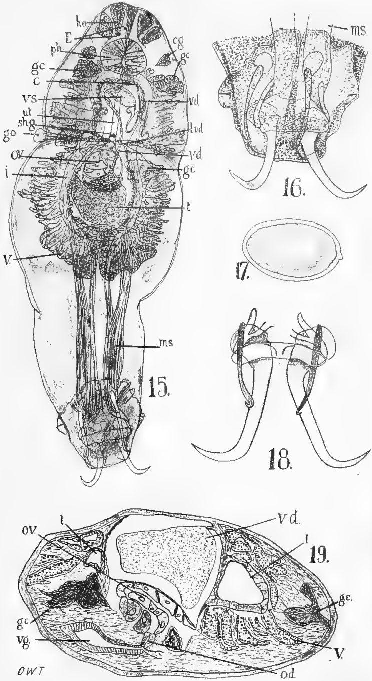

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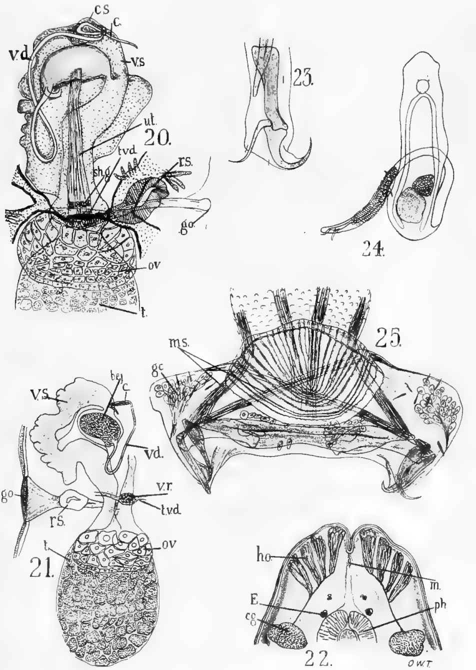

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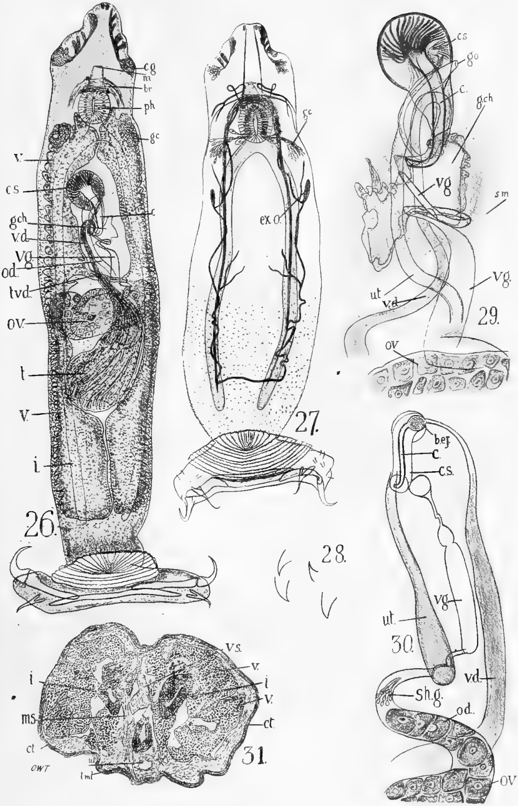

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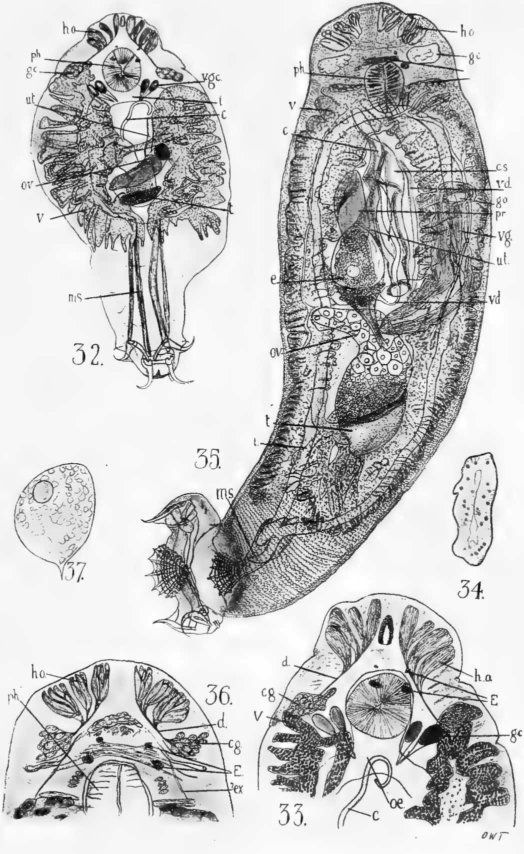

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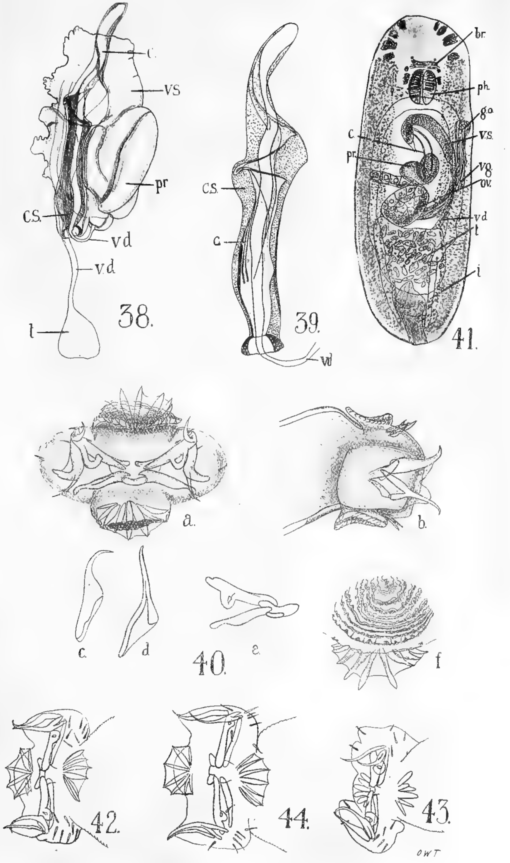

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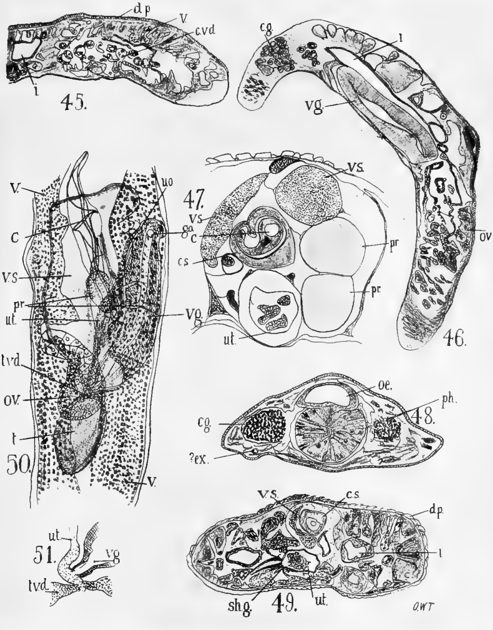

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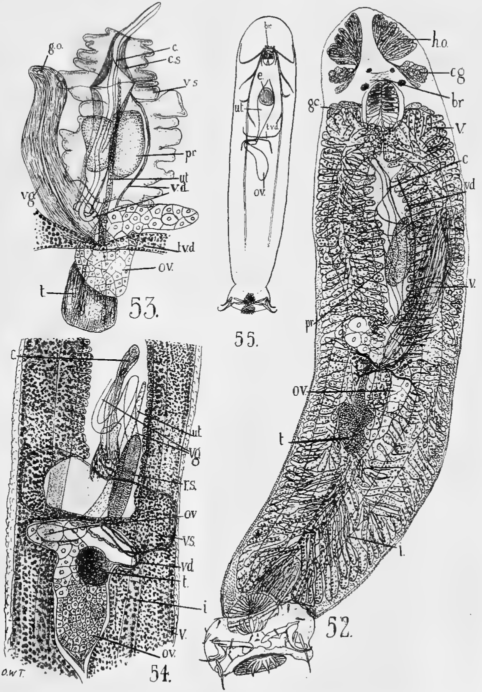

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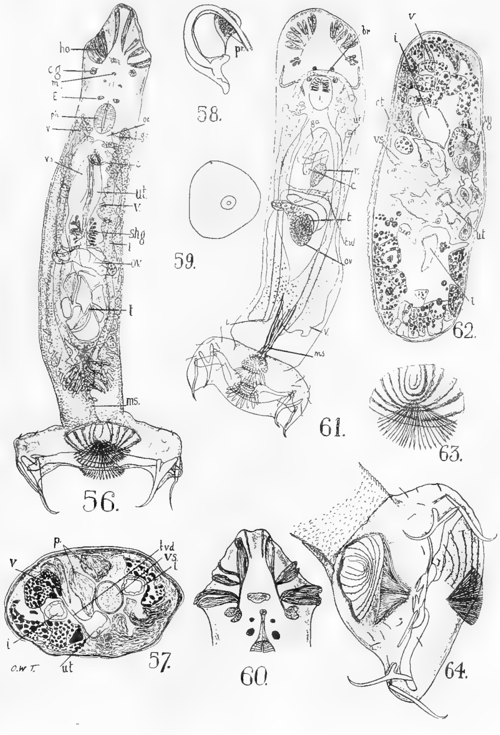

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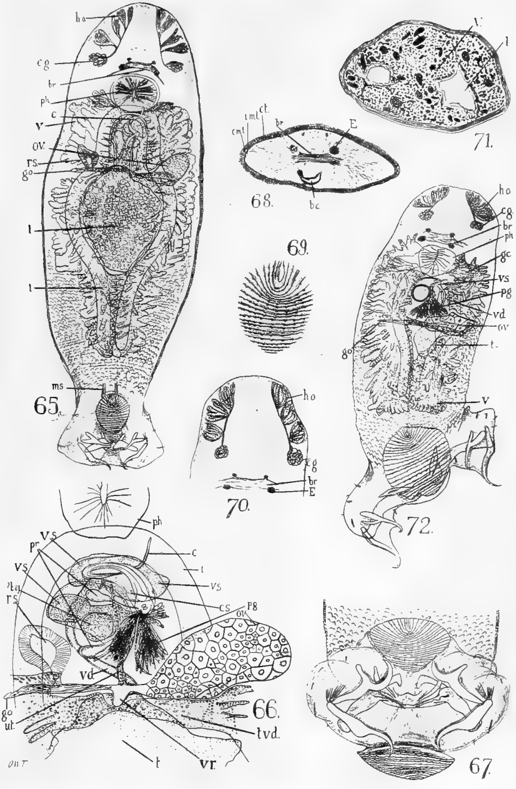

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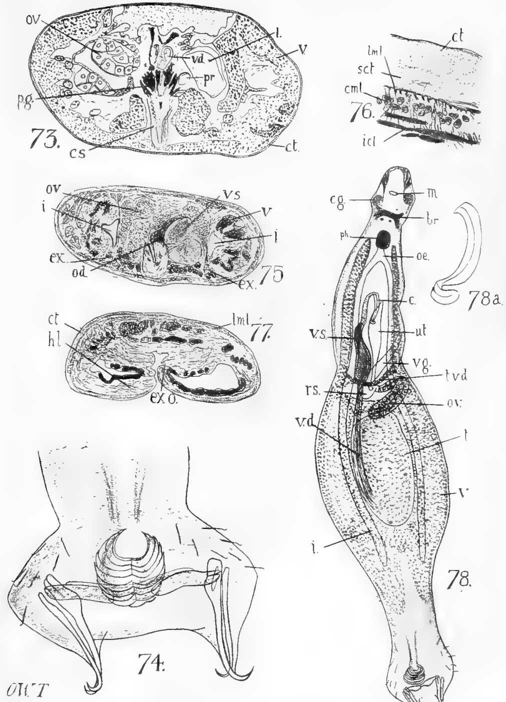

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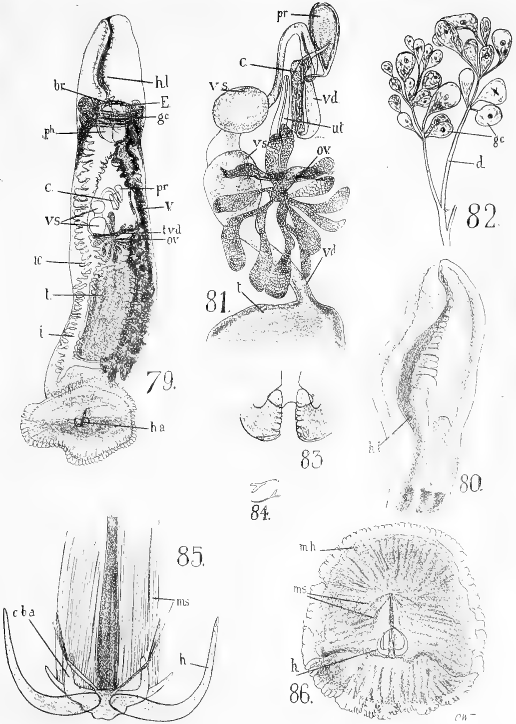


Gyrodactyloid Trematodes from Australian Fishes.

Fig. 1. *Eutermes vernoni*, n.sp. Termitarium.

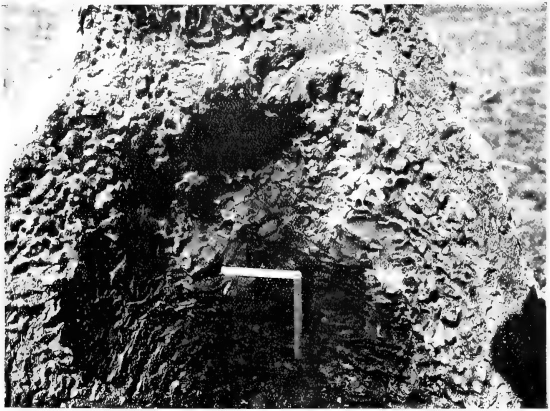


Fig. 2. *Eutermes vernoni*, n.sp. Termitarium.

Fig. 1. Termitaria of *Eutermes vernoni*, *Hamitermes wilsoni* and *Drepanotermes silvestrii.*

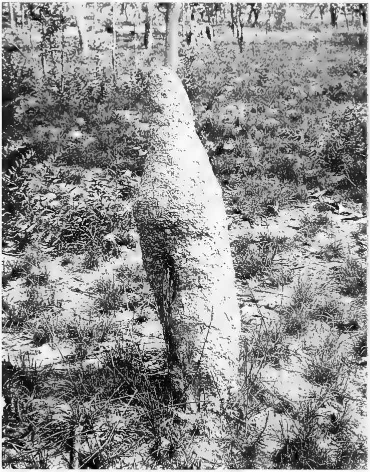
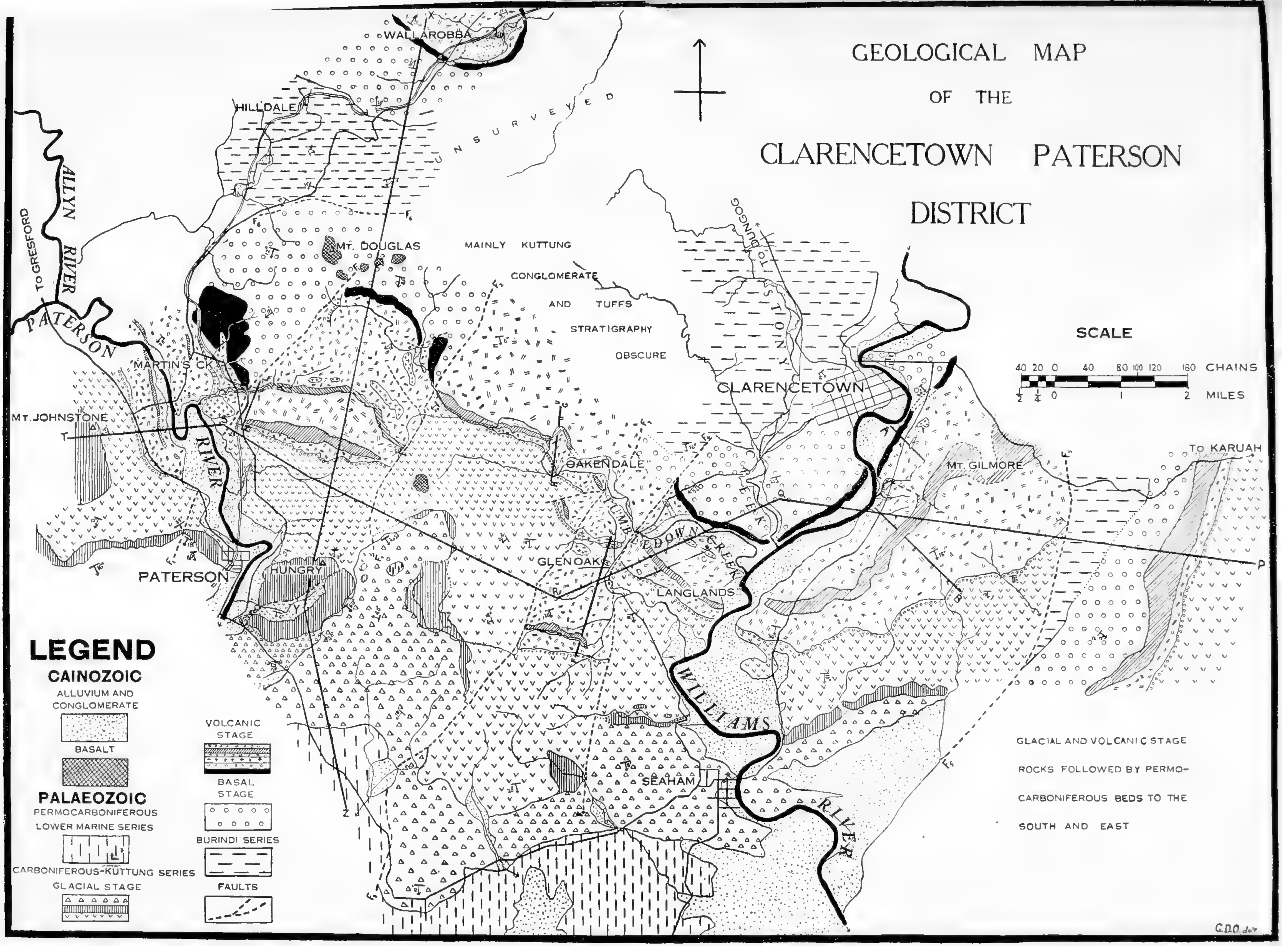


Fig. 2. Termitarium of *Eutermes longipennis* built over stump.

Fig.1. *Hamitermes germanus.* Fore and hind wings.
Fig.2. *Coptotermes acinaciformis.* Termitarium.

Fig.1. *Coptotermes acinaciformis.* Interior of Termitarium.



GEOLOGICAL MAP
OF THE
CLARENCETOWN PATERSON
DISTRICT
SCALE
40 20 0 40 80 100 120 160 CHAINS
½ ¼ 0 1 2 MILES
WALLAROBBA
HILLDALE
UNSURVEYED
ALLYN RIVER
To GRESFORD
PATERSON
MT. DOUGLAS
MAINLY KUTTUNG
CONGLOMERATE
AND TUFFS
STRATIGRAPHY
OBSCURE
TO DUNGOG
STONY CREEK
CLARENCETOWN
MARTIN'S CK.
MT. JOHNSTONE
RIVER
OAKENDALE
MT. GILMORE
To KARUAH
TUMBLEDOWN CREEK
GLENOAK
PATERSON
HUNGRY
LANGLANDS
WILLIAMS
SEAHAM
RIVER
GLACIAL AND VOLCANIC STAGE
ROCKS FOLLOWED BY PERMO-
CARBONIFEROUS BEDS TO THE
SOUTH AND EAST
LEGEND
CAINOZOIC
ALLUVIUM AND
CONGLOMERATE
BASALT
PALAEOZOIC
PERMOCARBONIFEROUS
LOWER MARINE SERIES
CARBONIFEROUS-KUTTUNG SERIES
GLACIAL STAGE
VOLCANIC
STAGE
BASAL
STAGE
BURINDI SERIES
FAULTS
G.D.O. del.

THE *LORANTHACEAE* OF AUSTRALIA. Part ii.

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

(Plates xxvii.-xxxii.)

[Read 28th June, 1922.]

Series **SANTALES** Lindl.

Subser. **Loranthineae.**

(Engler, in Engl. et Prantl, Pflzfam., Nachtr., iii., 1897, 346.)

Family LORANTHACEAE D.Don.

Flowers regular hermaphrodite or unisexual. Calyx usually gamopetalous, sometimes wanting, when present the limb entire or toothed. Bracts usually one under each flower, free or fused to the pedicel, sometimes calyculate. Petals 2 to 6, valvate in bud, free or united into a lobed corolla inserted on the summit of the ovary. Stamens as many as petals, opposite to and inserted on them or in the centre of the flower; anthers sessile, versatile, or adnate, 2-celled, opening by pores or longitudinally. Disc usually present though not conspicuous, annular, or somewhat pentagonal. Ovary inferior, 1-celled, with 1 erect or semi-erect ovule. Style simple; stigma small, awl-shaped, or more frequently sub-capitate. Fruit baccate or tripterous, crowned by the small disc and the persistent calyx lobes or petals, one-seeded, the seed adherent to the pulp of the pericarp, and surrounded by viscin, endosperm albuminous. Embryo clavate or cylindrical, the radicle superior, cotyledons 2-5, often remaining within the endosperm when germination takes place. Shrubs or trees with brittle, jointed branches, parasitic on the branches and roots of other plants. Leaves simple entire, with "stone cells all through the mesophyll; these are often star-shaped with long slender arms," * opposite or alternate, usually thick and coriaceous, tri- or quinque-nerved, or penninerved, sometimes reduced to minute scales or wanting, when absent the branches markedly compressed and viridulus. Stipules when present, small and persistent. Inflorescence cymose, racemose, capitate or fascicled; flowers conspicuous or minute, highly coloured or pale green.

"The only internal *secretory organs* found in this Order are mucilage-canals, which occur in *Nuytsia floribunda* R.Br. They appear in the pith and in the later stages in the bast; the pith contains a central mucilage-canal, and others

* A. G. Hamilton in Brit. Ass. Adv. of Sci., N.S.W. Handb. 1914, 402.

which are peripheral, and situated opposite the largest vascular bundles. The peripheral canals pass into the midrib of the leaf with the vascular bundles, retaining their position on the upper side of the latter; they do not appear to undergo any further branching; but become considerably swollen at certain points. The mucilage-canals of *Nuytsia* are provided with an epithelium of several layers, but are nevertheless of lysigenous origin; in the leaf the middle lamellae of the gelatinized cells, which form the canal, can still be clearly recognised." †

KEY TO THE SUBFAMILIES AND TRIBES.

(A). Receptacle with "Calyculus," or a calyx-like outgrowth surrounding the base of the perianth. Perianth double. Flowers bisexual. Filaments conspicuous; anthers adnate or versatile, two-celled, the cells opening longitudinally. Fruit with a central layer of viscin surrounding the endosperm. .. .. Subfam. I. LORANTHOIDEAE.

Stems with mucilage canals in the pith, and in the latter stages in the bast. Calyculus rudimentary. Fruit dry, tripterous; endosperm soft, albuminous. Viscin layer thin. Terrestrial root-parasitic shrubs or trees .. .. 1. NUYTSIEAE

Stems without mucilage canals. Bast only outside of the wood. Calyculus more or less developed. Fruit berry-like or like a stone-fruit. 2. LORANTHEAE.

Ovary one or more celled (one-celled in all the Australian genera); embryo sac only on fertilization pressing right up to the base of the style. Fruit drupaceous. Endosperm horny, deeply cleft. Viscin scanty. Terrestrial ? non-root-parasitic shrubs. .. .. 2a. GAIADENDRINAE.

Perfect ovary one-celled; embryo sac pressing up towards the base of the style. Endosperm soft, albuminous, smooth, or with faint longitudinal depressions. Viscin copious. Semi-parasitic shrubs. .. .. 2b. LORANTHINAE.

(B). Receptacle without "Calyculus," or a calyx-like outgrowth surrounding the base of the perianth, or the perianth single. Flowers always unisexual. Anthers sessile or nearly so, with three or numerous pollen-bearing chambers, dehiscent by pores. Fruit with a sticky central layer. Seeds compressed in all the Australian species. .. .. Subfam. II. VISCOIDEAE.

Placenta central. Anthers imperfectly 2-celled or dehiscent by a terminal orifice. Perianth 3-merous. .. .. 1. KORTHALSELLINEAE.

Placenta basal. Anthers adnate to the petals, many chambered, dehiscent by pores. Perianth 2—4-merous. .. .. 2a. VISCEAE.

I. 1. Loranthoideae-Nuytsieae.

Engler in Engl. et Prantl, Pflanzenfam., iii., i., 1889, 177, et Nachtr., iii., 1897, 124.—*Euloranthеae* Benth., in Bth. et Hook. f., Gen. Pl., iii., 1880, 205.

Calyculus rudimentary, shortly triquetrous. Fruit tripterous. Ovary 1-celled. Cotyledons 2-4. Endocarp soft, not furrowed. Xylem with bands of soft bast, traversed by concentric layers of thin-walled tissue, which consists chiefly of parenchymatous cells and includes mucilage-canals, also small groups of soft bast.

1. Nuytsia R.Br.

Journ. Geogr. Soc., i., 1831, 17; Benth., B.Fl., iii., 1866, 387.

Flowers bisexual. Perianth double. Calyx shortly winged, the tube adnate to the ovary; the limb short, irregularly 6-toothed. Petals 6, linear, free, erect or spreading. Stamens as many as petals, inserted on the lower half of the

† Solereder, Systematic Anatomy of the Dicotyledons, ii., 1908, p. 728.

petals; filaments slender, compressed. Anthers ovate-oblong, versatile with parallel cells, opening longitudinally. Ovary inferior, 1-celled. Style elongated subulate; stigma small, scarcely perceptible. Fruit a dry, scarious, tripterous, one-seeded nut ½ to ¾ inch long, and about as broad; seeds trigonous. Embryo clavate, surrounded by copious albumen, with 1 to 4, usually 3, unequal cotyledons. Terrestrial, root-parasitic, glabrous shrubs or trees; leaves alternate, opposite or in irregular whorls, linear, acute or obtuse, thick, one-nerved. Inflorescence racemose, terminal. Flowers orange-yellow, sessile, ternately arranged on the semifoliaceous, ternate, bracteate pedicels. The genus is limited to a single species endemic in Western Australia, and is named in honour of Peter Nuyts, a celebrated Dutch navigator, who discovered that part of Western Australia formerly known as Nuytsland.

NUYTSIA FLORIBUNDA R.Br. (Plate xxvii.)

(Syn. *Loranthus floribundus* Labill.)

Journ. Geog. Soc., i., 1831, 17; Bot. Works., i., 1832, 308; Benth., B.Fl., iii., 389.

Medium-sized trees or shrubs, growing singly or in clumps, 20-40 feet high, 1-3 feet in diameter; timber pale, soft and spongy; branches thick; bark dark grey or lead-coloured. Leaves dark green, sometimes glaucous, opposite, alternate or in irregular whorls of 3, narrow linear, acute or obtuse, narrow-oblong, shortly petiolate or sessile, 1-3 inches long, thick, nerveless, or with a central nerve, and numerous fine longitudinal wrinkles when dry. Inflorescence terminal, racemose, from a few inches to more than 1 foot long; pedicels angular or semi-terete, 10 to 15 mm. long, with 3, rarely 4 broad lanceolate or cordate foliaceous bracts, 3-7 mm. long (when in flower), supporting 3, sometimes 4 flowers. Flowers orange-yellow, sessile, with a small deciduous bracteole under each flower in addition to the three outer bracts. The central bract narrow, considerably longer than the lateral ones, all of which enlarge under the fruit to a length of 30 mm. and are markedly like those of *Loranthus grandibracteus* F. v. M. Not only do they enlarge, but they are of nearly equal length, with a conspicuous nerve down the centre. Buds cylindrical or slightly clavate, about 15 mm. long: the central one often larger than the others, usually developing first. Calyx triquetrous, 3-4 mm. long when the flower expands, the limb conspicuous, tridentate or irregularly toothed, enlarging with the fruit. Petals 6, cleft to the base into narrow linear segments. Filaments attached to the lower half of the petals. Anthers versatile, oblong, emarginate, 2 mm. long. Style straight, angular or slightly compressed, on a rather broad base; stigma small, acute. Fruit light to dark brown, broadly 3-winged, 20-30 mm. broad, and nearly as long, somewhat like fruits of *Dodonaea viscosa* or *D. triquetra*. Seeds trigonous, surrounded by a thin coating of viscin as in *Phrygilanthus* or *Loranthus*, 5-8 mm. long, 3-5 mm. broad. Endosperm albuminous, with a nutty flavour. Cotyledons 2-5, linear, subterete, acicular, unequal.

Mr. J. J. Fletcher (These Proceedings, xxxiii., 1908, 881) contends "that three is evidently the dominant number of cotyledons in *Nuytsia*." He also draws attention to the close relationship of this plant to *Persoonia* in its polycotyledonary characters, and illustrates his points with a number of interesting photographs. J. Drummond (Hooker's Jour. Bot., ii., 1840, 346), says the seeds resemble "Rhubarb" and that they vegetate with several cotyledons like the Pine.

As far back as 1841 M.H. (J.C.) Bidwill (Ann. Mag. Nat. Hist., viii., 1842, 438) draws attention to a plant of *Nuytsia* which flowered every year in the Government Botanic Gardens, Sydney, and at the same time pointed out that the seeds germinated with 3 awl-shaped cotyledons. The same plant was also referred to by Allan Cunningham (*op. cit.,* 439) as being "on the verge of a splendid flowering. It was brought from Western Australia by Baxter." Mr. J. H. Maiden informed me that he remembered the plant. It died in 1883.

Twenty years later the following reference to this plant appeared (N.S.W. Hort. Mag., iv., 1867, 23): "We believe it is somewhat over twenty years since the plant was first introduced to the colony, and various attempts have been made to propagate it, but without success; so that should the plant cease to exist, it will be a hopeless case to replace it." There is also a litho sketch by R. D. Fitzgerald.

Although the foliaceous floral bracts enclose 3 flowers, I have not seen them enclosing more than one ripe fruit. As the central flower appears to develop first, it is probably the fruit bearer, and the lateral ones are perhaps sterile. Whether this is so, I am not prepared to say without further field observations, or a supply of fruit in various stages of development. It is a matter which local botanists could look into with interest.

Mr. W. V. Fitzgerald (Mueller's Botanical Society, *l.c.*) supplies the following notes on its habit and reproduction: "Wood pale coloured, very soft and spongy, and of no commercial value. It exudes a white or pale-coloured gum, which in the fresh state is very adhesive. This remarkable and highly ornamental plant does not seem partial to any particular kind of soil, nor does it extend inland far distant from the coast. The flowers are produced during December, attaining their greatest perfection about the end of that month, hence the origin of the vernacular name of "Christmas Tree."

"According to Dr. Preiss, who collected specimens near Perth in 1838, it was termed by the colonists "Cabbage-tree." The radical portion of the stem thickens considerably immediately below the surface of the ground and often throws up white scaly shoots which, gradually ascending to the surface, develop into new plants. The roots are few, very watery and spongy. The species is reputed difficult of reproduction, but I have seen numerous seeds that have germinated after they had fallen on the surface of the ground and then perished, evidently from the effects of the direct rays of the sun; therefore it is apparent that the reproduction of the species from properly opened seed should not be attended with any great difficulty. Reproduction by means of the stolonlike shoots should be attended with reasonable success."

According to James Britten (Jour. Bot., xlvii., 1909, p. 143) *Nuytsia floribunda* is figured by Ferdinand Bauer in his drawings of Australian plants. Bauer collaborated with Robert Brown, and it is quite feasible that Bauer's detailed drawing of *Nuytsia* influenced Brown in segregating *Nuytsia* from *Loranthus.*

The anatomy of *Nuytsia,* also of *Loranthus* and *Viscum,* is dealt with by Solereder ("Systematic Anatomy of Dicotyledons," ii., 726-30, also Addenda, p. 1046). He also refers in his bibliography to Van Tieghem's contribution on the same subject (Bull. Soc. bot. de France, 1873, pp. 317-28).

O. H. Sargent (Annals Botany, xxxii., 1918, 216) contributes an interesting note on the fertilization of *Nuytsia,* and is inclined strongly to the opinion that birds are the "official" pollinators.

Range.—The *Nuytsia* appears to be confined to a limited coastal area in Western Australia. It extends from Bow River in the south, to the Murchison

River in the north. The following are the definite localities. Bow River ("Grows in damp places. Trees up to 30 ft. high and 2 ft. in diameter. Branches brittle and snap like carrots." S. W. Jackson, No. 997, Dec., 1912); Esperance Bay (Diels and Pritzel, Bot. Jahrb., 35, 1905, p. 175); Murray District (E. Pritzel, No. 139, Dec., 1901; in Bot. Jahrb., *l.c.*); Cannington (R. Helms, No. 996, 29-1-1899); Canning Plains (W. V. Fitzgerald, No. 1002, Jan., 1903); King George Sound (Robert Brown. Quoted by Bentham, B.Fl., iii., 389; B. T. Goodby, No. 312, Dec., 1901); Swan River (Drummond, 1st coll. Quoted by Bentham. Freiss, n. 1608 and others also quoted by Bentham); Perth (J. Sheath, No. 1001, Dec., 1910; Dr. J. B. Cleland; also photographs in the National Herbarium, Sydney, showing single-stemmed and Mallee-like plants, No. 999; Miss Moore, No. 1000); Wooroloo (Max Koch, No. 1902, Dec., 1907); Coolgardie (L. Webster, No. 998, 1898); Murchison River (Oldfield, quoted by Bentham, *l.c.*).

Economic Uses.

Nuytsia often exudes a quantity of transparent gum which hardens on exposure to the air, and which is said to make a good adhesive mucilage (*vide* Maiden, Useful Native Plants of Australia, 219; also Fitzgerald, Muell. Bot. Soc., *l.c.*).

Host Plants.

Mr. D. A. Herbert has recently (Journ. Proc. Roy. Soc. W.A., v., 1918-19, 72), contributed an important paper on the structure, parasitism, etc., of this plant, in which the following host plants are given, which I have arranged in botanical sequence.

Gramineae: *Cynodon dactylon* Rich. Proteaceae: *Banksia attenuata* R.Br., *B. Menziesii* R.Br., *Stirlingia latifolia* Steud. Polygonaceae: *Rumex acetosella* L. Rosaceae: *Rosa* sp. Leguminosae: *Acacia pulchella* R.Br., *Jacksonia furcellata* DC., *Cytisus proliferus* L. var. *alba* (Tree Lucerne), *Vicia Faba* L. (Broad Bean). Geraniaceae: *Geranium* sp. Rutaceae: *Citrus* sp. Vitaceae: *Vitis* sp. Dilleniaceae: *Hibbertia hypercoides* Benth. Myrtaceae: *Melaleuca Hugelii* Endl., *M. viminea* Lindl., *Calythrix flavescens* A. Cunn. Umbelliferae: *Daucus Carota* L. (Carrot). Epacridaceae: *Conostephium pendulum* Deless. Solanaceae: *Solanum* sp.

I. 2a. LORANTHOIDEAE-LORANTHEAE-GAIADENDRINAE.

Engl., *l.c.*, Nachtr., p. 125.—*Gaiadendrees*, van Tiegh., Bull. Soc. bot. France, xliii., 1896, 455.

Calyculus distinct. Ovary one- or more celled. Embryo clavate; cotyledons 2. Endosperm stone-like, deeply cleft.

2. GAIADENDRON G. Don.

Gen. Hist., iii., 1834, 431; Engler et Prantl, Pflanzenfam., iii., 177, and Nachtr., iii., 1897, 125; Benth. and Hook. f., Gen. Pl., iii., 212.—(*Gaiodendron*) *Gaidendron*, Endl., Gen., 1839, 801.—*Gaidendron*, Endl., Euchir, 1841, 399.

Calyx 6-8 toothed. Petals 6-8, narrow, free. Stamens 6-8, inserted on the petals. Style angular, subulate; stigma simple. Ovarium oblong-cylindrical. Fruit a drupe, endocarp hard, with 8 longitudinal ribs protruding into as many deep furrows of the seed. Terrestrial shrubs with opposite, lanceolate leaves, and axillary racemes of creamy white flowers.

Like *Nuytsia,* this genus is represented in Australia by one species only, but there are six representatives in Colombia and Chili, which, however, belong to a different section, *Eugaiadendron* Engler, distinguished from the Australian section, *Atkinsonia,* by the ternate disposition of the inflorescence.

Sect. ATKINSONIA (F. v. M.) Engl.

Flowers in simple racemes of 3-8 flowers.

GAIADENDRON LIGUSTRINA (A. Cunn.) Engler. (Plate xxviii.).

Engler, *l.c.*; G. Don, *l.c.*; Lindl., Swan River App., Bot. Mag., 1839, p. xxxix. (as *Nuytsia ligustrina* A. Cunn.); Veg. King., 1847, p. 791; Muell., Fragm., ii., 1860-61, 130 (as *N. ligustrina*); Fragm., v., 1865-66, 34 (as *Atkinsonia ligustrina*); Benth., B. Fl., iii., 1866, 388; Mart., Fl. Braz., 1868, p. 21; Etting., Uber die Blatts. der Lor., Taf. xii., fig. 6-8 (*Nuytsia* sp.); Hook. Icon. Pl., 13, 1880-82, fig. 1319 (as *Loranthus Atkinsonae*); Benth. and Hook., Gen. Pl., iii., 1880, 212; Moore and Betche, Handb. Fl. N.S.W., 1883, 228.

Terrestrial bushy shrubs, quite glabrous, 2 to 6 feet high, usually found in barren or rocky situations. Branches angular and somewhat striate, or the older ones echinate with the remains of the petioles. Leaves opposite (not alternate as stated by Bentham), narrow to broad lanceolate, or oblong lanceolate, scarcely acute, paler underneath, the margins recurved, midrib prominent, narrowed into a short petiole, 2-5 cm. long. Racemes axillary; the rhachis angular, 3-8 flowered, 1 to 2½ cm. long, shorter than the leaves, with three minute persistent acute stipules at the base. Flowers glabrous, single, opposite, on short thick pedicels, 3 mm. long. Bracts 3, decurrent on the pedicels and rhachis, unequal, the central one usually longer and broader than the lateral ones, occasionally all equal in length, narrow-linear or linear-lanceolate, 2-3 mm. long, enlarging under the fruit. Buds clavate, 5-8 mm. long. Calyx cylindric, 3 mm. long, the broad limb conspicuous, minutely irregularly denticulate. Petals 6 to 8, usually six, free, narrow-linear, acute, 6 mm. long. Filaments attached to the lower half of the petals, and about the same length as the anthers, usually with a small gland on the bent upper portion. Anthers versatile, lanceolate, 2.5 to 3 mm. long, and about 1 mm. broad. Style terete, considerably shorter than the petals, or well enclosed in the centre of the flower; stigma somewhat compressed. Fruit a hard drupe, ovoid to oblong, changing from scarlet to dark purple or nearly black when ripe, crowned with the persistent calyx limb, 10 to 13 mm. long, 8 mm. in diameter; epicarp very thin, coated with a thin layer of viscin; endosperm albuminous, deeply furrowed nearly to the centre into 7 or 8 divisions. Embryo oblique, suspended by a capillary suspensor, 1 mm. long, the suspensor slightly longer; embryonic cotyledons two, acute, unequal.

Synonyms.—*Nuytsia ligustrina* A. Cunn., *Loranthus epigaeus* F. v. M. (Coll.), *Loranthus Atkinsonae* Benth. and Hook., *Atkinsonia ligustrina* (F. v. M.) Benth.

Remarks.—The seeds of *Loranthus Exocarpi* Behr., show affinity to the fruits of *Gaiadendron ligustrina* in the somewhat deeply furrowed endosperm.

The leaves figured by Ettingshausen (Uber die Blatts. der Lor., *l.c.*) under *Nuytsia* sp. are without doubt *Gaiadendron ligustrina.*

Range.—This plant is so far confined to a small area on the Blue Mountains, as the following localities will show, but it is less common now than formerly owing to the rapidly increasing population.

Mueller (Report Burdekin Expedition, p. 12) mentions that it is "said to be found also on the north-western tributaries of the Darling." I have been unable to confirm this statement.

Springwood (H. Deane), Woodford (J. H. Maiden), Linden (J. H. Maiden and R. H. Cambage. Mr. Maiden informed me that he had often seen this plant in open forest), Lawson (Reader, A. A. Hamilton), Wentworth Falls (H. Deane), "On the side of the road to Mt. Wilson about 1½ miles from Bell Railway Station" (A. A. Hamilton, These Proceedings, xxxix., 1915, 409), about 100 yards west of the second danger post on the Mt. Wilson road (W. F. Blakely), Mount Wilson (J. Gregson, J. H. Maiden, A. G. Hamilton, These Proceedings, xxiv., 1889, 359), Mt. Tomah ["I was pleased also to meet at Mt. Tomah, with a plant which you probably have in your herbarium, under the name of *Loranthus,* but it is terrestrial and although I unfortunately neglected to put specimens of its flowers into spirits as I should have done, still I trust those I send will suffice to determine the question, whether or not it should form with *L. floribundus* of La Billardière the genus *Nuytsia* of Robert Brown. We brought home a growing specimen with us, which appears likely to succeed in the Botanic Gardens (Sydney)." R. Cunningham in a letter to the Editor, Botanical Magazine, Jan. 25th, 1835, *vide* Companion to Botanical Magazine, 1836, p. 218.], Mt. Tomah and Wheeny Creek (W. Woolls and L. Atkinson, quoted by Mueller in Fragm., v., 34. Probably the type locality), About 2½ miles north-east of Marrangaroo Railway Station (Flowers light to dark orange colour; the most westerly locality, Dr. E. C. Chisholm and W. F. Blakely).

There is also a specimen in the National Herbarium, collected by Dr. Leichhardt without locality.

Is Gaiadendron ligustrina *root parasitic?*

The late Mr. E. Betche investigated the supposed root parasitism of this plant, and collected a number of the roots which he preserved in alcohol. The Museum Register in the National Herbarium, Sydney, contains the following record relating to the roots, which is in Mr. Betche's handwriting: "In about 1890, I was sent by Mr. Moore to get specimens of the roots for Baron von Mueller, and to report whether it is a parasite or not. I collected the roots of (Atkinsonia) *Gaiadendron* in all sizes, the thick roots, the small fibre roots, and the saprophytic roots growing upwards into the humus."

Mr. Betche's report is not available but, judging from the record just quoted, his investigation gave a negative result. I examined these roots carefully and found the roots of a Myrtaceous plant amongst them, also the roots of another unknown plant. On making this discovery I decided to examine the plant in the field. Eventually I investigated several plants on the Mt. Wilson Road, and failed to find the slightest sign of parasitism, although the opportunity for such was very favourable. The plants were growing at the base of two trees of *Eucalyptus Sieberiana,* with which the roots of *Boronia microphylla, Eriostemon obovalis* and *Xanthosia pilosa* commingled. The soil consisted of fairly deep yellow sand with a little surface humus. The largest and apparently the oldest plant was growing between the two Eucalypts, its roots had grown across those of the Eucalypt, and some were also parallel with the roots of the latter, but no trace of parasitism was noticeable.

Young plants in the seedling stage with the endosperm attached to them were also found to be entirely dependent upon their own roots, which consisted of a deep radicle, and very fine lateral rootlets. Root hairs were abundant on the small roots. A three- or four-year-old plant was also carefully investigated and gave the same result.

The large roots, which vary from ½ to 1 inch in thickness, are markedly soft and pliable and grow to a length of 3-6 feet. When cut, the sap turns blue-black in colour; the cortex is also very thick for the size of the root. The young roots are yellowish but with age they change to a brownish pink.

There is a general belief that the plant is stoloniferous. Those investigated by me showed no sign of stolons, for they were inclined to penetrate deeply into the soil. On the other hand, the plant vegetates freely from the crown and also from the main stem three or four inches under the ground, which very largely accounts for its shrubby habit. When burnt over by bush fires it sends up a new crop of shoots from the old stem, similar to the Waratah, but on a much smaller scale.

The plant should be easily propagated from seed and also from cuttings.

I. 2b. LORANTHOIDEAE-LORANTHEAE-LORANTHINAE.

Engler in Engl. et Prantl, Pflanzenfam., Nachtr., iii., 1897, 125 and 127.

Calyculus developed, though very small. Petals free or united. Ovary 1-celled. Endosperm smooth or imperfectly canaliculate. Viscin copious. Anthers adnate or versatile.

(A). Filaments subterete, attenuated, subulate and often geniculate. Anthers versatile. .. .. 3. *Phrygilanthus*

(B). Filaments compressed, uniform, usually passing imperceptibly into the adnate anthers. .. .. 4. *Loranthus.*

Eichler (Martius, Flora Braziliensis, v., 2, 1868, p. 45-48) was the first to separate the versatile section of our *Loranthaceae* from the genus *Loranthus* and establish the genus *Phrygilanthus,* in which he included *P. celastroides, P. Bidwillii* and *P. myrtifolia,* all of which were placed under *Loranthus* by Bentham and others. Subsequently, Bentham and Hooker (Genera Plantarum, iii., 211) recognised *Phrygilanthus* as a sub-genus of *Loranthus,* and furnished a brief description accordingly.

The National Herbarium, Sydney, is indebted to Mr. James R. Weir, Forest Pathologist-in-Charge, Bureau of Plant Industry, Department of Agriculture, Washington, for the description of the genus *Phrygilanthus,* which is now produced, as not readily available.

PHRYGILANTHUS Eichler.

Fl. Brazil., v., 2, 1868, 24.—§§ *Loranthi Oscillantherae Tetramerae et Taguanae* DC., Prodr., iv., 307, 315.—*Teisterix* ex parte et *Struthanthi* species, Mart., Flora, 4, 1830, 104, 108.—*Gaiadendron, Notanthera* et ex aliis generibus species, Don, Gen. Syst., iii., 128, 431, etc.—*Loranthi* §§ 6. et 4 (ex parte), Oliv., Journ. Linn. Soc. London, vii., 98.—*Loranthi* specc. Auctt., *Epicoila* Raf., Sylva. Tellur., 1838, 126; *Taguaria,* Raf., ibid., 125.—*Loranthus,* Benth. and Hook. f., Gen. Pl., iii., 212; Engl. and Prantl, iii., i., 178, and Nachtr., 133.

Flores hermaphroditi, solemniter 6- (3 + 3-) meri, rarius 5-v. 4-nunc 7-8-meri. Calyx urceolatus v. marginiformis, integer v. dentatus. Petala libera, in corollam regularem conspirantia, alternatim apice latiora et obtusiora, angustiora et acutiora, rarius (in quibusdam 4- et 5-meris) aequalia. Stamina petalorum ratione aut aequalia aut diversa: longioribus altioribus solito more ante petala obtusa, brevioribus demissioribus ante acuta positis; Filamenta inferne petalo postposito adnata, superne libera cylindrico-filiformia, apice subulata, cum connectivo articulata; Antherae dorso plq. medio affixae, versatiles, ellipticae v. oblongae, biloculares, longitrorsum birimosae. Pollinis granula ut in *Psittacantho*. Ovarium cylindrico-subglobosum usque lineare, disco carnoso annuliformi integerrimo v. pro petalorum numero lobato tectum; Stylus cylindrico-filiformis, v. subulatus. Stigmate capitato v. punctiformi, rarius sub-bilobo. Bacca succosa, epicarpio carnoso, endocarpio plq. membranaceo, mesocarpio viscoso crasso totum semen involvente. Semen albuminosum; Endospermium aequabile (*Phr. aphyllus* et al.) aut plicis endocarpii ruminatum (*P. Tagua*), firme carnosum v. corneum; Embryo cylindricus, endospermii fere longitudine, Cauliculo plq. breviter exserto. Cotyledonibus 2 liberis semiteretibus applicativis.

Frutices super Dicotylearum ramos semiparasitici, rarius. Arbusculae terretres autotrophae. Radices solemniter nonnisi intracorticales, rarissime aereae prehensiles. Caulis Ramique plq. teretes. Folia opposita decussata, saepe metatopice disjecta, rarius per spiram 2/5 v. affinem alterna, frondosa, ruro ad squamas reducta, utrinque stomatophora. Flores solitarii v. per ternationes in racemis corymbisre terminalibus et axillaribus (in una adeo reductis, ut florem axillarem mentiantur, cf. infra n. 2); Bracteis Bracteolisque variis (cf. infra conspectum specierum), flore tamen ternationis intermedio nunquam cupula instructo, in lateralibus bracteolis secundariis constanter deficientibus. Flores inter majores, ½ poll.- spithamaei, rubri flavi v. albi. Crescunt majore numero in topicis Americae australis, regionibus praecipue montosis Columbiae, Peruviae, Chile et in Brasilia subtropica; paucae in Australia occurrunt.

The following brief description covers the Australian representatives of the genus: Flowers bisexual, ½ to 1¾ inch. long; calyx cylindric or pear-shaped, obscurely toothed or entire. Buds clavate; corolla straight or curved, on maturity readily separating to the base into 5, rarely 6 narrow-linear segments. Stamens as many as petals; filaments compressed or terete; anthers elliptic oblong, versatile; style filiform, terete or angular; stigma clavate or capitate. Fruit spherical, cylindrical or pear-shaped, 5 to 15 mm. long. Endosperm albuminous; embryo cylindric; embryonic cotyledons not withdrawn from the endosperm on germination. Primary leaves narrow lanceolate, broad spathulate to elliptical, 2, occasionally 3. Inflorescence sub-terminal, cymose or the flowers borne on very slender furcate peduncules. Flowers single or ternate, each supported by a small, navicular, persistent, pedicellate bract. Parasitic shrubs with numerous divaricate branches, and usually with conspicuous aerial roots. Leaves opposite, linear, spathulate, obovate to lanceolate-falcate. Differing from the Australian *Loranthus* mainly in the versatile anthers and terminal inflorescence.

The genus is represented by about thirty species, mainly from Brazil, Chili and Peru. New Zealand and the Philippine Islands have each one representative, while Australia has four.

Sect. MUELLERINA Engler.

Engl. and Prantl, Pflanzenfam., Nachtr., iii., 1897, 134; genus *Muellerina*, van Tiegh., Bull. Soc. bot. Fr., xlii., 1895, 25, 175.

Inflorescence cymose; flowers ternately arranged; the central flower sessile.

Leaves large.

1. Leaves narrow to broad lanceolate, often triplinerved, 5-16 cm. long. Pedicels and bracts glabrous. .. .. 1. *P. eucalyptifolius.*

1°. Leaves obovate to elliptical, penninerved. Pedicels and bracts minutely pubescent. .. .. 2. *P. celastroides.*

Sect. FURCILLA Engler.

Engler and Prantl, *l.c.*; genus *Furcilla,* van Tiegh., *l.c.,* pp. 85, 166.
Inflorescence furcate; the common peduncle bearing 2 pedicellate flowers.

Leaves small

1. Leaves cordate, very thin, almost sessile, 1-2 cm. long. .. 3. *P. myrtifolia.*

1°. Leaves linear, petiolate, 12-24 mm. long. .. .. 4. *P. Bidwillii.*

1. PHRYGILANTHUS EUCALYPTIFOLIUS (Sieb.) Engler. (Plate xxix.).

P. celastroides (Sieb.) Eichl. var. *eucalyptifolius* Engler (imp.), Nachtr., iii., 1897, 134; *L. eucalyptifolius,* Sieb. in Roem. et Schult., Syst. Veg., vii., 1829,163, *non* H.B. et K.; G. Don, Gen. Hist. Pl., iii., 1834, 431; Miq., Ned. Krudk. Arch., iv., 1856, 105; A. Gray, Bot. U.S. Exp. Exped., i., 1854, 741; F. Muell., Pl. Vic., t. 30 (fig. on right-hand side of plate); Ettingsh., Uber die Blatts. der Lor., Tab. xiii., fig. 11 to 13, Tab. xiv., fig. 2; Muell., Key Vic. Pl., part ii. (lower figure of t. 66); Muell., Rept. Burdekin Exped., 13; Kunth., Bl. Biol., iii., i., 255, fig. 45; Engler and Prantl, Pflanzenfam., iii., 179 (as *P. celastroides* (Sieb.) Eichl.); Ewart, Weeds Poi. Pl. Vic., 28 (Fig. on right hand side of plate).

I have not seen Sieber's original description but presume that of De Candolle is a reproduction, which, translated by Don, is as follows: "Glabrous; branches terete, dichotomous; leaves opposite, petiolate, lanceolate-linear, acutish, thick-coriaceous, almost veinless. *L. eucalyptifolius* Sieb. *Fl. Nov. Holl.* No. 242, but not of Kunth. Leaves 3-4 inches long and 6-7 lines broad. Petioles 6 lines long. Flowers and fruit unknown."

Asa Gray (Bot. Amer. Exp. Exped., *l.c.*) refers to this species in the following words: "Of this species as of *L. eucalyptoides* neither the flowers nor the fruits were known. They occur in our specimens, and are almost exactly like those of *L. celastroides.* Moreover some of the leaves, instead of being elongated-lanceolate and somewhat falcate, are elongated oblong, very obtuse and less than 2 inches in length; arising the question whether it may not be an extraordinary form of the foregoing species, *L. celastroides.*"

I, however, maintain it is a valid species and give the following evidence in support of that view. The original description is very imperfect, and I therefore proceed to describe it more fully: Strictly glabrous plants (even the inflorescence and young parts); union supported by numerous adventitious roots, frequently exceeding the branches by several feet; branches pendulous, smooth, terete except for a slight compression at the nodes of the young branches; lenticular, with linear, transverse, often red-brown lenticles, 1-10 feet long, sometimes forming dense masses, but as a rule hang in graceful showers (depauperate plants with short, matted, semi-erect branches); internodes 2-10 cm. long. Leaves opposite, thick, coriaceous, 5-20 cm. long, 1-3 cm. broad, somewhat shining when green, dull when dry, usually broad linear to narrow lanceolate, acuminate or falcate, occasionally long-spathulate, tapering at the base into a terete curved petiole, $\frac{1}{2}$-$1\frac{3}{4}$ cm. long (abbreviated forms often oblong obtuse to broad lanceolate); venation scantily penninerved or obscurely triplinerved at a distance from the base, the intermediate nerves rarely reaching the apex. In the narrow-leaved forms the midrib is alone conspicuous. Sometimes the veins are short and scarcely parallel, and are more numerous on one side of the midrib than the other, but they are always at a much higher angle, and less reticulate than those of *P. celastroides*. Inflorescence a terminal shortly branched cyme, 1-4 ins. long, bearing 12-24 bracteate flowers. Flowers in triads, the central ones sessile, maturing first, usually larger and longer than the lateral ones; bracts glabrous, small, concave, ovate-elliptic, spreading when dry; calyx subcylindric, curved at the base like the bowl of a pipe; the slender 4-7 mm. pedicel acting as the stem (the curvature of the calyx is erratic, and often causes the flowers to turn in various directions); limb truncate, rarely toothed, paler than the base, the whole 5-7 mm. long; buds often abruptly curved at the base and again at the top, the apex acute, ventricose in the lower portion and in the vicinity of the anthers, 4-$6\frac{1}{2}$ cm. long, marked by the unequal insertion of the filaments, slightly striate by the lines of demarcation of the perianth segments. Petals usually 5, occasionally 6 in the central flowers, or in luxuriant forms, free, linear-lanceolate, acute, reddish inside to the base of the filaments, yellowish-green, or occasionally shaded rose on the outside, deflexed or somewhat oblique, the two lowest cleft at least 5 mm. below the three upper ones, all minutely crenulate on the somewhat thickened inner margins at the base, but more conspicuous on the two lower petals, the top sometimes with a minute gland-like appendage inside above the filaments and a short distance from the extreme point. Filaments unequal in length, those attached to the upper petals longer than the others by 2-3 mm., and geniculate a short distance below the anthers, the longest with two rudimentary glands, the shorter ones with a single gland on the bent upper portion. Anthers versatile, oblong, 2-3 mm. long, about 1 mm. broad, minutely emarginate at both ends. Style pentagonal, usually green throughout, exceeding the anthers by about 3 mm., the upper portion geniculate or sometimes minutely flexuose, dotted with 4-8 minute glands; stigma minutely capitate or scarcely enlarged, reddish. Disc pentagonal, but not acutely so, pitted on the inside with five depressions or scars of the segments, and with a central pit or the remains of the style. Fruit usually curved, cylindric or pear-shaped, 10-15 mm. long, light green with a pale yellow top, opening semi-apically. Epicarp thick, coriaceous; viscin sac 7-12 mm. long, the spongy base globose; seeds turbinate with slightly raised angles at the top, surrounded by copious viscin, about 5 mm. long. Endosperm white; embryo elongated, terete, about 3 mm. long, green; the embryonic cotyledons narrow oblong, remaining in the endosperm when germination takes place; hypocotyl very short, scarcely 1 mm. long. On germination the hypocotyl, with the disc, resembles that of *Notothixos subaureus* Oliv. but, unlike the latter, it does not grow out from the seed in quest of a suitable spot for attachment, but turns abruptly under the seed or endosperm, and attaches itself to the host, as it were from the shelter of the seed which is thickly coated with very tenacious viscin, which hardens or liquefies according to the progress of the hypocotyl. Primary leaves narrow spathulate to lanceolate, developing to a length of 10 mm.

The seeds germinate very rapidly in favourable weather, on any object on which they chance to fall. An investigation showed that beneath a large fruiting plant of this species, the free germination of the seed was observed upon many objects, such as rocks, bones, blades of grass, leaves and gum of *Xanthorrhoea* *hastilis,* and on dead wood and leaves lying on the ground. Although germination takes place, the young seedlings do not adapt themselves to all their hosts; in fact, none survived on the objects mentioned above, which demonstrates clearly that more favourable conditions are necessary for the reproduction of the species and if these are forthcoming, the rapid spread of the plant is inevitable.

Much confusion has resulted in placing (*L.*) *P. eucalyptifolius* (Sieb.) as a synonym of (*L.*) *P. celastroides* (Sieb.) by Bentham (B.Fl., *l.c.*). To those familiar with the two plants, Bentham's decision, which no doubt was influenced by those of Mueller and Gray, has long been regarded as unsatisfactory. Mueller (Report Burdekin Expedition, 13) definitely states that "*L. eucalyptioides* DC. is, as suspected by Professor Asa Gray, referable to *L. celastroides*," and he afterwards figured both species (Plants of Victoria, i., Plate 30) as *Loranthus eucalyptioides* DC. The figure on the right hand side of Plate 30 is *P. eucalyptifolius* (Sieb.); that on the left is *P. celastroides* (Sieb.) Eichl. A glance at the plate will at once disclose the difference in the shape and venation of the leaves of these two species. The leaves of *P. eucalyptifolius* have the appearance of being uninerved or nerveless, and are considerably longer than those of *P. celastroides* which are short and broad, shortly petiolate and penninerved. In Mueller's "Key, Plants of Victoria," the species are again mixed; the lower figure of Tab. 66, is *P. eucalyptifolius* and the upper figure is *P. celastroides.*

A flowering branch of *P. eucalyptifolius* with a pair of depauperate leaves appears in Kunth (Bluten Biologie, viii., i., Fig. 45, 255) as *P. celastroides,* which is said to have been reproduced from Engler et Prantl, Pflanzenfam.; apparently Engler has followed Mueller in his "Plants of Victoria." The leaves figured by Ettingshausen (Uber die Blattskelette der Loranthaceen, Tab. xiii., Figs. 11-13) are all deformed, and therefore, the venation is abnormal. In the case of imperfect or irregularly shaped leaves, the venation is rarely the same as in well developed or proportioned leaves. A rupture to the median nerve in its initial stages will greatly change its natural contour and, by the time the leaf reaches maturity, its effect is apparent throughout the whole system of venation.

Deformity in the leaves of the *Loranthaceae* is very common, and most species readily lend themselves to insectival disfiguration, and also to ecological conditions and, because of these characteristic anomalies, it is not difficult to match the diagrams already quoted with specimens that are almost fac-simile. On Tab. xix., Fig. 2 (Ettingshausen, *l.c.*) a more perfect leaf is depicted, which is distinctly triplinerved.

P. eucalyptifolius is more polymorphous than *P. celastroides,* apparently the result of environment rather than racial distinction. Many plants of this species are very frequently found with large thick oblong to obovate leaves, of which some are strongly veined and are suggestive of *P. celastroides,* but when closely examined the venation and texture are entirely different from those of *P. celastroides.* It is not uncommon to see two different kinds of leaves on the same plant; they are very often due to old and young plants growing together, or sometimes the result of seasonal growth.

Those who are familiar with the versatile section of our *Loranthaceae* will admit there is a great similarity in the flowers, and it is specially so with *Phrygilanthus eucalyptifolius* and *P. celastroides.* In the case of these two species, the venation of the leaves presents a sharp line of demarcation between them, and there are other characters of differentiation, as the following tables show.

P. celastroides.	*P. eucalyptifolius.*
Erect divaricate-branched shrubs, 1-3 feet in diameter.	Pendulous shrubs, branches 1-10 feet long, 1-4 ft. in diameter.
Leaves obovate to elliptical, penninerved, darker on the upper surface, 1-2½ inches long.	Leaves oblong to broad lanceolate, triplinerved, light green on both surfaces, 1-10 inches long.
Petioles very short, compressed.	Petioles curved, terete, ½-1½ cm. long.
Cymes 1-1½ in. long, bearing 6-18 flowers.	Cymes 1-4 ins long, bearing 12-24 flowers.
Pedicels short, minutely pubescent.	Pedicels rather long, glabrous.
Anthers elliptical, smaller than *P. eucalyptifolius.*	Anthers oblong.
Fruit 7-11 mm. long, pale pink or reddish on one side.	Fruit 8-15 mm. long, yellowish, or green with a yellow top.
First pair of leaves elliptical.	First pair of leaves lanceolate.
Rarely parasitic on the Eucalypti.	Common on the Eucalypti.
Distribution strictly coastal.	Distribution coastal, and beyond the coast range.

Synonyms:—*Loranthus eucalyptifolius* Sieb., *Loranthus eucalyptioides* DC., *Dendrophthoe eucalyptioides* (Sieb.) Ettingshausen.

Range.—This species is exceedingly common along the East coast, from Victoria to southern Queensland; in the latter State it has been collected at a few places only. No doubt, if a thorough search were made, it would be found to be nearly as common in the northern State as in New South Wales, where it is a menace not only to the native vegetation, but to the exotic flora as well, especially fruit trees.

From my own observations, and from data culled from various sources, this species has a greater range of food plants than any other. Incidentally I might mention that as regards its choice of host plants, *Eucalyptus* seems to be one of its special favourites; while *P. celastroides,* which is almost as common in the Port Jackson District, has only been found once on *Eucalyptus* by me.

Victoria: Studley Park, near Melbourne (F. M. Reader, 6-3-1885, in Melbourne Herbarium); Yarra (F. Mueller, quoted by Bentham, B.Fl., iii., 389); Austral felix, Central Victoria (Mitchell. This is probably the specimen referred to by Bentham, *l.c.* The leaves are broad spathulate to narrow lanceolate, acuminate, obscurely nerved. This and the two preceding specimens were kindly lent by Professor Ewart of Melbourne Herbarium); Hawkesdale (H. B. Williamson, No. 169); Langwarrin to Frankston (Parasitic on the following plants: *Acacia armata* R.Br., *Casuarina suberosa* Ott. and Diet., *C. stricta* Ait., *Crataegus* sp., *Eucalyptus radiata* Sieb., *E. ovata* Labill., and *E. cinerea.* On some of the plants the larvae of the Mistletoe Butterfly, *Delias harpalyce* Don, were observed, while some were pupating. *See* T. S. Hart in Vict. Nat., xxxiv., 1917, 32).

New South Wales: Bermagui, on *Eucalyptus Sieberiana* and *Acacia decurrens.* (W. Dunn); Temora, on *Eucalyptus hemiphloia*, var. *albens,* (Bishop Dwyer, No. 157 and 981. This is the most distant inland locality for this species, 296 miles from Sydney and about 200 miles from the coast. The specimen does not differ in any way from the Port Jackson types.); Nerriga (J. L. Boorman); Wollondilly and Wombeyan Caves, on *Brachychiton populneus* (E. Cheel and Dr. J. B. Cleland); Nowra, on *Eucalyptus* sp. (W. Bauerlen); Bowral, on *Eucalyptus viminalis* (R. H. Cambage, These Proceedings, xxxi., 1906, 439);

Hill Top, on *Eucalyptus haemastoma* (E. Cheel); Mt. Kembla, on *Eucalyptus longifolia* and other Eucalypts (A. G. Hamilton, These Proceedings, xxx., 1905, 490, as *L. celastroides*); Wollongong (Asa Gray, *l.c.*); Picton, on *Eucalyptus amplifolia* (Dr. E. C. Chisholm); Camden, on *Eucalyptus crebra* (Dr. E. C. Chisholm); Cabramatta to George's River, on the following hosts—*Eucalyptus sideroxylon, E. Parramattensis, E. siderophloia, E. longifolia*; with short broad lanceolate to broad spathulate, triplinerved leaves, *E. amplifolia, E. tereticornis*. Leaves broad, 3- to 5-nerved, bank of George's River. Leaves thick, broad lanceolate, almost nerveless, on *Angophora intermedia*, a short leaved form (W.F.B*., D.W.C.S. and H. Bott); Canley Vale, on *Eucalyptus siderophloia, E. hemiphloia* (same collectors); Fairfield, on *Eucalyptus tereticornis, E. amplifolia*, and *E. sideroxylon* (same collectors as preceding); Como (E. Betche); Tom Ugly's Point (J. H. Camfield); Hurstville, on *Eucalyptus* sp., *Casuarina* sp., and on *Angophora intermedia* (J. H. Camfield); on *Eucalyptus acmenioides* (W.F.B.); Carlton, on *Casuarina suberosa* (J. H. Camfield); Carr's paddock, Carlton, on the following hosts: *Eucalyptus punctata, Angophora lanceolata, Casuarina suberosa, Exocarpus cupressiformis* (W.F.B.); Botany Bay (J. H. Camfield); Sydney (B. Bynoe); Garden Palace Grounds, Sydney (J. H. Camfield); on *Platanus orientalis* (J. Murphy); Botanic Gardens, Sydney, on *Eucalyptus tereticornis*, with short broad leaves; on *Quercus bicolor*: leaves broad lanceolate, 1½ to 3 inches long, very thick; on *Quercus lusitanica, Quercus alba, Juglans cinerea, Eucalyptus viminalis, E. ficifolia, Platanus orientalis, Carya olivaeformis, Eucalyptus Watsoniana, E. ochrophloia* and *E. melanophloia*. Two examples of double parasitism, (1) showing self-parasitism and (2) parasitic on *Phrygilanthus celastroides* (W.F.B.); on *Cytisus proliferus* (J. Driver); Lady Macquarie's Chair, on *Eucalyptus resinifera* (J. H. Camfield); Neilsen Park, Vaucluse, on *Eucalyptus haemastoma*, leaves linear-lanceolate, acute, obscurely 3-nerved; also on *Casuarina suberosa*, with short broad leaves (W.F.B.); Willoughby, on *Eucalyptus Sieberiana* (D.W.C.S. and H. Bott); The Spit, on the following hosts: *Casuarina suberosa, Eucalyptus punctata, E. piperita*, Pear Tree, (W.F.B. and J.L.B.); between 7-8 mile post, Gordon-Pittwater Road, on *Eucalyptus capitellata*, and *E. eugenioides* (W.F.B. and D.W.C.S.); Meadowbank, on the following hosts: *Eucalyptus tereticornis, E. eugenioides, E. amplifolia, Angophora intermedia, Melaleuca parviflora, M. lineariifolia, Acacia decurrens* var. *mollis* (W.F.B.); Ermington Park, on *Melaleuca styphelioides, Eucalyptus crebra*, and on *E. amplifolia* (W.F.B. and D.W.C.S.); Rydalmere, on the following hosts: *Eucalyptus longifolia, E. paniculata, E. acmenioides, E. punctata, E. siderophloia*, and *E. resinifera* (W. F. Blakely and D.W.C.S.); Parramatta River, Parramatta, on *Callistemon salignus* (W.F.B. and D.W.C.S.); Homebush Road, Homebush, on *Eucalyptus longifolia* (E. Cheel); Blacktown (R. H. Lalor); Glenbrook, on *Eucalyptus notabilis* (J.L.B.); Mt. Wilson (A. G. Hamilton, These Proceedings, xxiv., 1899, 359); on *Eucalyptus viminalis* (J. Gregson); Jenolan Caves, on *Eucalyptus punctata*—The only specimen noted in the district of this species, whereas *Loranthus pendulus* is very common (W.F.B.); Rylstone and Goll River District, in fruit (R. T. Baker, These Proceedings, xxi., 1896, 452)—A distant locality for the species (W.F.B.); Mudgee district (A. G. Hamilton, These Proceedings, xii., 1887, 282)—this is also a distant locality for this coastal plant (W.F.B.); Lindfield, on the following hosts, *Eucalyptus eugenioides, E. paniculata, E. saligna, Angophora lanceolata, A. intermedia*,

* Abbreviations: W.F.B. = W. F. Blakely, D.W.C.S. = D. W. C. Shiress, J.L.B. = J. L. Boorman.

Casuarina suberosa (W.F.B.); Killara, on *Eucalyptus resinifera*,—The host is badly infested with the parasite, the young plants have narrow lanceolate leaves, the old ones broad lanceolate leaves; on *Crataegus oxycantha, Prunus Laurocerasus,* and on *Quercus pedunculata* (W.F.B. and D.W.C.S.); Gordon, near Station, on *Eucalyptus saligna,* and also on a Pear tree (W.F.B.); St. Ives, on the following hosts: *Eucalyptus paniculata, Photinia serrulata, Angophora Bakeri, A. lanceolata, A. intermedia, Acacia decurrens* var. *pauciglandulosa,* also *Loranthus vitellinus* (W.F.B., D.W.C.S. and H. Bott); Pymble, on the following hosts: *Acacia decurrens* var. *mollis, Casuarina suberosa, Angophora intermedia,* flowers 2¼ in. long, on Peach Tree, *Acacia floribunda, Eucalyptus saligna, E. paniculata, E. pilularis,* leaves broad lanceolate, triplinerved (W.F.B.); Pennant Hills, on *Schinus molle,* showing example of self-parasitism, and double parasitism with *Loranthus vitellinus,* on *Quercus pedunculata* (T. Steel); Turramurra, on *Acacia decurrens* var. *mollis, A. implexa,* and on *Eucalyptus saligna,*—On the latter host it is very often suspended from the trunk of the tree (W.F.B.); Warrawee, on *Platanus orientalis,* showing examples of double parasitism with *Phrygilanthus celastroides,* and vice versa—One of the young plants of the latter had alternate leaves, which appeared to be quite natural; on *Angophora intermedia,* Plum tree, also on a Cherry tree, and *Salix Babylonica* (W.F.B.); Normanhurst, on the following hosts: *Eucalyptus saligna, E. pilularis, E. eugenioides, E. resinifera, E. paniculata,*—The two latter are almost identical with No. 33, from Wallangarra; on *E. piperita, Casuarina torulosa, C. suberosa,* leaves linear, lanceolate; on *Angophora lanceolata,* leaves all narrow lanceolate, mostly under 2 ins. long; on *A. intermedia,* leaves broad lanceolate, 2 to 5 inches long, ½ to 1 inch broad; on *Cytisus proliferus* var. *palmensis,* in company with *Loranthus vitellinus,* an unusual host (W.F.B. and D.W.C.S.); Pennant Hills Road between Wahroonga and Normanhurst, on the following hosts: *Euonymus japonicus, Magnolia grandiflora,* showing examples of secondary parasitism, and also double parasitism with *Phrygilanthus celastroides*; on *Melia Azedarach, Photinia serrulata, Acacia implexa, Tristania conferta,* and *Erythrina indica* (W.F.B.); Wahroonga, on the following hosts: *Viburnum odoratissimum, Laurus nobilis, Acacia Baileyana*; Waitara, on *Acacia prominens, Acacia decurrens* var. *mollis,* leaves broad lanceolate to broad spathulate, the largest 3 inches by 1¾ inches, 3- to 5-nerved (W.F.B.); Hornsby, parasitic on the following hosts, *Eucalyptus eugenioides, E. piperita, E. paniculata, E. haemastoma, Casuarina suberosa,* branches 5 feet long, leaves acuminate, triplinerved; on *Angophora cordifolia,*—the host was almost dead, but the parasite was strong and healthy and measured 5 feet long, and 3 feet in diameter, with leaves 2 to 6 inches long; on *Leptospermum stellulatum, Callistemon lanceolatus,* with flowers 18 to 24 in the cyme; on *Platanus orientalis,* and *Acacia linifolia* (W.F.B.); on track to Gibberagong Creek, 3 miles east of Hornsby, on *Eucalyptus Sieberiana, E. piperita, E. haemastoma* var. *micrantha* (W.F.B.); Asquith, on the following hosts: *Eucalyptus resinifera, E. paniculata, E. eugenioides, Exocarpus cupressiformis,*—on the latter, the plant was about 18 inches long, but the adventitious roots were 7 feet long; on Peach tree, Plum tree, and on *Leptospermum attenuatum* (W.F.B.); Galston Road, near 16½ mile post, on *Eucalyptus haemastoma,* growing from the trunk of the tree, about two feet from the ground (W.F.B. and D.W.C.S.); Galston Valley, on the following hosts: *Eucalyptus eximia,* and *Angophora Bakeri* (W.F.B. and D.W.C.S.); Mt. Colah, on Pear tree and on *Angophora lanceolata* (W.F.B., D.W.C.S. and H. Bott); 2 mile post, Kuring-gai Chase Road, E. of Mt. Colah, on *Eucalyptus squamosa* (same collectors as preceding); Trig Ridge, 1 mile N.W. of Mt. Colah station, on *Eucalyptus squamosa,* with young plants parasitic on the parent plant (W.F.B. and D.W.C.S.); Bobbin Head, Kuring-gai Chase, on *Eucalyptus punctata* (W.F.B.); near Kuring-gai Station, on *Casuarina suberosa,* (D.W.C.S. and T. Steel); Berowra Creek, foot of Crosslands Track, on *Angophora lanceolata* and on *Casuarina suberosa* (W.F.B. and D.W.C.S.); Berowra, near Station, on *Eucalyptus eugenioides*; Berowra Creek, Berowra, on the following hosts: *Eucalyptus piperita, E. haemastoma, E. punctata,* leaves like the Wallangarra specimen; on *Casuarina suberosa,* with short broad leaves; on *C. torulosa,* with linear to broad lanceolate leaves; on *Angophora intermedia,* and *A. lanceolata* (W.F.B.); near Cowan Station, on *Eucalyptus eugenioides* (W.F.B. and D.W.C.S.); Cowan Creek, Cowan, on *Eucalyptus squamosa, E. haemastoma, Casuarina suberosa,* and *Eucalyptus punctata* (W.F.B., D.W.C.S., and H. Bott); Hawkesbury River, near Brooklyn, on the following hosts: *Angophora lanceolata, Eucalyptus piperita, E. punctata, E. corymbosa,* No. 26, *E. umbra, Casuarina suberosa,* and *Exocarpus cupressiformis* (W.F.B. and D.W.C.S.)—It was also parasitic on *Loranthus Miquelii* and on *L. vitellinus,* the former on *Eucalyptus citriodora* and the latter on No. 26; Gosford, on *Angophora intermedia* (W. A. W. de Beuzeville); Belmont, Lake Macquarie, on *Casuarina glauca,* No. 1061, and also parasitic on *Loranthus Exocarpi* var. (a), No. 1062 (Bishop Dwyer); Hunter River District (A. C. Barwick, These Proceedings, xxviii., 1903, 940); Wallangarra, on *Eucalyptus Bancrofti,* No. 33, leaves narrow to broad lanceolate, triplinerved, 3 to 8 inches long; also on *Eucalyptus sideroxylon* (J.L.B.).

Queensland: Main Range, Highfields (F. M. Bailey, in Queensland Herbarium)—This specimen is identical with No. 33 from Wallangarra; Bunya Mountains, No. 1 on *Acacia decurrens* var. *pauciglandulosa,* No. 2 on *Exocarpus cupressiformis,* No. 3 on *Eucalyptus* species (C. T. White, Oct., 1919). Also recorded by C. T. White (Queensland Agricultural Journal, xiii., 1920, 30) as *Loranthus eucalyptifolius* Sieb. (I take the responsibility for the nomenclature). Bay of Inlets; Thirsty Sound (Banks and Solander, 1770) mixed with specimens of *Loranthus longiflorus* (= *L. vitellinus*). Ex Herbario Musei Britannici. This locality is doubtful.

Hosts.—Juglandaceae: *Carya olivaeformis* Nutt., *Juglans cinerea* L. Betulaceae: *Quercus bicolor* Willd., *Q. pedunculata* L., *Q. alba* L., *Q. lusitanica* Lam. Casuarineae: *Casuarina suberosa* Ott. and Dietr., *C. glauca* Sieb., *C. stricta* Ait. Salicaceae: *Salix babylonica* L. Loranthaceae: *Loranthus pendulus* Sieb., *L. vitellinus* F. v. M., *L. Exocarpi* Behr. var. (a), *L. Miquelii* Lehm., *Phrygilanthus celastroides.* Santalaceae: *Exocarpus cupressiformis* Labill. Magnoliaceae: *Magnolia grandiflora* L. Lauraceae: *Laurus nobilis* L. Platanaceae: *Platanus orientalis* L. Rosaceae: *Crataegus oxycantha* L., *Prunus Lauro-cerasus* L., *Photinia serrulata* Lindl., Plum, Peach, Quince, Pear. Leguminosae: *Acacia adunca* A. Cunn., *A. armata* R. Br., *A. Baileyana* F. v. M., *A. decurrens* Willd. var. *mollis* Benth., *A. decurrens* Willd. var. *pauciglandulosa* F. v. M., *A. floribunda* Willd., *A. implexa* Benth., *A. linifolia* Willd., *A. prominens* A. Cunn., *Cytisus proliferus* L. var. *palmensis, Erythrina indica* L. Meliaceae: *Melia Azaderach* L. var. *australasica.* Celastraceae: *Euonymus japonicus* Thunb. Sterculiaceae: *Brachychiton populneus* R. Br. Myrtaceae: *Tristania conferta* R.Br., *Angophora Bakeri* Hall, *A. cordifolia* Cav., *A. lanceolata* Cav., *A. intermedia* DC., *Callistemon lanceolatus* DC., *C. viminalis* Cheel, *C. salignus* DC., *Leptospermum attenuatum* Sm., *L. flavescens* Sm., *L. stellulatum* Sm., *Eucalyptus acmenioides* Schau., *E. amplifolia* Naudin., *E. Bauerleni*

F. v. M., *E. Bancrofti* Maiden, *E. capitellata* Sm., *E. cinerea* F. v. M., *E. corymbosa* Sm., *E. crebra* F.v.M., *E. eugenioides* Sieb., *E. eximia* Schau., *E. ficifolia* F. v. M., *E. haemastoma* Sm., *E. haemastoma* Sm. var. *micrantha* Bth., *E. hemiphloia* F. v. M., *E. longifolia* Link et Otto., *E. melanophloia* F. v. M., *E. Muelleri* Naudin., *E. notabilis* Maiden, *E. ochrophloia* F. v. M., *E. ovata* Labill., *E. paniculata* Sm., *E. Parramattensis* Hall, *E. pilularis* Sm., *E. piperita* Sm., *E. punctata* DC., *E. radiata* Sieber, *E. resinifera* Sm., *E. saligna* Sm., *E. siderophloia* Benth., *E. sideroxylon* A. Cunn., *E. Sieberiana* F. v. M., *E. squamosa* Deane and Maiden, *E. tereticornis* Sm., *E. umbra* R. T. Baker, *E. viminalis* Labill., *E. Watsoniana* F.v.M. Caprifoliaceae: *Viburnum odoratissimum* L.

2. PHRYGILANTHUS CELASTROIDES (Sieb.) Eichl. (Plate xxx.).

Eichl., Fl. Bras., v., 1868, 48; Engl. and Prantl, Nat. Pflanzenfam., iii., 179; Sieb. in Roem. and Schult., Syst. Veg., vii., 1829, 163, as *Loranthus celastroides*; De Candolle, Prod. Syst. Veg., iv., 1830, 318; Bauer's drawings, Aust. Plants, 145; A. Gray, Bot. Wilkes Expl. Exped., i., 1854, 740, t. 100; F. Mueller, Pl. Vic., Fig. on left hand side of Plate 30; Benth., B. Fl., iii., 1866, 389; Mueller, Key Vic. Fl., Fig. on upper side of tab. 66, Part ii., *vide* also Part i., 1887-88, p. 273 (in part); Ewart, Weeds Vict., after p. 28, Fig. on left hand side of plate; Bailey, Qland Fl., v., 1377; Ettingshausen, Uber Die Blatts., Tab. i., Fig. 7-9.

I have not seen the original description; those of De Candolle and Dr. A. Gray, in the above works are much the same. I, however, give the latter preference, as he has gone to great pains in drawing up a very clear description. I therefore quote him in full:

"L. glaber; ramis teretibus; foliis oppositis obovato-oblongis seu ellipticis basi attenuatis breviter petiolatis obtusissimis fere aveniis; pedunculis axillaribus vel ramulos breves bifoliatos desinentibus brevibus cymulifloris; floribus breviter pedicellatis pentameris unibracteolatis; antheris ovali-oblongis dorso-fixis versatilibus.

"The specimens bear flowers, which have not before been described. The plant is *glabrous,* except an extremely minute pubescence on the peduncles and nascent parts. *Branches terete,* nodose. *Leaves opposite, obovate, oblong,* or *elliptical,* with a *narrowed base,* contracted into a very short petiole, 1½ to 2 inches long, *very obtuse,* dull, thick and fleshy-coriaceous in texture, *nearly veinless,* even the midrib inconspicuous except towards the base. *Peduncles axillary,* or more commonly *terminating short and two-leaved axillary branchlets,* 2 to 5 lines long, *cymosely several-flowered. Flowers in threes, the lateral short-pedicelled,* the intermediate one sessile, or sometimes all pedicelled,* each subtended by a small ovate bractlet, recurved, *pentamerous.* Ovary ovoid. Calyx-tube short, coroniform, truncate, puberulent on the edge, which is entire or obscurely denticulate, at length sometimes 4—5-toothed or lobed. Corolla apparently red or purple, an inch and a quarter in length, curved in bud, and the apex clavate-thickened; the slender petals connivent into a tube, but separating after anthesis. Filaments free down almost to the middle: *anthers oval,* or *short-oblong,* emarginate at both ends, *fixed by the middle, versatile.* Style filiform, as long as the stamens: stigma minute, subcapitate. Fruit not seen."

* I have not been able to confirm this statement. In the large amount of material examined by me, the central flower is always sessile.

Supplementary notes.—*P. celastroides* always forms round, compact shrubs, 1-3 feet in diameter. Branches short divaricate. Union often obscured by matted adventitious roots, causing irregular swellings on the host; sometimes the main attachment is enlarged to a diameter of 2-4 inches on very old plants; the adventitious roots are shorter than those of *P. eucalyptoides* and are more firmly attached to the host, very rarely free as in that species. Leaves mostly oblong elliptical, 1-nerved with numerous fine parallel veins at an angle of about 45 degrees, with reticulate veins between them. Cymes minutely pubescent on the pedicels and bracts, bearing 6-18 flowers, nearly all pendulous, but often crossing each other owing to the curved calyx. Buds 3-4 cm. long, sea-green underneath, shading on the upper surface from a deep rose pink, plate 120, to carmine-red, No. 1, plate 114 (Rep. de Col., Dauthenay). Petals about the same colour inside. Free portion of the filaments dark violet, No. 2-4 plate 193 (Rep. de Col.), the adnate portion carmine-red, the upper filaments the longest, with a small solitary gland on the geniculate portion close to the anthers. Anthers yellow, elliptical, 1 mm. long, opening before the flower expands, smaller than those of *P. eucalyptifolius*. Style curved in bud, exceeding the stamens when the flower opens. Stigma small, often minutely bi-lobed. Fruit usually pear-shaped, 7-11 mm. long, 4-6 mm. in diameter, very smooth and glossy, turning a strawberry red, especially on the upper surface, ripening somewhat later than *P. eucalyptifolius,* without the yellow top of that species, and usually free from any depression at the top, but marked by two slightly-raised rings surrounding the angular disc, which is also more or less conspicuous. Endocarp thick and leathery; viscin sac 5-8 mm. long, the spongy base very small and globose; seed turbinate, somewhat angular at the top, 3-4 mm. long; endosperm white, embryo clavate, 2 mm. long; embryonic cotyledons spathulate, remaining in the endosperm when germination takes place; hypocotyl very short, about 1 mm. long, disc broad. Primary leaves broadly ovate to spathulate 5 mm. long.

Synonyms.—*Loranthus celastroides* Sieber, *Loranthus maytenifolius* A. Gray (in Wilkes, Expl. Exped., p. 739, plate 99, in part), *Dendrophthoe celastroides* Mart. (*vide* Ettingshausen in Uber die Blatt. der Loranth., p. 20, Taf. ix., Figs. 7-9).

G. Don (Gen. Hist., iii., 432) places *Loranthus celastroides* Sieber, No. 244, with *Nuytsia floribunda* R. Br., probably on account of the versatile anthers.

Port Jackson, in the vicinity of Sydney, is probably the type locality of this species. It is evident that Sieber obtained his specimens close to Sydney in 1825, where it is still very common, especially along the coast. It rarely extends more than ten miles beyond the salt water limit of the tidal creeks and rivers.

This species has a decided dislike for *Eucalyptus* and *Acacia.* After a thorough search over a large area, and investigations of the specimens in the National Herbarium, I have only found one example of this species living upon a *Eucalyptus.* It is frequently found parasitic upon *P. eucalyptifolius* and vice versa, and in all cases observed, both species maintained their own individuality; I cannot find one example where these two species, *P. celastroides* and *P. eucalyptifolius,* pass into each other or show any signs of mimicry, even when living on each other.

Examples of double parasitism of these species may possibly have given rise to the idea that they were one and the same plant, as it is frequently met with in the field. For instance *P. celastroides* and *P. eucalyptifolius* gave examples of double parasitism on the Eastern Plane, *Platanus orientalis,* and also on a species of *Pyrus*,* at Warrawee, Sydney, and had confined themselves to separate branches on the same tree. Another example in the same locality was that of *Eucalyptus paniculata* Sm. acting as host for *P. eucalyptifolius*, which in turn became the host of *P. celastroides*. It is noteworthy that when these two species unite, the union in many cases is scarcely noticeable, and it is no wonder that confusion has arisen owing to the mistaken identity of these two plants, so closely related and having much in common with one another. A little study and closer observation of the habit and general appearance of both in the field will enable one to separate or distinguish them at a glance.

Its chief food-plants are *Banksia serrata*, *B. integrifolia* and *Casuarina suberosa*. In the neighbourhood of Bondi, *Nerium*, amongst the exotic genera, is a very common host, and a little further inland *Platanus orientalis* is a favourite food-plant of this species. It is a common sight to see trees of the Eastern Plane green with the parasite in winter, or in exposed situations the leaves are often a pale purple brown.

Range.—South Australia: Professor Tate (Trans. Roy. Soc. S. Aust., iii., 1879-80, 68, and also Handbook Flora Extra Tropical S.A., 1890, 106) records this species for South Australia, but I have not seen a specimen from that State. Professor Osborn, of the Adelaide University Herbarium, also informs me that it is not represented in that Herbarium.

Victoria: Snowy River (Flowers pink, E. E. Pescott, No. 175, per Chas. Walter, Feb., 1901); Mentone, on *Schinus molle* L. ("Said to be the first record in Victoria of the parasite growing on it; also that there were no Mistletoes within a radius of 2 or 3 miles, so the seed must have been carried some distance by birds," J. R. Tovey, Vict. Nat., xxxi., 154); Brighton, on British Oak, *Q. robur* L. (Miss O. B. Davis, Vict. Nat., xxvi., 177); Scorsby, on *Casuarina suberosa* and *Acacia armata* R. Br. (T. S. Hart, Vict. Nat., xxxiv., 32-33); Lake King (in Herb. Melbourne, labelled *L. eucalyptoides* DC. var., F. Mueller; quoted by Bentham, B. Fl.); Yarra (F. Mueller, B. Fl.); Grampians (D. Sullivan, Aust. Assoc. Adv. Sc., ii., 1890, 509); Greenvale (C. S. Sutton, Vict. Nat., xxxiii., 136); Barry's Hill, Wilson's Promontory (Ewart, Vict. Nat., xxvi., 131); Victorian Alps (Ewart, Vict. Nat., xxvii., 112); North West Victoria (St. Eloy D'Alton, Aust. Assoc. Adv. Sc., vii., 465).

New South Wales: Twofold Bay (B. Fl., *l.c.*); Narrawallee (R. H. Cambage, No. 3501. The flowers are in sessile clusters of three at the end of the pedicel as in *L.* No. 18 [W.F.B.]); Milton, on *Banksia integrifolia* L. (R. H. Cambage, No. 4061); Sussex Inlet Heads, on *Banksia integrifolia*, and *Eugenia Smithii* (J. H. Maiden; the leaves are small, broadly spathulate to elliptical and almost identical with the Bondi specimens [W.F.B.]); Mount Kembla, on *Psychotria loniceroides*, *Persoonia salicina*, *Elaeodendron australe*, *Comersonia Fraseri* (A. G. Hamilton, These Proceedings, xxx., 490); Wollongong (Dr. A. Gray, *l.c.*); Cronulla, on *Banksia integrifolia* (E. Cheel); Shipwright's Bay, George's River, on *Banksia integrifolia* (J. H. Camfield); Carr's paddock, Carlton, on *Banksia serrata*, and also parasitic on *Callistemon lanceolatus* (W.F.B.); Kurnell Bay (J.L.B.); Port Jackson (E. Betche); Farm Cove, Outer Domain (J. H. Camfield, Annual Report Botanic Gardens, 1902, 30); Botanic Gardens, on *Nerium Oleander* (R. Mitchell); on *Quercus alba*, *Q. Lusitanica*, and *Platanus orientalis* (W.F.B.); on *Phrygilanthus eucalyptifolius* and also parasitic on *Eucalyptus tereticornis* (A. Stanley and G. Rollinson); on *Quercus virens* (R. Mitchell); Double Bay, on *Banksia* sp. and *Robinia Pseudo-Acacia* (Dr. J. MacPherson); Bondi sand-hills, on *Banksia serrata* (Leaves rather small, spathulate, W.F.B.); Neilsen Park, Vaucluse, on *Banksia integrifolia, Casuarina suberosa, Phrygilanthus eucalyptifolius* which was parasitic on *Eucalyptus haemastoma* (W.F.B.); Lavender Bay, on Pear tree (W.F.B.); Berry's Bay, on *Robinia Pseudo-Acacia* (W.F.B.); Wollstonecraft, on *Schinus molle* (W.F.B.); Sirius Cove, on *Banksia integrifolia* (Dr. J. B. Cleland); The Spit, on *Casuarina suberosa* Ott. & Diet., also on Pear tree (W.F.B. and J.L.B.); Curl-Curl (H. Deane, Jan., 1884); on *Banksia integrifolia* (E. Ellen); the neighbouring portions of the contiguous Boroughs of Hunter's Hill, Lane Cove and Ryde, parasitic on 37 hosts, *vide* J. J. Fletcher, These Proceedings, xxx., 488-89. *P. eucalyptifolius* is also included under this species; Field of Mars (H. Deane); Lindfield, on *Casuarina suberosa* and also parasitic on *Phrygilanthus eucalyptifolius* on the same host (W.F.B.); Gordon, near Station, on Pear tree (W.F.B.); Pymble, on the following hosts, *Casuarina suberosa, Loranthus congener,* the *Loranthus* on the same host, *Casuarina torulosa* and on *Schinus molle* (W.F.B.); St. Ives, on *Acacia decurrens* var. *pauciglandulosa, Melia Azedarach, Schinus molle, Magnolia grandiflora, Casuarina suberosa, Pyrus* sp. *Phrygilanthus eucalyptifolius,* which in turn was parasitic on *Angophora intermedia.* A clump of seed of this species containing seeds of *Notothixos subaureus* was also noticed on the *Acacia* (W.F.B., D.W.C.S. and H. Bott); Pennant Hills, on *Schinus molle,*—Flowers white, shading into very pale pink (T. Steel); Normanhurst, on *Casuarina suberosa, Syncarpia laurifolia, Casuarina torulosa, Photinia serrulata, Melia Azedarach, Prunus Persica, Phrygilanthus eucalyptifolius,* the latter on *Eucalyptus saligna* (W.F.B.); near Pearce's corner, Wahroonga, on *Magnolia grandiflora* (J. Sydenham,—Six months later I visited the same plant and noticed that cattle had eaten all the lower leaves and young branches of the parasite as high as they could reach [W.F.B.]); Warrawee, on *Platanus orientalis,* No. 10, *Prunus* sp., No. 197, also parasitic on *Phrygilanthus eucalyptifolius,* both on No. 10, and No. 197 (W.F.B.); Wahroonga, on *Schinus molle, Syncarpia laurifolia,* Apricot tree (W.F.B.); Waitara, on *Syncarpia laurifolia* (W.F.B.); The Valley, Hornsby, on *Phrygilanthus eucalyptifolius,*—The latter on *Angophora lanceolata* (W.F.B. and D.W.C.S.); Cockle Creek, Hornsby, on *Banksia serrata* (W.F.B.); Asquith, near the waterfall, on *Syncarpia laurifolia, Phrygilanthus eucalyptifolius,* the latter on *Eucalyptus piperita, Astrotricha floccosa, Hakea saligna* (W.F.B.); Gibberagong Creek, 4 miles east of Hornsby, on *Casuarina suberosa, Syncarpia laurifolia* (W.F.B.); Bobbin Head, Kuring-gai Chase, on *Casuarina torulosa, Loranthus vitellinus,* the *Loranthus* parasitic on *Angophora intermedia,* on *Loranthus congener,* the latter on *Casuarina suberosa* (W.F.B.); Junction of Berowra and Connelly's Creeks, on *Casuarina torulosa* (W.F.B.); Berowra Creek, Berowra, on *Loranthus vitellinus,* the latter on *Angophora Bakeri, Phrygilanthus eucalyptifolius,* the latter on *Angophora intermedia* (W.F.B.); Cowan Creek, near Windybank's, on *Synoum glandulosum* (W.F.B., D.W.C.S. and H. Bott); Cowan Creek, Cowan, on *Casuarina torulosa* (W.F.B. and D.W.C.S.); Hawkesbury River, Brooklyn, on *Exocarpus cupressiformis* (W.F.B. and D.W.C.S.); Belmont, on *Banksia integrifolia* (Bishop Dwyer, No. 1070); Hastings River (Forester Brown); Macleay River, Crescent Head, on *Casuarina suberosa* (J. Sydenham); Coff's Harbour, on *Banksia integrifolia* and *Cupaniopsis anacardoides* (J.L.B.); Dorrigo (W. Heron); Dorrigo Forest Reserve,—On the summit of the Round Mountain, Guy Fawkes district (J. H. Maiden, Agric. Gaz., N.S.W., 1894, 615); Evans River, on *Acronychia imperforata* (E. Betche); Clarence River (Beckler, quoted by Bentham, B. Fl., 390, thus:—"In reference to Beckler's series of specimens from

Clarence River, several are quite intermediate as to the shape of the leaf." Beckler's specimens include more than one species [W.F.B.]); Mullumbimby (W. Bauerlen, No. 1519); Tweed River, on *Notothixos subaureus* Oliv. (W. Guilfoyle, 1871, in Melbourne Herbarium).

Queensland: Macpherson Range, on *Casuarina* and *Persoonia* (C. T. White, Feb., 1912, recorded as *Loranthus maytenifolius* Gray); Brisbane River, Moreton Bay (quoted by Bentham, *l.c.*; F. M. Bailey and J. E. Tenison-Woods, These Proceedings, iv., 1879-80, 160); Noosa Heads, on *Banksia integrifolia* (C. T. White, No. 13,—The typical form; No. 14, with larger and thicker leaves); Burpengary (Dr. T. L. Bancroft, No. 178, 1901, in Queensland Herbarium, labelled *L. maytenifolius* Gray); Tambourine Mountain, on *Litsea reticulata* (Longman and White, Proc. Roy. Soc. Q'land, 29, 67, also Ex. Queensland Herbarium, No. 184, Feb., 1917).

Affinities.—Besides the close relationship of this species to *P. eucalyptifolius*, it bears a striking resemblance to *Loranthus alyxifolius* F.v.M., particularly in the shape and colour of the leaves, but the floral characters are totally different. *L.* No. 5, n.sp., is another species with leaves somewhat similar in shape, but differing considerably in venation. The same may be said of *L.* No. 9, n.sp. The anthers of these species are however basifixed, and when the flowers are available there is little chance of them being confused with *P. celastroides.*

Hosts.—Pinaceae: *Pinus insignis* (J. J. Fletcher, These Proceedings, xxx., 488-9). Casuarineae: *Casuarina torulosa* Ait., *C. suberosa* Ott. and Diet. Salicaceae: *Salix babylonica* L. Loranthaceae: *Notothixos subaureus* Oliv., *Loranthus vitellinus* F.v.M., *L. congener* Sieber, *Phrygilanthus eucalyptifolius* (Sieb.) Engler. Betulaceae: *Quercus robur* L., *Q. virens* Ait. Proteaceae: *Banksia serrata* L.f., *B. integrifolia* L.f., *Hakea saligna* R. Br., *Persoonia salicina* Pers. Magnoliaceae: *Magnolia grandiflora* L. Rosaceae: *Prunus Persica* L., *Pyrus* sp., *Crataegus oxycantha* L. Lauraceae: *Litsea reticulata* Benth. Leguminosae: *Robinia Pseudo-Acacia* L. Platanaceae: *Platanus orientalis* L. Rutaceae: *Acronychia perforata* F.v.M. Meliaceae: *Synoum glandulosum* Juss. Sapindaceae: *Cupaniopsis anacardoides* Radt. Anacardiaceae: *Schinus molle* L. Celastraceae: *Elaeodendron australe* Vent. Sterculiaceae: *Commersonia Fraseri* J. Gray. Myrtaceae: *Angophora intermedia* DC., *Eucalyptus tereticornis* Sm., *Callistemon lanceolatus* DC., *Eugenia Smithii* Poir., *Syncarpia laurifolia* Ten. Araliaceae: *Astrotricha floccosa* DC. Apocynaceae: *Nerium Oleander.* Rubiaceae: *Psychotria loniceroides* Sieb.

3. PHRYGILANTHUS MYRTIFOLIUS (A. Cunn. Herb.) Eichl. (Plate xxxi.)

Eichl., Fl. Brazil, v., 1868, 48; Engler and Prantl, Pflanzenfam., iii., 197; Bentham, B. Fl., iii., 1866, 390, as *Loranthus myrtifolius*; Ettings., Uber die Blatts., Tab. iii., Fig. 21 and 22; Bail., Queensland Fl., v., 1378, tab. 63.

Supplementary notes to the description in B. Fl., iii., 390.

It is usually a small plant with short, divaricate, brittle branches; union slightly swollen, surrounded by numerous slender adventitious roots, capable of clinging to small objects. Buds very slender, curved, as in all the allied species, and usually the same colour as *P. eucalyptifolius.* Filaments dark crimson; style green, shaded pink; stigma pink, very small. Fruit elliptical or oblong, pale pink. Cotyledons unknown.

Range.—The type comes from Logan Vale, Queensland, which is in the vicinity of Mt. Sturt, and Canning Downs, and was probably collected between

Freestone Creek and Killarney by Allan Cunningham in May, 1827. Since then it has been found in the following localities, which are not far from the spot where Cunningham first found it:—Gladfield (F. M. Bailey, 1890.—This locality is between Allora and Hendon, not far from the New South Wales border and is almost on the Macpherson Range); Killarney (Joe Webb, *vide* Bail., Qland. Fl., *l.c.*).

New South Wales: Acacia Creek, on *Lyonsia largiflorens* F. v. M. (W. Dunn, No. 259); Oakey Creek, Macpherson Range, on *Tecoma jasminoides* Lindl. (W. Dunn, No. 259a).

Affinity.—It is closely allied to *P. Bidwillii*, from which it differs in its sessile and broader leaves, which suggest the same variation between several species of *Loranthus* that have sessile cordate leaves and no essential difference in the flowers. This opens up the question as to the relationship existing between the sessile-leaved forms, and the narrow-leaved petiolate forms. In these two species which reproduce annually, they show marked differences in the leaves and are peculiarly constant in these characters which we are apt to treat lightly when they are not supported by floral or carpological characters. If we apply the same line of reasoning to other members of this family, we must also admit their broad-leaved allies as distinct individuals, since by the same natural process, they too are constant in these particular characters. I allude to *Loranthus pendulus* Sieb. var. *amplexifolius* Benth., *L. Quandang* Lindl. var. *amplexifolius* Benth., *L. longiflorus* Desr. var. *amplexifolius* (*L. amplexifolius* Bth., *non* DC.).

Hosts.—Apocynaceae: *Lyonsia largiflorens* F. v. M., Bignoniaceae: *Tecoma jasminoides* Lindl.

4. Phrygilanthus Bidwillii (Benth.) Eichl. (Plate xxxii.)

Eichl., Fl. Brazil, v., 1868, 48, Engl. and Prantl, Pflanzenfam., iii., 179; Benth., B. Fl., iii., 1866, 390 as *Loranthus Bidwillii*; Bail., Qland Fl., v., 1378, t. 62 as *L. Bidwillii* Bth.

Supplementary notes to the description in B. Fl., iii., 390.

This is a small growing species, rarely more than 1 ft. long, rather dense, with short jointed brittle branches; invariably parasitic on *Callitris*. Union club-like, developing short slender adventitious roots, which throw out supports beneath their lower surface almost at every inch, causing the host to gradually thicken, as in the case of the main attachment, and form new plants upon them. Flowers yellowish-green, shaded pink in the lower portion, reddish at the top. Buds slender, curved. Petals acute, the lowest exceeding the stamens by about 5 mm., the upper ones by about 2½ mm. Filaments dark red, compressed and somewhat furrowed, thickened at the point of attachment. Style bent in bud, exceeding the anthers by 2-3 mm. when the flower expands, green throughout; stigma rather small, reddish, capitate. Fruit broadly pear-shaped to globular, pink or bright red, 5 to 7 mm. long; epicarp very thin; endosperm white, turning green when germination takes place. Cotyledons obtuse, but not seen in a fully developed state.

This species, as far as my own observations go, is not a gross feeder nor a rapid grower, and it appears to be rather slow in the process of reproduction; whether this is due to its palatable fruits which are freely eaten by birds, or to the low germinating power of the seed remains to be proved.

Range.—The first record of the species is from Wide Bay, Queensland, B. Fl., *l.c.* The late Revd. B. Schortechini (These Proceedings, viii., 1883, 251) has the following interesting note:—"*Loranthus Bidwillii,* Nerang Creek Heads, on the branches of *Callitris cupressiformis* Vent. The same mistletoe is more widely spread at Stanthorpe on the same kind of Pine, and at the mouth of the Mary, from which district the original specimen sent by Mr. Bidwill, whose name it bears, probably came." Through the kindness of Professor Ewart of Melbourne, I was able to see the Revd. Schortechini's specimen, which does not differ from the following New South Wales specimens in the National Herbarium, Sydney.

New South Wales: Wallangarra (J. Staer); Baradine, on *Callitris robusta* (G. Burrow and J. B. Cleland, Botany of the Pilliga, p. 10, N.S.W. For. Dept., Bulletin No. 10, 1920); Forked Mountain, Coonabarabran, on *Callitris calcarata* R. Br. (Dr. H. I. Jensen); on White Pine, *C. robusta* (C. B. Meek); Pilliga, on *Callitris calcarata* (W. A. W. de Beuzeville); Warrumbungle Ranges (W. Forsyth); Narrabri, on *Casuarina Luehmanni* (R. T. Baker, These Proceedings, xxvii., 1902, 541); New England, on *Callitris* sp. (C. Stuart, No. 623, from Dr. Leichhardt's collection); Tamworth, on *Callitris calcarata* (W. M. Carne); Upper Moore Creek, Tamworth District, on *Callitris* sp. (Rev. H. M. R. Rupp); Owen's Gap, near Scone, on Cypress Pine (H. L. White); Mount Duri, Currabubula, on *Callitris robusta* (R. H. Cambage, No. 3549); Murrumbo, 50 miles north of Rylstone, on *Callitris* sp. (R. T. Baker, These Proceedings, ix., 1893, 732, also xxvii., 1902, 541); Cox's Gap, on *Callitris* sp. (R. T. Baker, *Id.*, xxi., 1896, 452); Bowan Park, near Cudal, on *Callitris calcarata,*—flowers pink; fruit globular, bright red (W.F.B.); Young, on Black Pine, *Callitris calcarata* (T. G. Sloane, *vide* J. J. Fletcher, These Proceedings, xxxiii., 1908, 291); Burren Juck, on *Callitris calcarata* R. Br. (E. Cheel, These Proceedings, xxxvii., 1912, p. 137, *vide* also Aust. Nat., 2, 135).

Affinity.—Differing from *P. myrtifolia* (A. Cunn.) Eichl. chiefly in its more erect habit and narrower leaves.

It is a summer flowering species, ranging from October to January.

Hosts.—Pinaceae: *Callitris calcarata* R. Br., *C. cupressiformis* Vent., *C. robusta* R. Br. Casuarineae: *Casuarina Luehmanni* R. T. Baker.

EXPLANATION OF PLATES XXVII.-XXXII.

Plate xxvii.

Nuytsia floribunda R. Br.

1. Portion of flowering branch; flowers slightly reduced. 2. A very common obtuse leaf, natural size. 3. A triad of buds. 4. Flower (after Lindley). 5. Anther. 6. Calyx and Style. 7. Portion of fruiting branch, natural size. 8. Fruit removed from bracts, natural size. 9. Seed, natural size. 10. Longitudinal section of seed showing position of the embryo. 10a. Cross section of seed. 11. Embryo showing 3 cotyledons. 12. A seedling (after Fletcher). 13. Parasitism of *Nuytsia* [A. Root of *Nuytsia;* B. Host; C. Parasitic root of *Nuytsia;* D. Haustoriogen of parasitic root (after Herbert)]. 14. Longitudinal section of a Carrot showing the Haustoriogen (after Herbert).

Plate xxviii.

Gaiadendron ligustrina (A. Cunn.) Eichl.

1. Flowering branch, natural size. 2. Bud. 3. Flower on the bracteate pedicel. 4. One of the segments (after Hook.). 5. Anther (after Hook.). 6. Style. 7. Fruit, natural size. 7a. Embryo. 8. Longitudinal section of fruit. 9. Cross section of fruit (after Hook.), also the two preceding. 10. Stipules. 11. Cross section of root, natural size, (a) thick bark. 12. A seedling plant, natural size, showing the fibrous roots. 13. Types of floral bracts, after the fruits had fallen, natural size.

Plate xxix.

Phrygilanthus eucalyptifolius (Sieber) Engler.

1. Flowering branch, natural size. 1a. Anther. 2. A common type of deformed leaf. 3. Fruit, natural size. 4. Longitudinal section of fruit. 5. Cross section of fruit. 6. Longitudinal section of seed. 7. Germinating seed, natural size, with viscin removed. 8. Germinating seed showing two primary leaves. 9. Germinating seed surrounded with viscin. 10. A young plant, natural size, showing the two radicles (a, a), and the adventitious root (b.). 11. Section of host, *Casuariua suberosa*, natural size, showing the method of attack by the radicle which divides and infests the sapwood, causing a fusiform swelling. 12. Galled fruits, natural size, showing insect punctures. (4, 5, and 6 after Mueller.).

Plate xxx.

Phrygilanthus celastroides (Sieber) Eichl.

1. A flowering branch, natural size. 2. A bud. 3. Flower. 4. Anther. 5. Fruit. 6. Seed, enlarged. 7. Embryo. 8. Embryo opened out. 9. A germinating seed, natural size. 10. A ger minating seed, natural size, with three primary leaves. 11. A young seedling plant showing the adventitious roots (a, a), and the alternate leaves (b. b). 12. Microscopic Fungus found on the viscin of the germinating seed.

Plate xxxi.

Phrygilanthus myrtifolius (A. Cunn.) Eichl.

1. Flowering branch, natural size. 2. A bud. 3. Flower. 4. One of the free filaments. 5. Anthers, front and back view. 6. Calyx and Style. 7. Fruit. 8. Disc. 9. Leaf, natural size, showing venation.

Plate xxxii.

Phrygilanthus Bidwillii (Benth.) Eichl.

1. Flowering plant, natural size, showing union, and the fine adventitious roots. 2. Bud, enlarged. 3. Flower. 4. One of the free segments. 5. Anther. 6. Fruit, natural size.

DESCRIPTIONS OF NEW AUSTRALASIAN BLATTIDAE WITH A NOTE ON THE BLATTID COXA.

By ELAND SHAW, M.R.C.S., F.E.S.

(Seven Text-figures.)

[Read 26th July, 1922.]

In this paper will be found descriptions of nine new cockroaches. Three are additions to the large genus *Platyzosteria* Brunner von Wattenwyl, two of them from Queensland, and one from Western Australia; five are placed in *Cutilia* Stal, a genus which will probably be found to embrace many more species than the sixteen now included in it; and one is referred doubtfully to the genus *Zonioploca* Stal.

Note on the Blattid Coxa.

Most of the Blattidae spend their lives in narrow places such as under bark, under fallen wood, in crevices, or under stones, leaves, or rubbish, necessitating a depression of form characteristic of the family, in the production of which the middle and posterior coxae take part. When the leg is drawn up with the femur flexed on the coxa the thickness of the femur and coxa together would add considerably to the depth of the insect; so to obviate this, the part of the coxa (Text-fig. 1, b) adjacent to the flexed femur is grooved out to receive it. This groove, it is suggested, should be called the *coxal groove*; the thickened part (Text-fig. 1, a) internal to the groove the *coxal ridge*; and the flattened part (Text-fig. 1, c) external to it the *coxal border*. The coxal border is quite flat, and is frequently of a pale colour, a point of considerable taxonomic importance, and the pale colour is usually exhibited on both the dorsal and the ventral aspects. The coxal ridge is always thick, the thickest part of the coxa, its thickness varying somewhat in different genera, and the slope of the coxal groove varies with it. The distal part of the coxal ridge terminates externally in a backwardly-produced flattened lobe, rounded at its apex, which is the *coxal process* (Text-fig. 1, d); this varies somewhat in size and shape, and sometimes, as in *Platyzosteria cingulata* mihi, and *P. babindae* mihi (*infra*) is distinctively coloured. The *trochanter* (Text-fig. 1, e), firmly attached to the proximal end of the *femur* (Text-fig. 1, f) and protecting the coxo-femoral joint, is itself protected by the coxal process, being safely tucked in between it and the distal end of the coxal border. Were it not for this, the trochanter would be in danger of being torn off as the insect crept through narrow places, but the coxal process is admirably adapted to act as a guide along which injurious objects might safely ride over the free margin of the trochanter.

The terms "coxal process" and "posterior coxa" are in use amongst coleopterists for a structure homologous to that found in the cockroaches; the large flattened-out posterior coxa of the Dytiscidae with its coxal process bears a strong resemblance to the Blattid one, though in the water beetle the coxa is not grooved out to receive the flexed femur, great depression of form not being called for.

Subfamily BLATTINAE.

Genus PLATYZOSTERIA Br. v. W.

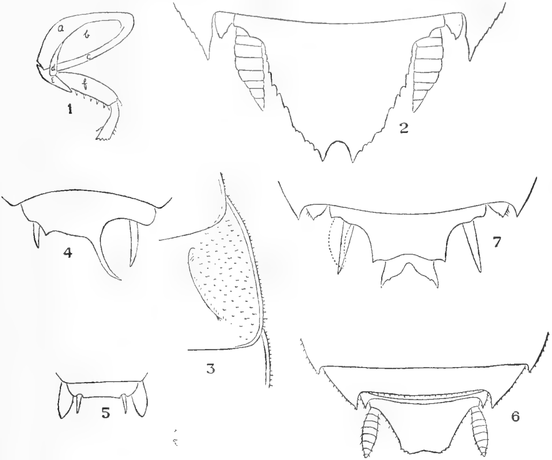
PLATYZOSTERIA BABINDAE, n.sp.

Black, nitid. Head black, eyes greyish, ocelliform spots yellow, antennae fuscous, basal segments darker. Thoracic tergites with large scattered shallow pits; postero-lateral angles slightly produced backwards; posterior margin with a slight medial backward production; no tegminal vestiges, but shallow lateral grooves on the mesonotum and metanotum indicate the position of the lost flying organs (*See* Shaw, Mem. Qland Mus., vi., 1918, p. 152). Abdominal tergites with a row of short longitudinal carinae at their posterior margins; lateral portions of tergites 2, 3 and 4, and the whole of tergites 5, 6 and 7 coarsely scabrous; tergites 5, 6 and 7 with their postero-lateral angles backwardly produced; lateral margins of tergite 7 denticulate, and an orange macula occupying its antero-lateral angle; tergite 9 with the postero-lateral angles yellow. Supra-anal lamina of ♂ subquadrate, scabrous; posterior margin faintly emarginate, ciliate; lateral margin furnished with a few stout spines; cerci exceeding the lamina by about one-third of their length, tips fuscous. Subgenital lamina of ♂ subquadrate, posterior margin irregularly crenulate and spined (possibly malformed), styles laterally situate, tips rufo-castaneous. Lateral margins and postero-lateral angles of abdominal sternites 7 and 8 spined in ♂. Supra-anal lamina of ♀ rounded, scabrous, coarsely spined, roundly emarginate, projecting slightly beyond the cerci. Legs black, coxal borders broadly yellow, coxal processes orange red; posterior meta-tarsi shorter than the remaining segments combined, their pulvilli occupying almost their entire length; basal portion of the distal segments of all the tarsi yellowish. *Length*, ♂ 16 mm., ♀ 19 mm.

Type, specimen No. 143 (♂); allotype, specimen No. 144 (♀), Coll. Shaw.

Hab.—Queensland: Babinda (3 specimens. Dr. J. F. Illingworth, Nov., 1919).

Notes.—This species appears to be allied to *P. bicolor* Kirby, from which its entirely apterous condition distinguishes it. *P. bicolor* came from Cornwallis Island and Torres Straits and *P. babindae* mihi, from near Cairns. There are also in my collection specimens from S. Queensland of what seems to be an undescribed species, distinguished from *babindae* by the absence of the yellow macula on the 7th tergite, and on the other side very close to *P. scabrella* Tepper, from New South Wales, Victoria, and South Australia. These four species, with perhaps *P. scabra* Brunner, may form a group whose winged ancestor came from the north; and it is interesting to note that while *bicolor* Kirby, the most northerly of the group still possesses vestigial tegmina, and *scabrella* Tepper the most southerly, has no trace of tegmina at all, the two species intermediate in latitude,



Text-fig. 1. *Platyzosteria analis* Sauss. Portion of left posterior leg, ventral aspect. (a) Coxal ridge; (b) Coxal groove; (c) Coxal border; (d) Coxal process; (e) Trochanter; (f) Femur; (g) Tibia.

Text-fig. 2. *Platyzosteria spatiosa* Shaw. ♀. Apex of abdomen, dorsal aspect. (Paratype. No. 124, Coll. Shaw).

Text-fig. 3. *Cutilia illingworthi* Shaw. ♀. Right tegminal vestige. (Paratype. No. 142, Coll. Shaw).

Text-fig. 4. *Cutilia illingworthi* Shaw. ♂. Subgenital lamina. (Type. No. 136, Coll. Shaw).

Text-fig. 5. *Cutilia spryi* Shaw. ♂. Apex of abdomen, ventral aspect. (Paratype. No. 243, Coll. Shaw).

Text-fig. 6. *Cutilia feriarum* Shaw. ♀. Apex of abdomen, dorsal aspect. (Paratype. No. 253, Coll. Shaw).

Text-fig. 7. *Zonioploca dixoni* Shaw. ♂. Apex of abdomen, dorsal aspect. (Type. No. 232, Coll. Shaw).

in the course of their progress towards the loss of all trace of flying organs, show shallow grooves indicating the position of the lost tegmina, the more northerly of the two species having these grooves the better marked.

PLATYZOSTERIA CINGULATA, n.sp.

Black, banded with bright yellow, smooth, nitid. Head rufo-fuscous, ocelliform spots minute, yellow; eyes black; antennae rufo-fuscous, basal segments darker. Thoracic tergites with some scattered, shallow, impressed dots, and with all their visible margins broadly yellow on both dorsal and ventral aspects; the black discs of these tergites with their posterior margins sinuate, that of the pronotum showing anteriorly a sinuate margin, from the centre of which two small dashes extend forward about 1 mm. into the yellow margin, and showing posteriorly on each side of the middle line an outwardly curving, rounded black process extending into the posterior yellow margin; no tegminal vestiges. Abdominal tergites, except 8th and 9th, broadly margined yellow posteriorly and laterally; postero-lateral angles of 5th, 6th and 7th tergites backwardly produced; posterior margin of 7th tergite subsinuate, lateral margins entire. Abdominal sternites black, or dark castaneous, broadly margined yellow. Supra-anal lamina of ♂ subquadrate, angles rounded, emarginate, with a medial longitudinal sulcus, posterior margin more or less spined, black, with the posterior two-thirds yellow. Cerci flattened, black, tips fuscous. Supra-anal lamina of ♀ rounded, subtectiform, posterior margin strongly denticulate, denticulations tipped fuscous. Subgenital lamina of ♂ subquadrate, posterior margin straight; styles black, situate at the angles. Legs rufo-fuscous, coxal borders on both aspects broadly pale yellow; all the coxal processes yellow; posterior metatarsus nearly as long as the remaining tarsal segments combined, its pulvillus occupying almost its entire length; arolia moderate in size. *Length,* ♂ 17 mm., ♀ 18 mm.

T y p e, specimen No. 130 (♂); a l l o t y p e, specimen No. 131 (♀), Coll. Shaw. Paratypes, 4 ♂, 3 ♀.

Hab.—Queensland: Spring Bluff, 1500 ft. (Miss Brigit Shaw, Jan., 1919), Bunya Mts., 3300 ft. (R. Illidge, Oct., 1919), Stanthorpe district, 2700 ft. (H. Jarvis, Nov., 1919).

Notes.—This beautiful species closely resembles *P. balteata* Tepper, but it is larger, broader, the yellow margins are relatively wider, and it is apterous whilst *P. balteata* possesses tegminal vestiges. It appears to be widely distributed on the Darling Downs, but has not hitherto been observed on the coastal belt.

In some specimens the supra-anal lamina of ♂ is furnished with several stout spines, though in the Type these are merely indicated; and in one paratype the lamina is spined on one side and practically entire on the other.

The Type shows the "titillator" and several of the other chitinized portions of the genital membrane protruding from the cloaca, and it may be useful to draw attention to the fact that cockroaches killed by immersion in alcohol exert in dying a strong expulsive effort, and the usually concealed 8th and 9th tergites may become visible (vide *Cutilia feriarum,* infra) and a considerable part of the genital membrane may be extruded.

PLATYZOSTERIA SPATIOSA, n.sp.

♀ black, nitid. Head with the vertex castaneous, the frons black, margins of the clypeus and labrum yellowish-brown, the ocelliform spots large, quadrangular and yellow; the antennae as long as the body, brown, with the proximal segments darker, the second segment about as long as two, and the third segment about as long as four of the distal segments. Pronotum anteriorly parabolic, posterior margin nearly straight, and together with the mesonotum and metanotum showing some crumplings of the surface and some impressed dots; lateral margins of the meso- and metanotum somewhat thickened and everted; tegminal vestiges with their apices definitely separated from the tergite; no trace of wings; postero-lateral angles of the metanotum slightly produced. Abdominal tergites with their postero-lateral angles backwardly produced, stigmata well marked; lateral margins of the 7th tergite finely serrate. Supra-anal lamina extending to nearly twice the length of the cerci, triangular, cucullate, apex roundly emarginate, with the lateral margins prominently spined (Text-fig. 2). Abdominal sternites black; valves of the subgenital lamina long, not strongly curved. Legs castaneous, tibiae darker, triseriately spined on the outer aspect; posterior metatarsus nearly as long as the remaining tarsal segments combined; pulvillus long; coxal borders narrowly margined with ochreous brown. *Length,* 41 mm.; pronotum 11 x 15 mm.

Type, specimen No. 123 (♀), Coll. Shaw; paratype ♀, No. 124, Coll. Shaw.

Hab.—Western Australia: Cunderdin (R. Illidge, Oct., 1913).

Notes.—Mr. Illidge, who kindly gave me these two female specimens, took them at Cunderdin about 120 miles east of Perth. The species belongs to the *analis* group of the genus, and is closely allied to *P. grandis* Sauss. differing from it in the possession of tegminal vestiges, larger size, and relatively larger supra-anal lamina.

Genus CUTILIA Stal.

CUTILIA ILLINGWORTHI, n.sp.

Rufo-fuscous, nitid. Head fusco-rufous; eyes black; ocelliform spots large, yellowish, filling in the angle formed between the eyes and the antennary fossae; antennae testaceous, proximal segments darker. Pronotum anteriorly parabolic, posterior margin almost straight, angles rounded, with a few erect hairs. Tegminal vestiges (Text-fig. 3) not free at the tips, but each indicated by a deep curved sulcus occupying the position of the inner (or caudal) margin of the usual form of tegminal vestige; no wing vestiges. Abdominal tergites with the posterior half of each darker in colour, lateral margins thickened; postero-lateral angles of 5th, 6th and 7th tergites backwardly produced; 7th tergite with the posterior margin sinuate, lateral margins entire. Supra-anal lamina of ♂ subquadrate, deeply emarginate, ciliate, postero-lateral angles spined. Cerci about $1\frac{1}{2}$ times as long as the lamina. Supra-anal lamina of ♀ trigonal, subtectiform, apex truncate, widely emarginate. Subgenital lamina of ♂ (Text-fig. 4) asymmetrical, triangularly produced, terminating in a long spine curving towards the left; styles long, incurved, the left style longer, and situate nearer the middle line than the right, which has a short blunt process internal to it. Legs fusco-rufous, coxal borders rufo-testaceous, posterior metatarsi longer than the remaining tarsal segments combined, biseriately spined beneath, with short pulvilli; 4th and 5th segments of the tarsi paler. *Length,* ♂ 17.5—22.5 mm., ♀ 23.5—24.5 mm.

Type, specimen No. 136 (♂); allotype, specimen No. 137 (♀), Coll. Shaw. Several paratypes.

Hab.—Queensland: Cairns (Dr. J. F. Illingworth, 1917 to 1920).

Notes.—About a dozen specimens of this remarkable cockroach were sent to me from Cairns by Dr. Illingworth. In describing *Cutilia uncinata* (Mem. Qland Mus., vi., 1918, p. 160), a new species from islands off the coast of North Queensland, attention was drawn to the hitherto unknown form of the vestigial tegmina, and of the subgenital lamina of the ♂, and now, from the adjoining coast, comes another species almost identical in form in these two particulars;

but whilst *uncinata* mihi is dark castaneous with a yellow lateral border, the present species is of quite different appearance, being considerably larger, of much lighter colour, and almost concolourous. It is curious that two species should differ so much in facies, whilst both of them present two almost identical and very striking departures from the usual form. That the one is not an insular form of the other is shown by the fact that Dr. Illingworth has since forwarded some specimens of *uncinata* (smaller than the Type) taken in 1919 "ex beach Herbert River" about 130 miles south of Cairns; and also some taken at Gordonvale.

Dr. Illingworth has submitted to me a considerable number of Blattidae from the neighbourhood of Cairns and Gordonvale, and has kindly given me many of them. Three new species of his discovering are described in the present paper, and it is a pleasure to propose that this one should bear his name.

Cutilia brevitarsis, n.sp.

Nigro-castaneous, smooth, nitid except the posterior tergites which are finely shagreened. Head rufo-castaneous; ocelliform spots yellow; antennae pale fuscous, of about the length of the body. Thoracic tergites with their posterior margins slightly backwardly produced medially. Tegminal vestiges completely separated from the mesonotum, articulation not completely covered by the pronotum, apex not obliquely truncate. No vestiges of wings beyond a slight backward prolongation of the postero-lateral angles of the metanotum. Abdomen with the postero-lateral angles of tergites 5, 6 and 7 backwardly produced; tergites 6 and 7 and the supra-anal lamina faintly shagreened, lateral margins entire. Supra-anal lamina of ♂ and of ♀ subtriangular, apex truncate, widely emarginate, (emargination angular in ♂, rounded in ♀,) extending to about half the length of the cerci; sternites concolourous. Subgenital lamina of ♂ subquadrate, posterior margin rounded, with a very long spine at the base of each style. Legs fusco-castaneous, posterior metatarsi about equal to the remaining tarsal segments combined, biseriately spined beneath, pulvilli short, middle metatarsi not spined beneath.

Ootheca chitinous, castaneous, approximately twice as long as deep; suture serrate, carried uppermost; surface smooth, entirely devoid of carinae. *Length*, ♂ 15—18 mm., ♀ 15—19 mm.

T y p e, specimen No. 233 (♂); a l l o t y p e, specimen No. 234 (♀), Coll. Shaw. Several ♂ and ♀ paratypes.

Hab.—N. Queensland: Cairns, Gordonvale (Dr. J. F. Illingworth, 1917-1919).

Notes.—Dr. Illingworth sent me for identification several specimens of this cockroach. It closely resembles *C. nitidella* mihi (Mem. Qland Mus., vi., 1918, p. 155), but is not of so depressed a form, and its short posterior metatarsus with comparatively long pulvillus at once separates it from that species. The posterior metatarsus is definitely biseriately spined beneath, so it seems best to refer *brevitarsis* to the genus *Cutilia*. This segment is about the length of, or slightly shorter than the remaining tarsal segments combined; its pulvillus is not apical, but extends a little upwards, though not so far as in *Platyzosteria*. The ootheca is still attached to one of the paratypes (No. 235, Coll. Shaw) and while of similar proportions to that of *C. nitidella* (*l.c.*, p. 157) it differs from it in being not fluted, but quite smooth. Half the paratypes are in Dr. Illingworth's collection.

Cutilia spryi, n.sp.

Head and thoracic tergites ferrugineous; antennae fuscous. Abdominal tergites gradually darkening caudally to nigro-castaneous; abdominal sternites wholly nigro-castaneous. Pronotum with the posterior margin slightly produced backwards in the middle. No trace of tegmina or wings. Abdominal tergites 5 and 6 with the postero-lateral angles slightly produced backwards, tergite 7 more produced, particularly in the ♀; first abdominal tergite of ♂ with a medial "gland" orifice surrounded by bristles and sometimes concealed by the metanotum; 7th abdominal tergite with the posterior margin sinuate, lateral margins entire. Supra-anal lamina of ♂ triangular, apex much truncate, not extending to half the length of the cerci, widely emarginate, lateral margins entire, and slightly concave; of ♀ triangular, less of the apex truncate, extending to more than half the length of the cerci, emargination deeper and narrower than in the ♂, the tips of the valves of the subgenital lamina showing in the emargination. Subgenital lamina of ♂ (Text-fig. 5) quadrate, posterior margin faintly concave, styles situate in a conspicuous notch at the postero-lateral angle, lateral margins anterior to the styles convex. Legs testaceous, with a large castaneous macula at the base of the coxae; posterior metatarsus longer than the remaining tarsal segments combined, biseriately spined beneath, pulvillus apical, remaining pulvilli occupying the whole length of the segment. *Length,* ♂ and ♀ 10.5 mm.

Type, specimen No. 237 (♂); allotype, specimen No. 238 (♀), Coll. Shaw. Five ♂ and two ♀ paratypes.

Hab.—Queensland: Spring Bluff, near Toowoomba (Miss Brigit Shaw, Jan., 1919).

Notes.—Nine specimens were collected at Spring Bluff in Jan., 1919, by my daughter Brigit. The species is near *Cutilia tepperi* mihi (Mem. Q. Mus., vi., 1918, p. 157), which is also apterous, but it differs in the smaller size, and complete absence of flavid markings on the dorsum. In general colour it resembles *C. sedilloti* Bol. from New Zealand and, like that species, has the postero-lateral angles of the distal abdominal tergites scarcely produced, especially in the ♂. In naming this species after my friend Mr. F. P. Spry, I desire to acknowledge our indebtedness to him for his long study of Australian forms of *Blattidae,* and to express my personal gratitude for numerous specimens sent, and for much kindly assistance.

CUTILIA PHILPOTTI, n.sp.

♂ nigro-castaneous, bordered yellow. Head yellow, a broad castaneous macula occupying the frons, clypeus and labrum; eyes castaneous; antennae missing except the proximal segment on the right side, which is castaneous. Thoracic tergites dark castaneous with a broad lateral yellow border, the extreme margin of which is slightly thickened and fuscous; pronotum with the anterior margin truncate, exposing the yellow vertex which completes the yellow border anteriorly; posterior margin subsinuate, as also are those of the meso- and metanotum. Tegminal vestiges completely separated from the mesonotum, apex obliquely truncate, forming part of the lateral yellow border except towards the inner margin, which portion is of the castaneous ground colour. No trace of wings. Abdominal tergites dark castaneous, the lateral yellow border being continued on tergites 3, 4 and 5 as yellow maculae diminishing in size from before backwards; tergites 5, 6 and 7 with the postero-lateral angles strongly produced backwards, margins entire; tergite 7 with the posterior margin sinuate. Supra-anal lamina quadrate, widely emarginate, ciliate, angles slightly obtuse extending to about half the length of the cerci, lateral margins somewhat everted, cerci rufo-castaneous at the tips. Subgenital lamina quadrate, posterior margin convex, faintly emarginate, with a stout prominent spine within the base of the styles, which are long and inserted sublaterally. Abdominal sternites dark castaneous, paler in the disc.

Legs with the coxae testaceous, a large castaneous macula occupying the basal portion of the coxal groove, and the whole of the coxal ridge and coxal process; the remainder of the legs castaneous, spines paler. Posterior metatarsus about the length of the remaining tarsal segments combined, somewhat dilated distally, biseriately spined beneath, pulvillus apical; remaining segments with large pulvilli; middle metatarsus biseriately spined beneath towards the base. *Length,* 17.5 mm.

Type, specimen No. 110 (♂), Coll. Shaw.

Hab.— *? New Zealand*: Invercargill.

Notes.—This unique specimen was sent to me in 1918 by Mr. A. Philpott, now of the Cawthron Institute, Nelson, N.Z., taken at Invercargill in the shop of a fruiterer who dealt largely in Australian fruits; and I have kept it hoping that other specimens would be forthcoming. As such has not been the case, I now propose that it should be named after its discoverer, as an acknowledgment of the keen interest he takes in New Zealand Blattidae. Until further material is discovered there must be a doubt as to whether this species is a native of Australia, or of New Zealand, or occurs in both; but, with the exception of *C. nitida* Brunner v. W., the whole genus *Cutilia* is confined to these countries.

CUTILIA FERIARUM, n.sp.

Small, nigro-castaneous, nitid, apterous. Head with the vertex rufous, frons black; margins of the clypeus and labrum fuscous; ocelliform spots large, triangular, pale yellow; antennae fuscous, densely ciliated, shorter than the body. Thoracic tergites dark castaneous, with the lateral portions rufo-castaneous; pronotum somewhat truncate anteriorly, exposing the vertex; lateral margins of the meso- and metanotum slightly thickened; the lateral and posterior margins of all the thoracic tergites ciliate. Abdominal tergites with the lateral margins slightly thickened and ciliate, posterior margins tuberculate and ciliate. In the Paratype the posterior portions of tergites 8 and 9 are visible; these are not ciliate, and are of a pale cream colour, except the postero-lateral angles of the 9th which are black, ciliate and produced into a spine. The surface of all the tergites with a few scattered erect cilia. Supra-anal lamina triangular, apex truncate, lateral margins everted, as is also the posterior margin in the ♂, emarginate, not reaching to half the length of the cerci in the ♂, but considerably longer in the ♀; cerci black, tips rufous. Subgenital lamina of the ♂ short, posterior margin nearly straight, lateral margins convex. Abdominal sternites black. Legs with the coxae black, coxal borders cream-white, distal portion of the coxal ridges and coxal processes, and the rest of the legs rufo-castaneous; posterior metatarsi longer than the remaining tarsal segments combined, biseriately spined beneath, pulvillus apical; remaining tarsal segments unspined, pulvilli large, arolia large. *Length,* ♂ 12 mm., ♀ 13 mm.

Type, specimen No. 252 (♂); allotype, specimen No. 254 (♀), Coll. Shaw. Paratype, No. 253 (♀).

Hab.—Queensland: Stanthorpe; *N.S. Wales*: Wilson's Downfall (Jan., 1921).

Notes.—Three specimens were collected during holidays in Jan., 1921, by my daughter Brigit, one at Stanthorpe, the others just over the border in N.S.W. The species is distinguished by its small size, almost black colour, very pale coxal borders, and absence of tegminal vestiges. As previously pointed out (Shaw, Mem. Qland Mus., vi., 1918, p. 151), species having long, biseriately spined posterior metatarsi, with apical pulvilli should be included in *Cutilia* Stal, even though completely apterous. *C. tepperi* (Shaw, *l.c.*, p. 157) was the first of these species to be described; the present paper includes two more, *spryi* and *feriarum*, and an undescribed species in my collection from Daly River, N. Territory, makes a fourth.

Genus Zonioploca Stal.

Zonioploca dixoni, n.sp.

Castaneous above, rufo-testaceous beneath. Head with the vertex rufo-castaneous; a large rufo-castaneous macula occupying the greater part of the frons, but paling to testaceous around the antennary fossae, on the margin of the clypeus and on the lateral portions of the head; eyes black; antennae rufo-testaceous. Thoracic tergites rugose; pronotum with the lateral margins much thickened, meso- and metanotum with the lateral margins thickened, postero-lateral angles somewhat produced backwards, no flying organs. Abdominal tergites smooth, nitid, their posterior margins furnished with a row of small tubercles; tergite 5 with the postero-lateral angles not, or but slightly produced backwards, tergites 6 and 7 with the same well-produced, lateral margins entire. Supra-anal lamina of the ♂ (Text-fig. 7) rufo-testaceous, subquadrate, widely emarginate, ciliate, lateral margins concave, ending posteriorly in a spine directed backwards and outwards; cerci slightly incurved, blunt at the apex, extending to about the length of the lamina; of the ♀ narrower at the apex, with three or four blunt spines at each side, lateral margins slightly crenulate. Subgenital lamina of ♂ (Text-fig. 7) backwardly produced, lateral margins concave, terminating in two divergent pointed processes; styles long, acuminate, laterally inserted. Legs rufo-testaceous; coxal borders pale; posterior tibiae in the ♀ furnished on the whole length of their inner borders with a closely-set brush of fine hairs; posterior metatarsus of about the length of the remaining tarsal segments combined, not spined beneath, pulvillus apical, remaining pulvilli occupying the whole segment, arolia large. *Length*, ♂ 26.5 mm., ♀ 32.0 mm.

Type, specimen No. 232 (♂); allotype, specimen No. 251 (♀), Coll. Shaw. Paratypes, 1 ♀ and 1 larval ♀, Coll. F. P. Spry.

Hab.—Central Australia; *South Australia*; *Victoria*: Mallee district.

Notes.—The material on which this species is founded came to me from my friend Mr. F. P. Spry. About a year ago he sent me a ♀ of what appeared to be a new *Zonioploca* Stal taken by Mr. J. C. Dixon in the Mallee district of Victoria, and later, in response to enquiries, a larval ♀ from the same locality and captor, and a ♂ and a ♀ labelled as from Central and South Australia respectively, from an old collection of Mr. C. French, lately Govt. Entomologist of Victoria. These latter have been selected as the types, and the Mallee specimens, though so far structurally indistinguishable, are of a darker colour, less robust, and less rugose; until more material is found no good purpose will be served by regarding them as more than a dark variety. The species differs from the rest of the genus in some particulars such as the postero-lateral angles of the 5th abdominal tergite being scarcely produced, the smoother dorsum, the thickened lateral margins of the meso- and metanotum, and the form of the subgenital lamina of the ♂; but the 6th and 7th tergites are well produced, the pronotum has a thickened margin, and the tarsal structure is that of *Zonioploca* Stal. Mr. Dixon is a keen naturalist who has added considerably to our knowledge of the Mallee fauna, and as some slight acknowledgment of this it is proposed that this species should be named after him.

NOTES ON NEMATODES OF THE GENUS *PHYSALOPTERA*.

Part iii. The Physaloptera of Australian Lizards.

By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

(Thirty-eight Text-figures.)

[Read 28th June, 1922.]

Three collections of Physaloptera material, received from the Zoology Department of the University of Sydney, contain specimens of a species which appears to be identical with *Physaloptera antarctica* Linstow. Linstow's description is insufficient to characterise the species clearly, but the few measurements which he gives accord with those of specimens which are regarded in the following paper as representing the typical variety.

Two of the collections (B and C) consist entirely of this variety (var. *typica*); the third (A) contains a few specimens of the same variety, mostly immature, scattered among a large number of very similar worms, which show certain constant differences and have been considered as a new variety of the species, var. *lata.*

All three collections were obtained during class dissection of lizards, lot A being labelled "From the intestine of a lizard, 1915," lot B "From the lower intestine of a blue tongued lizard, *Tiliqua scincoides,* 24 June, 1919," lot C "From the intestine of *Tiliqua scincoides,* 12 August, 1919." In each case the *Physaloptera* were the only Nematode parasites present, and occurred in considerable numbers, lot A consisting of about 65 specimens, among them many larvae and 21 adult males, lot B of some 50 larvae and adults, 20 of them males, lot C of 29 specimens, 17 of them males.

Treatment.—The specimens in lot B were received alive, in normal salt solution, and a few of them were kept in this medium for periods ranging up to three weeks, when they were still alive, though very sluggish. The remainder were killed at once, various fixatives being tried for comparison. Hot corrosive sublimate acetic proved a very bad fixative. Specimens immersed in this for ten minutes and afterwards treated with 70% alcohol and iodised alcohol, were so hard and shrunken as to be almost useless for examination. Carl's solution was also unsatisfactory, and fixation in warm glycerine-alcohol did not secure well extended specimens. Almost boiling 70% alcohol gave much the best results. 70% alcohol had been used to fix and preserve lot A, and most of these specimens were in very good condition, though the caudal extremity in a number of the females was very contracted, and the cuticle showed some abnormal distension. All the specimens of lot C were fixed in hot glycerine alcohol, but some of them were subsequently transferred to 70% alcohol, and after dehydration and treatment with cedar oil or clove oil made successful canada balsam mounts. In these cases the oil was added to the absolute alcohol in gradually increasing strengths, from one third, one half, two thirds, to the pure oil after three days, and the specimens remained quite clear when mounted, and showed details of internal structure well. Cedar oil proved better than clove oil. Other mounts were made in glycerine jelly, after clearing in glycerine by the gradual evaporation of the glycerine alcohol. But with these stout-bodied worms the jelly mounts were not clear enough for good microscopical examination, though papillae and other cuticular structures showed up better than in any other medium. Glycerine also proved a very good medium in which to dissect the specimens. The most useful reagent, however, both for rapid microscopical examination, and for clearing and preserving specimens during dissection was alcoholic phenol, used in the proportions of 80 parts phenol to 20 parts absolute alcohol, though permanent mounts could not be made from these preparations.

Superfamily *SPIRUROIDEA* Railliet & Henry, 1915.

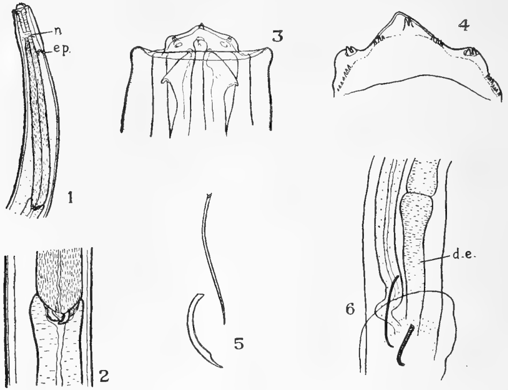
Family ACUARIIDAE Seurat, 1913.

Subfamily PHYSALOPTERINAE Seurat, 1913.

Genus P h y s a l o p t e r a Rudolphi, 1819.

Species Physaloptera antarctica Linstow, 1899, var. typica.

Body robust, elongated, slenderly and evenly proportioned, of a uniform diameter in the middle region, tapering at each extremity. Cuticle thick, undulant, densely striate transversely, the striations very fine and inconspicuous; cephalic collarette large. Post-cervical papillae thorn-shaped, situated on the lateral lines in depressions in the cuticle, slightly behind the junction of muscular and glandular oesophagus (Text-fig. 23), at an average distance of .5 to .7 mm. from the anterior extremity, according to the length of the worm. Excretory pore on the ventral median line, .08 to .09 mm. behind the post-cervical papillae (Text-fig. 1). Lateral lips slightly trilobed, the buccal pads, applied to them externally, thick and hemispherical, bearing the paired lateral papillae (Text-fig. 3). External labial tooth stout and conical, with a small, deeply-notched, double-pointed tooth at its base internally. The small bicuspid tooth, situated internally on the summit of each lateral lobe of the lip, widely notched to the base, the cusps short and broad (Text-fig. 4). The internal denticular border made up of a group of three fairly large, sharply-pointed denticles on each side of the base of the median tooth, and a line of five or six similar denticles down each side, each group being continued by a few very minute and indistinct denticles, not always visible, along a well-marked curved line forming the inner edge of the lip. Buccal cavity short; oesophagus in two parts, the anterior part muscular, usually less than one-eighth of the total length, narrower than the glandular oesophagus, which expands just behind the junction and has an almost uniform diameter throughout. Glandular oesophagus conspicuous by its dark colour, the transition into the lighter muscular oesophagus well marked (Text-fig. 23). The nerve ring broad, surrounding the muscular oesophagus just above the junction. Total length of oesophagus one-tenth of the body length in the longest individuals (43 mm. specimens), becoming relatively longer as the length of the body decreases, i.e., in the younger specimens, though the relative increase

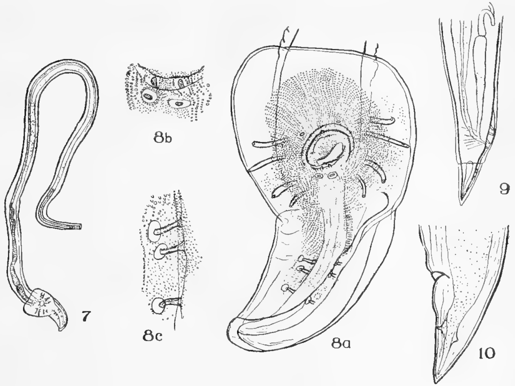


Figs. 1-6. *Physaloptera antarctica* var. *typica*.

1. Anterior end of male, showing oesophagus (x 15); e.p., excretory pore, n., nerve ring; 2. Junction of oesophagus and intestine (x 48); 3. Lateral view of anterior extremity (x 125); 4. Internal face of lip (x 190); 5. Male spicules (x 48); 6. Portion of posterior region of male, showing spicules and ductus ejaculatorius (d.e.), (x 27).

is not constant, and the length is found to vary slightly in specimens of the same size, from one-seventh to one-eighth of the body length in males and females 23 to 28 mm. long. The base of the oesophagus is broadly pointed, and inserted into the middle of the wide intestinal lumen, where the narrow entrance to the oesophagus is protected by valves (Text-fig. 2). Intestine slightly wider than oesophagus, usually straight, occasionally sinuous, or with a single loop.

Males (Text-fig. 7) 10 to 28 mm. long, diameter in middle of body .45 to .78 mm., diminishing a little in front of caudal wings. Cloaca at a distance of one-fourteenth to one-twenty-third of the body length from the tail point, the distance not having a constant relation to the total length, but varying in specimens of the same length. Tail deeply excavated and curved ventrally; lateral alae ample, very wide anteriorly, .32 to .45 mm., narrowing rapidly towards the tip of the tail, and tapering to a point a little behind the posterior extremity of the body proper; margin even, outlined by a double line (Text-fig. 8a). Bursa formed by the alae massive, broadly lanceolate, 2.5 mm. long in the largest specimens, and 1.2 mm. wide from side to side. Cloacal aperture large and circular, with a prominent rim, opening in the centre of a cuticular pad closely beset with rod-like processes or "knobs," the knobs arranged in radiating rows continued over the margin of the cloaca into its interior, decreasing in size on its inner folds. Radial arrangement not so distinct at the sides of the cloaca, but appearing again below it, the rows extending down the wings to the level



Figs. 7-10. *Physaloptera antarctica* var. *typica*.

7. 24 mm. male (x 5); 8a. Caudal extremity of the same specimen (x 32); 8b. Post-anal papillae (x 67); 8c. Caudal papillae (x 67); 9. Caudal extremity of 14 mm. male larva (x 32); 10. Caudal extremity of 43 mm. female (x 32).

of the last of the caudal papillae. Behind the cloaca, the surface of the tail is covered with very small cuticular points, densely and irregularly arranged, extending just beyond the second of the caudal papillae. The peduncles of the four pairs of external papillae, ensheathing the cloaca, are long and slender; the second pair longest, reaching nearly to the margin of the wings, the fourth pair much shorter. In the largest male, 28 mm. long, they measure respectively .368, .416, .336, .256 mm. Of the three sessile preanal papillae, the unpaired papilla near the anterior border is small and inconspicuous, the paired papillae, a little further forward, large and oval. The first pair of postanal papillae are finger-like, situated on the margin of the cloaca and projecting over its rim; the second pair, a little further back and wider apart, broadly oval and sessile (Text-fig. 8b). The three pairs of caudal papillae all possess fairly long peduncles, and each at its distal extremity is surrounded by a large corona (Text-fig. 8c).

The peduncles of the first pair (from the caudal extremity) measure .078 mm., the others .081 and .111 mm. respectively. They are situated in the midregion of the tail, the most posterior .512 mm. from its extremity, the other two at distances of .768 and .864 mm., in a specimen 28 mm. long, where the cloacal aperture is 1.8 mm. removed from the tail point.

The spicules are both short, and only slightly unequal, the right about three-fifths the length of the left. The left is straight and very slender, the right curved and stouter, indented near the distal extremity, and tapering to a point (Text-fig. 5). It is commonly found nearer to the cloacal aperture than the left, and often protruded for part of its length. The posterior portions of the single genital tube are stout, deep-coloured, and clearly visible through the body wall. The ejaculatory duct is infundibuliform, from 1.0 to 1.7 mm. long, and thickest anteriorly where it is divided from the vesicula seminalis by a deep constriction (Text-fig. 6). The vesicula seminalis is dilated just beyond the junction, and then extends as a broad tube, of uniform width, usually straight forward to join the vas deferens. Sometimes it is recurved at the anterior end, and the vas deferens runs parallel with it for a short distance, before turning forward again. The vesicula seminalis is from 2.4 to 3.2 mm. long, and the transition into the vas deferens is marked by an abrupt narrowing. Vas deferens and the thread-like testis may extend straight forward, towards the base of the oesophagus, or be looped and coiled in the middle region of the body.

Genitalia and caudal bursa are sometimes found already developed in specimens only 10 mm. long, though most individuals of this length are still in the larval stage. In a larva 14 mm. long, in which the posterior extremity is a little withdrawn from the cuticle of the larval tail, caudal alae, papillae, and other structures can be seen in an early stage of formation beneath the larval cuticle (Text-fig. 9). On the other hand, many males are found in the adult stage at a length of 15 mm. Males of the largest sizes, over 20 mm. long, are rare, the majority of the specimens being between 15 and 19 mm. long. In collection B, which contains the only specimen 28 mm. long, the average length is 19 mm. In collection C, in which the largest male is 20 mm., the average length is 15 mm.

Females (Text-fig. 20) 11 to 43 mm. long, diameter in middle of body .57 to 1.36 mm., diminishing to .25 mm. at the base of cephalic collarette, and to .24 to .40 mm. at anus. Anus at a distance of one-sixtieth to one-fiftieth of the body length from the posterior extremity in the larger specimens, sometimes longer in the younger specimens, varying from one-fortieth to one-fifty-sixth of the body length in specimens of lengths 25 mm. and under. Tail straight, conical, and sharply pointed (Text-figs. 10, 27). Caudal pores difficult to distinguish; only observed in a few specimens, opening in slight depressions in the cuticle, .320 mm. from the extremity on a tail .768 mm. long. Vulva prominent, always some distance behind the junction of oesophagus and intestine, but varying in position from 1/3.0 to 1/4.9 of the body length from the anterior extremity, the average distance being 1/3.8. Eggs very thick shelled and broadly oval, measuring .051 x .040 to .044 x .033 mm.; always containing embryos when oviposited.

Individuals of all lengths between maximum and minimum occur in collection B, but the intermediate lengths are most numerous. Only 3 specimens are over 35 mm. long, and the average length is 26 mm. Collection C contains smaller and evidently younger specimens, the largest female being 30 mm. long, and the average length 21 mm. A few very young specimens of the same type and two or three adults, up to 27 mm. long, occur in collection A.

A vulva is usually present in specimens over 18 mm. long, but up to lengths of 25 or 28 mm. the genital system, though developed, is generally not fully mature. As with the males, the degree of development varies in individuals of the same length. Many specimens of 18 mm. are still in the larval stage, and specimens up to 23 mm. long in collection A, which appear to belong to this species, show no trace of a genital system (Text-fig. 32).

Interesting variations occur in the dimensions and disposition of the various parts of the female genitalia, and a large number of specimens of all sizes have been dissected and measured in order to make a special study of them.

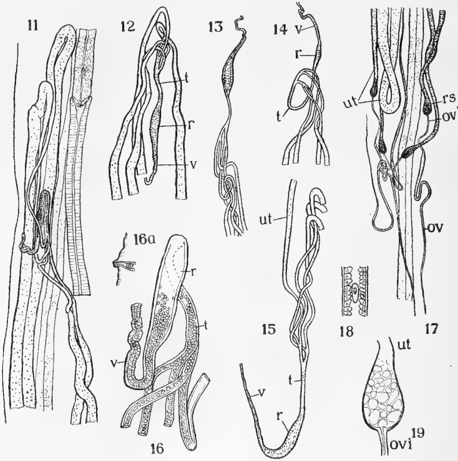
The female genital system.

Physaloptera antarctica belongs to the group distinguished by Seurat as "formes tetrahystériennes," having four uteri. Like *P. abbreviata* and *P. pallaryi,* the division into the four branches is dichotomous, and the general formation of these and the other parts of the genital system is similar. The vagina leads into a narrow cylindrical vestibule with thick muscular and cuticular walls, which forms an ovijector. Upon this follows a dilated chamber, the reservoir, leading to the common trunk, with walls lined by large polygonal epithelial cells. This, after a short course, divides into two branches, which very soon divide again, the four branches being continuous with the four uteri, which occupy the greater part of the body. Each uterus terminates in a small bulb-like receptaculum seminis, from which is given off a very narrow oviduct, with walls composed of a single row of cells. This soon passes abruptly into the wider and elongated ovary.

Writers describing the female genital system in other species have usually given definite measurements for the various parts of it, and have described their exact conformation and disposition in the body, evidently on the assumption that these are constant characters, and have some specific value. But, in *P. antarctica,* the examination of a long series of specimens has proved that in no two, even among worms of the same size, are they alike.

The striking diversity which is found in the disposition of the terminal portions of the system is illustrated in Text-figures 11-16. The vestibule is usually sinuous, but may extend either straight back (Text-fig. 15) or straight forward (Text-fig. 12) from the vulva, the reservoir continuing on in the same direction (Text-figs. 12-14) or bending abruptly, and forming with the vestibule a U-shaped loop either inverted or upright (Text-fig. 15). The common trunk, in turn, may be bent back on the reservoir (Text-fig. 16) or continue in the same direction as it (Text-figs. 12-13), so that the forking of the trunk occurs anywhere from the level of the vulva to the maximum length of the tubes from it, either anteriorly or posteriorly. All the various forms are found in adult specimens of about the same size, so that they do not represent different stages of growth. The disposition of the uteri, however, shows a certain uniformity in general arrangement, in spite of the diversity in detail.

Text-figure 11, of a 34 mm. specimen, represents a fairly typical arrangement. Here the division into the four branches takes place in the region of the vulva, and two branches, one from each of the second forkings, immediately turn forward and extend straight up, side by side, to a little distance in front of the junction of oesophagus and intestine, where they bend abruptly and run back parallel, straight down the ventral side of the body, to about a fifth of the body length from the posterior extremity. The other two branches do not bend forward at all, but almost immediately cross to the dorsal side of the alimentary canal and have a straight course, dorsally, down the body, extending a little further back than the ventral pair of uteri, to within 5.6 mm. of the posterior extremity. Each uterus folds forward again for a distance of 5 or 6 mm., and terminates, somewhere about the posterior fourth of the body, in the receptaculum seminis, from which the looped and coiled ovary extends backwards.



Figs. 11-19. *Physaloptera antarctica* var. *typica.*

Female genitalia. Variations in arrangement of the parts nearest to the vulva shown in figs. 11-16. (Figs. 11-15, x 10, fig. 16, x 20).

11. 34 mm. specimen; 12. 40 mm. specimen; 13. 23 mm. specimen; 14. 25 mm. specimen; 15. 34 mm. specimen; 16. 43 mm. specimen; 16a, vulva (x 32); 17. Ovaries, oviducts, receptacula, seminis, and terminal portions of the four uteri of a 43 mm. specimen (x 6.3); 18. Ovum in oviduct (x 127); 19. Receptaculum seminis (x 32); ov., ovary; ovi., oviduct; r., reservoir, r.s., receptaculum seminis; t., common trunk; ut., uterus; v., vestibule.

The regular disposition of the uteri in straight lines, parallel to the length of the body, with very few coils or twists, their forward extension beyond the level of the vulva, and their termination a considerable distance in front of the anus are all characteristic features. The paired arrangement, one pair above and one below the intestine, is also very common, and the tendency to forward growth is usually confined to one pair which can, as a rule, be distinguished, even where the forking of the common trunk occurs in front of the vulva, and the direction of all four uteri is at first anterior, or where the whole system is directed backwards, behind the vulva. The latter arrangement, shown in Text-fig. 13, is that most commonly found in immature specimens under 25 mm. in length, though some young specimens as small as 18 mm. show the forward extension which is present in all the older individuals.

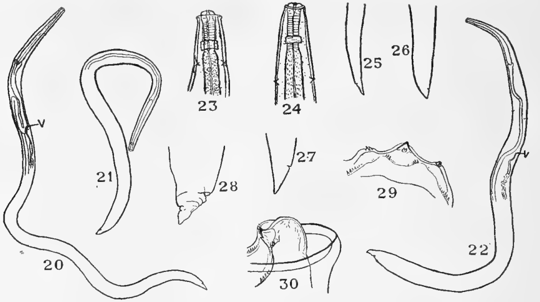
The exact position of the most anterior loops of the uteri varies considerably, and has no constant relation to the total body length. Some specimens less than 20 mm. long have been found with the anterior uteri reaching far forward, beyond the base of the oesophagus, while in mature specimens between 34 and 43 mm. long, the anterior loops may be found either behind or in front of the junction of oesophagus and intestine, the distance from the anterior extremity varying from 1.5 mm. (43 mm. specimen) and 2.6 mm. (34 mm. specimen) to 7.8 mm. (40 mm. specimen). In the latter example (40 mm. specimen), which is shown in Text-fig. 12, and of which the complete measurements are given in the table (p. 243), the vulva is rather exceptionally far from the anterior extremity, 11 mm. distant, where other individuals of the same length have it 9 mm. distant.

The distance of the most posterior loops of the uteri from the posterior extremity varies similarly, from 13.3 mm. in a 43 mm. specimen, to 4.1 mm. in a 34 mm. specimen; and the receptacula seminis may be situated either in front of the uterine loops or behind them (Text-fig. 17), at a distance of 11.9 to 5.2 mm. from the posterior end. In young specimens of 20 to 25 mm. length, the uteri are more closely packed than in the older individuals, and frequently do not occupy more than 3 or 4 mm. of the total body length. In an immature specimen 18 mm. long, in which the anterior extension of the uteri is very pronounced, the receptacula seminis are found only 2 mm. behind the level of the vulva, and the uteri do not extend more than 1 mm. further back, so that the whole genital system is grouped in the anterior half of the body. Even in the more common arrangement among immature specimens, in which it lies entirely behind the vulva (Text-figs. 13, 14), the narrow, delicate, poorly developed uterine tubes do not extend far posteriorly, usually terminating at a distance of 6 to 11 mm. from the tail.

The dimensions of the various parts of the system vary quite as much as their disposition, and measurements taken from a single specimen are of little specific value.

In many adult individuals the reservoir is sharply delimited, and much dilated, being crammed with eggs, while the common trunk is also distended with eggs, and a continuous row of eggs extends along the vestibule to the vulva (Text-fig. 16). But in other adults of the same size, which have large uteri distended with eggs, the reservoir swelling is slighter and more gradual, its limits less clearly defined, and the few eggs in it are gathered into a cluster towards its middle; while no eggs are present in the vestibule, the walls of which are in contact, and only a few isolated eggs occur in the common trunk. Some immature specimens have the position of the reservoir marked only by a slight increase in diameter in the otherwise uniform trunk, due to the presence of a single row of eggs there, no other eggs being found till the uteri are reached (Text-fig. 14), but in other specimens not more than 18 mm. long, in which the uteri are only .08 mm. wide, and contain only one or two rows of undeveloped eggs, the reservoir is already well defined, and has a greater diameter than in mature worms of twice the size. The reservoir, therefore, appears to be simply a more or less distended portion of the common trunk, varying in length from .72 to 1.2 mm., and in width from .144 to .288 mm.

The vestibule is always long, though its length is often concealed in sinuous folds which make exact measurements difficult. Its length varies quite irregularly from .90 to 1.8 mm. and the common trunk shows similar variations, irrespective of the size of the worm, from 1.44 to .720 mm. The diameters of vestibule and common trunk vary from .064 to .112 mm., the maximum width being due to the presence of eggs, but the vestibule is always slightly wider than the common trunk of the same specimen. The two branches into which the common trunk divides are very narrow, .06 to .08 mm., and slightly unequal in length, their respective lengths varying from .144 and .192 mm. through all intermediate lengths to .480 and .544 mm. After the second forking, the four slender branches connect with the four uteri at distances varying from .640 to 1.56 mm. in different individuals.



Figs. 20-30. *Physaloptera antarctica* var. *typica,* and var. *lata.*

20. Var. *typica*, 20 mm. female; v., vulva; 21. Var. *lata*, 14 mm. female; 22. Var. *lata*, 18.6 mm. female; 23. Var. *typica*, and 24. Var. *lata*.—dorsal view of anterior end, showing position of cervical papillae, nerve-ring and junction of muscular and glandular oesophagus (x 20); 25. Var. *typica*, 26. Var. *lata*, 22 mm. females,—posterior end (x 6.3); 27. Tail of female, var. *typica*, same specimen as shown in fig. 20 (x 20); 28. Tail of 31 mm. female, var. *lata* (x 20); 29. Internal face of lip, var. *lata* (x 116); 30. Dorsal view of lip, var. *lata* (x 116).

The uteri in the older specimens are crowded with eggs and attain a maximum width of .35 mm., smaller and younger specimens having proportionally narrower uteri, only .08 mm. wide when quite immature. The receptacula seminis are marked off from the oviducts by deep constrictions, but pass gradually into the uteri (Text-fig. 19), the diameter of uterus at the junction being .128 mm. and of oviduct .048 mm. The receptaculum seminis, in its maximum development, measures .480 mm. in length, and .288 mm. in diameter; the oviducts 1.6 to 1.8 mm.; the ovaries about 9.5 mm

The lengths given by Linstow for males and females of *Physaloptera antarctica* (27 mm. and 42 mm.) correspond exactly with the maximum lengths found among these specimens, and with the lengths given by Stossich for *P. alba.* The size is exceptionally large for species parasitic in lizards and, as already pointed out in the review of the *Physaloptera* of lizards (Irwin-Smith, Proc. Linn. Soc. N.S.W., xlvii., 1922, p. 58), *P. alba* is probably a synonym. The figure of the male tail given by Stossich shows the characteristic pedunculated caudal papillae, though not preanal papillae. And the host from which his specimens are recorded, *Cyclodus boddaertii* Dum., has been shown to be probably identical with *Tiliqua scincoides* White, from which the present specimens were obtained. Linstow's specimens were taken from a closely related host, *Tiliqua occipitalis* Gray.

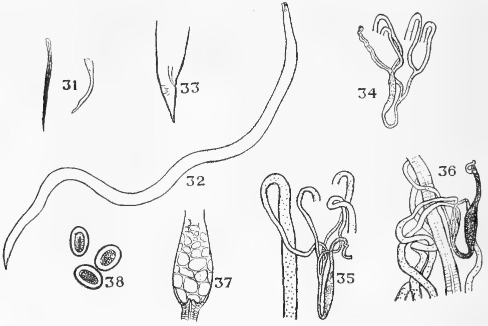
PHYSALOPTERA ANTARCTICA VAR. LATA.

Most of the specimens in collection A are of somewhat shorter and stouter build than those in collections B and C, and the body is unevenly proportioned, being thickest in the posterior third, gradually attenuated towards the anterior (Text-figs. 21-22). The structure and dimensions, otherwise, are very similar in the two forms, and the relative proportions of the different parts vary much within the same limits, as will be seen by the comparative tables of measurements below. The differences, which are best illustrated by Text-figs. 20-28, do not seem to be of sufficient importance to warrant the classification of these specimens as a new species. Therefore, I have grouped them as a new variety, *lata*, of the species *Physaloptera antarctica.* The most notable differences are the disproportionate thickness of the posterior end in var. *lata,* in all specimens, even to the most immature, and the more advanced maturity of the smaller-sized females, between 18 and 25 mm. long.

Diagnosis.—Denticular formation on lips (Text-fig. 29) very similar to that in var. *typica.* Oesophagus one-eighth to one-seventh of the total body length in the larger specimens, increasing to one-fifth in the smallest, slightly longer, on the average, than in var. *typica* of corresponding size. Postcervical papillae a little further back from the junction of muscular and glandular oesophagus, the maximum distance from the anterior extremity being .880 mm. (Text-fig. 24).

Males 13 to 23 mm. long, average length 17.7 mm.; maximum diameter .53 to .80 mm. Bursa quite similar to var. *typica,* but relatively a little larger, its alae .48 mm. wide; the three pairs of caudal papillae a little further removed from the tail point, the cloacal aperture one-fourteenth to one-eighteenth of the body length from the extremity. Spicules similar in form and length to those of var. *typica,* but of a slightly heavier build (Text-fig. 31). Genital system just as in the other form.

Females (Text-figs. 21, 22) 14 to 34 mm. long, average length 24 mm.; maximum diameter .80 to 1.45 mm. Tail more or less shrunken and distorted in all the specimens; measurements only approximate, but apparently shorter and more obtuse than in var. *typica* (Text-fig. 28); anus one-ninetieth to one-sixtieth of the body length from its extremity. Vulva prominent, 1/2.5 to 1/4.8 of the body length from the anterior extremity, average distance 1/3.5. Eggs quite similar. Genitalia grouped entirely behind the level of vulva; consisting of the same parts as in var. *typica,* with the dichotomous division into four uteri. Uteri, in all specimens, quite irregularly arranged, much twisted, intertwined and spirally coiled; mostly on the ventral side of the body, and crowded towards the posterior third, the last coils and the receptacula seminis always within a short distance of the anus. Maximum diameter of uterus .336 mm., much larger in the smaller specimens than in var. *typica*; crowded and distended with well developed eggs in specimens of 18 and 19 mm. lengths; measuring .288 mm. in width, as compared with .080 mm. in the other form. The terminal portions of the system variable in arrangement, but frequently reservoir and common trunk form a U-shaped loop, and the uteri are much coiled in the region of the vulva, rarely extending anterior to it, and never more than 1.8 mm. (Text-figs. 34-36). The dimensions similarly variable, without relation to the length of the specimen. Vestibule 1.0 to 1.44 mm. long; reservoir .56 to 1.08 mm. long; and .112 to .400 mm. wide; common trunk .64 to 1.12 mm. long; the two branches respectively .08 and .16 mm. to .56 and .64 mm. long. Receptaculum seminis .416 mm. long



Figs. 31-38. *Physaloptera antarctica* var. *typica* and var. *lata*.

31. Male spicules, var *lata* (x 32); 32. Immature specimen of same type as var. *typica*, in collection A., with var. *lata*, 20 mm. long, genitalia not developed (x 5); 33. Tail of specimen shown in fig. 32 (x 20); 34-36. Female genitalia, var. *lata* (x 10); 34. 19 mm. specimen; 35. 27 mm. specimen; 36. 33 mm. specimen; 37. Receptaculum seminis, var. *lata* (x 67); 38. Eggs from uterus, var. *lata* (x 127).

and .272 mm. wide; oviduct at junction with it .048 mm. wide, but uterus merging gradually into it, .080 mm. wide at junction. Uteri 20 to 30 mm. long; oviducts 1.3 to 1.7 mm. long. Distance of most posterior loops of uteri from tip of tail .640 to 3.64 mm.

Unfortunately, the student who collected these specimens (lot A) did not make a specific record of the host from which they were taken, and the only information available is "From the intestine of a lizard, Sydney, 1915." The species commonly used for class dissection in the Zoology School in Sydney is *Tiliqua scincoides* White, but at the date of this collection some specimens of *Egernia cunninghamii* Gray were included among the lizards examined in class, and it is possible, though not probable, that the nematodes were taken from the latter species.

Examples of *P. antarctica* var. *typica* and type specimens of var. *lata* have been deposited in the Australian Museum, Sydney.

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Table of measurements (in mm.) of females of P. antarctica.

	var. *typica.*			var. *lata.*		
Total length	40	34	18	34	28.7	19
Maximum diameter	1.0	1.0	.59	1.25	1.0	1.0
Length of muscular oesophagus	.528	.480	.352	.512	.480	.480
Total length of oesophagus	4.16	4.00	2.70	4.26	4.10	3.90
Distance from cephalic extremity of: nerve ring	.480	.432	.320	.480	.360	.448
postcervical papillae	.608	.640	.544	.768	.784	.640
vulva	11.18	7.12	5.82	8.00	7.02	7.28
most anterior loop of uterus	7.28	3.5	1.82	8.2	8.58	7.0
Distance from posterior extremity of: most posterior loop of uterus	9.51	4.16	9.3	1.28	1.12	1.21
receptac. seminis	8.58	5.2	10.1	.96	1.8	.94
anus	.80	.68	.37	.51	.32 ?	.32
Length of vestibule	.96	1.82	1.0	1.44	1.44	1.22
Length of reservoir	.96	.88	.88	1.04	1.08	.88
Width of reservoir	.176	.256	.240	.128	.368	.144
Length of common trunk	.72	1.44	.79	.96	.96	1.12
Length of the two branches	.32, .35	.48, .54	.21	.32, .40	.16, .28	.56, .64
Egg	.051 × .040	.048 × .037	.048 × .034	.051 × .040	.048 × .040	.055 × .037

Table of measurements (in mm.) of males of P. antarctica.

	var. *typica.*			var. *lata.*	
Total length	23.5	15	larva. 14	23	16
Maximum diameter	.640	.448	.592	.768	.720
Length of muscular oesophagus	.368	.320	.352	.448	.416
Total length of oesophagus	3.0	2.28	2.70	3.53	2.91
Distance from cephalic extremity of: nerve ring	.336	.256	.320	.400	.368
postcervical papillae	.576	.448	.480	.576	.592
Diameter of body above bursa	.512	.320		.672	.640
Length of bursa	1.76	1.47		2.49	1.71
Lateral width of bursa	.80	.69		1.23	.89
Length of left spicule	.720	.700		.752	.720
Length of right spicule	.384	.320		.416	.384
Length of bursal papillae, 1	.240	.208		.368	.368
Length of bursal papillae, 2	.304	.240		.432	.400
Length of bursal papillae, 3	.240	.192		.320	.272
Length of bursal papillae, 4	.192	.144		.256	.240
Distance from tail point of: anal papillae, 1	.384	.272		.592	.352
anal papillae, 2	.528	.416		.816	.544
anal papillae, 3	.592	.464		.912	.608
cloaca	1.12	.96	.45 (larval tail)	1.60	1.12

NOTES ON AUSTRALIAN *TABANIDAE*. PART ii.

By EUSTACE W. FERGUSON, M.B., Ch.M., and GERALD F. HILL, F.E.S.

(Ten Text-figures.)

[Read 26th July, 1922.]

The present paper is in continuation of our previous one published in These Proceedings (1920, p. 460). Certain additional information has in the meantime come to hand regarding Australian species and has been incorporated in the present paper. For much of this information we are again indebted to Dr. Guy A. K. Marshall of the Imperial Bureau of Entomology. An examination of the Tabanid types in the Queensland Museum has also revealed the necessity for further alterations.

The arrival of Surcouf's Monograph of the *Tabanidae* (Wytsman's Gen. Insect., Fasc. 175, 1921) has revealed an extensive use of names, particularly in the genus *Tabanus,* preoccupied by species in other portions of the world Unfortunately a name (*minusculus*) we proposed in our previous paper to replace a preoccupied name (*minor*) is also preoccupied, but as it is not given in Kertesz's Catalogue, we overlooked its prior use.

The following names appear from Surcouf's work to be preoccupied. Alternative names are proposed for these in the body of the paper.

Tabanus confusus Taylor (1917) preoccupied by *T. confusus* Walker (1838); *T. latifrons* Ferg. (1921) by *T. latifrons* Zetterstedt (1842) = *T. cordiger* Meigen; *T. macquarti* Ric. (1915) by *T. macquarti* Schin. (1868) = *T. bigoti* Bellardi (1859); *T. meridionalis* Ferg. (1920) by *T. meridionalis* Thunb. (1827); *T. minusculus* Ferg. & Hill (1920) by *T. minusculus* Hine (1907); and *T. pygmaeus* Ferg. & Henry (1919) by *T. pygmaeus* Williston (1887).

There also seems to be a prior use of *Tabanus bifasciatus,* but the reference is queried as follows:—

144 ? *T. bifasciatus* Fourcroy (= ? *Chrysops*) Ent. Paris, Vol. 2, p. 450 (1785) Europe.

This would appear to preclude the use of the name by Macquart (1834), but as the species has not been recognised in recent collections we do not propose to make any alteration in the name.

Silvius notatus Ric. (1915) might also be regarded as preoccupied by *Diachlorus notatus* Bigot (1893) a synonym of *Silvius quadrivittatus* Say (*Chrysops*) (1823). In this case also we do not propose to alter Miss Ricardo's name, as *Diachlorus notatus* Bigot does not appear to have been known as *Silvius* *notatus*. If, according to the strict application of the rules of nomenclature, a change becomes necessary, *S. psarophanes* Taylor (1917) might be used for the species, or if, as suggested in our previous paper, *S. fuliginosus* Taylor (1916) is merely a geographical race of the same, then that name might be given precedence.

Pangonia dorsalis Macquart (1838) is apparently preoccupied by *Pangonia dorsalis* Latreille (1821), though Macquart's species has been placed by Surcouf in *Corizoneura*. Nothing resembling the description has been found by recent collectors in Australia, and we doubt if the species is really Australian, particularly as no Australian member of the Pangoninae known to us is without ocelli.

M. Surcouf similarly expresses doubt as to *Stibasoma hemiptera* Surcouf being Australian. A doubt is also expressed as to *Acanthocera australis* Ric. (1915) really belonging to this genus, in view of the fact that the antennae were missing when described.

Two species *Corizoneura alternans* Macq. and *C. sulcifrons* Macq., removed from the Australian list as African species, are still retained as from Oceania in M. Surcouf's monograph.

The locality of Australia, given by Surcouf (p. 134) for *Corizoneura umbratipennis* Ric., is an evident misprint for Africa.

Tabanus dubiosus Ric. (1915) from Australia is placed by Surcouf (p. 67) as a synonym of *T. dorsovittatus* Macq. (1855) from South America. That specific identity should exist between an Australian species and a South American is, we consider, extremely doubtful. Possibly the resemblance may be due to convergence. We do not know if *T. dorsovittatus* Macq. is a common and well authenticated South American species; if not, the question of correct location might require to be considered.

Two other species that occur on the Australian list should, we consider, be also removed as not being Australasian. Both are placed by Ricardo in *Pangonia* (sens. strict.) which, as far as our knowledge goes, does not occur in Australia.

Pangonia fulviventris Macq. (1838) was described from an unknown locality, but was queried by Walker as Australian. There appears to be no evidence whatsoever that it is from Australia.

Pangonia fuscanipennis Macq. (1855), described from Cape of Needles, Oceania, is probably an African species. The evidence for this suggestion is that several other species described in the same place and from the same locality—*Cadicera rubramarginata* Macq., *Corizoneura alternans* Macq., *C. sulcifrons* Macq. —are now known to be African species. Cape of Needles is a translation of Cap des Aiguilles and in all probability is intended for Cape Agulhas, though, as Dr. Marshall who made this suggestion to us also points out, there is the possibility of Cape Aiguilles on Great Barrier Island, N. Zealand being the place intended. As *Pangonia* (sens. strict.) does not occur in New Zealand it is much more probable that the African locality is correct.

Under *Pangonius* Latr. in Surcouf's monograph, appear several Australian species relegated by Miss Ricardo to *Pangonia* (sens. lat.). Undoubtedly none of these will come into *Pangonius* (sens. strict.), but further consideration of the species concerned is deferred for the present.

A further alteration made by M. Surcouf that might be noted is the revival of the genus *Mesomyia* for species of *Silvius* with pubescent eyes. *S. niger* Ric. is placed in this genus, but *S. montanus* Ric., *S. imitator* Ferg. and *S. sulcifrons* Ferg. might also be placed here.

M. Surcouf has also separated *Diclisa* from *Scione,* one Australian species (*Scione singularis* Macq.) being placed in *Diclisa.* Into the question of the validity of the two genera we do not propose to enter, but it must be emphasised that as *Scione* and *Diclisa* were founded on the same genotype—*S. incompleta*—the name *Diclisa* becomes an absolute synonym of *Scione* and cannot be separately used for a distinct genus.

It is rather unfortunate that several papers dealing with Australian Tabanidae have not been noticed by Surcouf. Many of these are probably of too recent date for inclusion, but species described in papers by Taylor and also by Hardy should not have been overlooked.

While our present communication deals in great measure with questions of synonymy and nomenclature, a number of new species are also described. These include one species of *Silvius* and 7 species of *Tabanus.*

APOCAMPTA SUBCANA Walker.

Chrysops subcanus, Walker, List Dipt. Brit. Mus., 1., 1848, p. 204.—*Apocampta subcana,* Ricardo, Ann. Mag. Nat. Hist., (7), viii., 1901, p. 287.—*Apocampta nigra,* Schiner, Nov. Reise, Dipt., 1868, p. 96; Ricardo, *op. cit.,* (7), v., 1900, p. 99.—*Diachlorus melas,* Bigot, Mem. Soc. zool. France, v., 1892, p. 625; Ricardo, *op. cit.,* (7), xiv., 1904, p. 357.—*Diatomineura ? gagantina,* Bigot, Mem. Soc. zool. France, v., 1892, p. 620; Ricardo, *op. cit.,* (8), xv., 1915.—*Diatomineura minima,* Ricardo, *op. cit.,* (7), v., 1900, p. 119, tab. 1, fig. 4-5.—? *Pangonia anthracina,* Macq., Dipt. Exot., Suppl. iv., 1850, p. 23, Tab. 2, fig. 3.—*Corizoneura anthracina,* Ricardo, *op. cit.,* (7), v., 1900, p. 113.

The synonymy *Chrysops subcana* Walk. = *Diachloris melas* Big. = *Apocampta nigra* Schin. has already been recorded by Ricardo, as has also that of *Diatomineura gagantina* Bigot with *Diatomineura minima* Ric.

At the request of one of us (E.W.F.) Dr. Guy Marshall very kindly compared a specimen sent to him with the types of *subcana, gagantina,* and *minima* and informed us that the three species were synonymous.

It is possible that *Corizoneura anthracina* Macq., should also be referred to the same species. The rather meagre description fits *subcana,* except that the eyes are described as bare; but as the specimen was abraded when described, this fact may account for the eyes being so described. There are specimens of *subcana* under the name of *anthracina* Macq. in the Macleay Museum.

On several occasions specimens have been received for identification (G.F.H.) which were taken whilst attacking persons bathing along the beaches of Magnetic Island, N.Q. (6.2.21).

DIATOMINEURA SUB-APPENDICULATA Macq.

Pangonia sub-appendiculata, Macquart, Dipt. Exot., Suppl. 4, 1850, p. 19.—*D. subappendiculata,* Ricardo, Ann. Mag. Nat. Hist., (7), v., 1900, p. 113.—*D. inflata,* Ricardo, Ann. Mag. Nat. Hist., (8), xvi., 1915, p. 34.

Macquart's species has not been identified by recent workers on Australian Diptera, but the size and description tally with *D. inflata* Ric.

The presence of an appendix to the fork of the third longitudinal vein is, however, variable, and in the majority of our series there is no appendix, but only a slight angulation; in some, however, there is a short but definite spur. The frontal callus is stated to be black, but it is more generally reddish; our series again shows this to be variable.

It is probable that the actual type of *D. sub-appendiculata* has been examined by one of us (E.W.F.). In the Museum d'Histoire Naturelle, Paris, several specimens of *D. inflata* were seen, labelled *Pangonia fuscitarsis* Macq. This name, however, does not appear to have been published, and it seems possible that the name may have been altered before publication and *sub-appendiculata* inserted. The specimens were also labelled as from Tasmania and from the Verreaux collection. The species, however, has not been met with by recent collectors in Tasmania and is a common one in the coastal districts of New South Wales, so that the locality has probably been wrongly given.

Diatomineura violacea Macquart.

Pangonia violacea, Macquart, Dipt. Exot., Supp. 4, 1850, p. 22.

These flies were very plentiful indeed on Palm Island, N.Q. in late September. Specimens were taken on the beach, on hillsides, in scrub-covered ravines, on open grassy flats and in the dwellings. They were more sluggish than most species of the family, keep near the ground, and show a decided preference for persons dressed in dark-coloured materials.

Specimens of this species from the southern part of its range (New South Wales) are as a rule of a greenish-blue colour, while northern forms are more purple. Both forms are to be taken in southern Queensland. The Magnetic Island specimens are of interest in that their colouration corresponds with the southern form.

Corizoneura chrysophila Walker.

Tabanus chrysophilus, Walker, List Dipt. Brit. Mus., 1, 1848, p. 155; Ricardo, Ann. Mag. Nat. Hist., (7), v., 1900, pp. 113, 120.—*Pangonia aurofasciata,* Jaennicke, Abh. Senck. Gesellsch., vi., 1868, p. 327, Pl. 43, fig. 5; Ricardo, *l.c.,* pp. 113, 120.—*Pangonia nigrosignata,* Thomson, Eugen. Resa., 1868, p. 541; Ricardo, *op. cit.,* (8), xvi., 1915, p. 36.—*Pangonia rufovittata,* Macq., Dipt. Exot., Supp. 4, 1850, p. 19.

The above synonymy, with the exception of *Pangonia rufovittata* Macq., is given on the authority of Miss Ricardo. This species was seen (E.W.F.) in the Paris Museum among Macquart's specimens of Tabanidae labelled *Pangonia rufovittata* Macq., n.sp. Tasmania No. 529. The description of *Pangonia rufovittata* also agrees with *C. chrysophila* Walk. The locality (Tasmania) given by Macquart is probably wrong, other records appearing to be all from Sydney—specimens are in the Australian and Macleay Museums from here. The species seems to be now much rarer, as few captures appear to have been made of recent years. There are, however, two specimens under examination, one taken at Roseville in January, 1914, and one at Broadwater, Richmond River, during last season (1920-21).

We have retained the old generic title for this and allied Australian species, though these species (at any rate *chrysophila* and *fulva*) do not come under the restricted generic diagnosis of *Corizoneura* given by Austen (Bull. Entomol. Research, xi., part 2, 1920, p. 139). At the same time, it hardly seems justifiable to place them under the new genus *Buplex.* Probably extensive alterations in the generic designations of Australian Pangoninae may be required owing to the revival of Walker's sub-genera (Insect. Saund., Dipt. Part 1, 1850, pp. 7-11), and until all our Australian forms can be examined and compared with species from other parts of the world, it seems better to continue to employ, for the time being, the well-known nomenclature of Rondani.

Coenoprosopon hamlyni Taylor.

Taylor, Proc. Linn. Soc. N.S. Wales, xlii., 1917, p. 521, Plate xxviii., fig. 3.

Examination of the type in the Queensland Museum (E.W.F.) shows that the species is incorrectly referred to *Coenoprosopon*. The palpi are altogether different from the form described by Ricardo as characteristic of this genus, as will be seen from a glance at the figure given by Taylor. In *Coenoprosopon* the second joint is club-shaped with the expansion situated apically. The exact genus to which this species should be referred is uncertain, and provisionally it might be referred to *Corizoneura*, as the palpi are similar to those structures in *C. fulva* Macq. The antennae should have the third joint 8-annulate, but the annulations are not easy of definition, the apical 4 are distinct, but the basal 4 are more or less fused, with only indistinct traces of the annulations. A very similar structure is seen in *Pseudotabanus* * and it is possible that *hamlyni* would be more correctly placed in that genus.

The name *Corizoneura* is used in the old sense; probably our Australian species will come under Austen's new genus *Buplex*.

Palimmecomyia walkeri Newm.

Pangonia walkeri, Newman, Trans. Ent. Soc. Lond., iv., 1856, p. 56.—*Palimmecomyia celaenospila*, Taylor, Proc. Linn. Soc. N.S. Wales, xlii., 1917, p. 518, Plate xxviii., fig. 2.

There seems no doubt that Taylor's species is the same as Newman's. The latter's name has dropped out of Miss Ricardo's list, though given in Froggatt's. We are indebted to Mr. Longman, Director of the Queensland Museum, for the loan of a paratype of *Palimmecomyia celaenospila* Taylor, and it corresponds closely with Newman's description, the only difference being the omission of any mention of the lateral spots on the basal abdominal segments. The colouration is most distinctive, especially the contrast of the black scutellum and under surface with the yellow colour of the rest of the insect. Taylor's figure of the wing is darker than it should be, and Newman's terse description "alis, nitidissimis hyalinis, nebula apicali fusca" gives a better picture. The first posterior cell appears to be variable; it is described as open by Taylor, and is open in the paratype—the figure, however, shows it as nearly closed in the margin and in a specimen in the Macleay Museum it is closed above and united to the margin by a short stem.

Newman's type came from the same locality as Taylor's. The species extends into New South Wales, and the specimen in the Macleay Museum is from Lane Cove, Sydney, while there is also a specimen in the collection of the Department of Agriculture of New South Wales, from Temora.

Silvius equinus, n.sp. (Text-figures 1 and 2.)

Colour. Antennae and thorax mummy brown, scutellum paler, 1st abdominal segment darker, palpi, proboscis and legs blackish-brown, wings uniformly dark smoky, excepting costal cell, which is darker than others; remainder of abdomen blackish, each segment excepting the last with a narrow but distinct apical fringe of white hairs. *Head* (Text-figs. 1 and 2): Frons clothed with golden pile and scattered short black hairs. Callus more or less quadrate, as wide as frons, with backward linear extension nearly reaching ocellar triangle. Occiput golden, with fringe of scattered silvery hairs. Antennae with first and second

* At any rate in *P. queenslandi* Ric., the only species of the genus examined.

joints clothed with short black hairs; third joint globose in profile, compressed laterally. Palpi long and slender, clothed with numerous short black bristles. Genae with long black hairs. *Thorax*: Dorsum of thorax with traces of golden dusting, anterior two-thirds clothed with black hairs, posterior third and scutellum with white hairs. Legs densely clothed with black hairs, knees pale. *Wings*: Vein R. 4 without appendix but markedly geniculate. *Abdomen* long and narrow, densely clothed with black hairs, excepting apex of segments one to six which are white.

Dimensions: ♀. Total length, 11 mm.; wing, 10.5; width of head, 3.80; width of frons, 0.40.

Type unique; in coll. Australian Institute of Tropical Medicine, Townsville, N.Q.

Hab.—N. Queensland: Gordonvale, December (A. P. Dodd).

This species appears to be most closely related to *Silvius distinctus* Taylor (Bathurst Island, Northern Territory) from which it is distinguished, *inter alia*, by the form of callus, presence of silvery pubescence on thorax and scutellum, more sinuous vein R. 4, and much narrower white bands on abdomen.

A male from Moa Island probably belongs to the same species, but as both antennae are broken the identity is not certain.

SILVIUS TRYPHERUS Taylor.

Silvius trypherus, Taylor, Proc. Linn. Soc. N.S. Wales, xl., part 4, 1915, p. 811.—*Silvius elongatulus*, Taylor, *loc. cit.*, p. 812.—*Silvius elongatulus* var. *persimilis*, Taylor, *op. cit.*, xliv., part 1, 1919, p. 43.

We have had under examination a series of *S. elongatulus* Taylor, and of *S. elongatulus* var. *persimilis* Taylor from Batchelor and Stapleton and also the unique type of *S. trypherus* Taylor from Boorooloola. Included in the series are specimens from Stapleton which were placed by Taylor in two series A and B, no name being however attached. A. agrees with var. *persimilis* in that the base of the abdomen is lighter in colour, while B. agrees with *S. elongatulus*. In both cases there is, however, some difference in the shape of the callus. Examination of the series of *elongatulus* shows that the callus is variable in shape as is also the amount of light colouration of the base of the abdomen.

The type of *S. trypherus* Taylor has also been compared with the series and, while at first sight the species appears to differ from *S. elongatulus* in that the callus seems broader and less prominent, examples occur in the series of *S. elongatulus* in which the callus is exactly as in *S. trypherus*. One specimen has the callus of *S. trypherus* and the abdomen of *S. elongatulus* var. *persimilis*.

It seems evident therefore that these three names apply to only the one species which is, however, variable in the exact shape of the callus and in the abdominal colouration.

The name *trypherus* has priority of one page over *elongatulus*.

SILVIUS LURIDUS Walker.

Walker, List Dipt., 1, 1848, p. 140; Ricardo, Ann. Mag. Nat. Hist., (7), v., 1900, p. 121 and (8), xvi., 1915, p. 260; Ferguson and Henry, Proc. Linn. Soc. N.S. Wales, xliv., 4, 1919, p. 838.—*S. hackeri*, Taylor, Proc. Linn. Soc. N.S. Wales, xliv., 1, 1919, p. 45.

The type of *S. hackeri* Taylor in the Queensland Museum has been examined and compared with a specimen of *S. luridus* Walk. from Kendall. The determination of the Kendall series was originally made by comparison of a specimen with Walker's type.

SILVIUS SORDIDUS Taylor.

S. sordidus, Proc. Linn. Soc. N.S. Wales, xl., 1915, p. 808—*S. subluridus*, Taylor, *op. cit.*, xli., 1916, p. 752.

We have examined the type of *S. subluridus* Taylor and cannot distinguish it from *S. sordidus* Taylor; the name must therefore be added to the synonymy already given by us in our previous paper (Proc. Linn. Soc. N.S. Wales, xlv., 1920, p. 462).

SILVIUS FULVOHIRTUS Taylor.

S. fulvohirtus, Taylor, Proc. Linn. Soc. N.S. Wales, xl., 1915 (1916), p. 814.—*S. vicinus*, Taylor, Proc. Linn. Soc. N.S. Wales, xliv., 1919, p. 46.

Two specimens of this rare species have recently been received for identification from Cairns district, N. Queensland.

A specimen which had been compared with the type *S. fulvohirtus* Taylor, was forwarded to the Queensland Museum and Mr. Hacker very kindly compared it with the type of *S. vicinus* Taylor in that Institution. Mr. Hacker subsequently wrote that, apart from some slight differences in the clothing and in the colour of the legs, the specimen sent agreed with the type of *S. vicinus*. He further stated that in his opinion the two species were identical, the apparent differences being due to abrasion and to fading.

TABANUS NEMOPUNCTATUS Ric.

T. nemopunctatus, Ricardo, Ann. Mag. Nat. Hist., (8), xiv., 1914, p. 388.—*T. aurihirtus*, Ricardo, *op. cit.*, (8), xv., 1915, p. 290.—*T. hackeri*, Taylor, Proc. Linn. Soc. N.S. Wales, xlii., 1917, p. 522.

The synonymy of this species is somewhat involved and has been the subject of much correspondence between the authors and Dr. Guy A. K. Marshall of the Imperial Bureau of Entomology, to whom their thanks are due for his kindness in helping to elucidate this and other problems.

The chief point at issue was the identity of the specimens in the British Museum labelled *T. townsvillei* Ric. These did not in the least correspond to the description given by Miss Ricardo, and we are now informed that the specimens in question are really the types and paratypes of *T. aurihirtus* Ric., the wrong name-label having been attached. The question of the identity of *T. townsvillei* Ric. must remain in abeyance for the present.

For our identification of *T. nemopunctatus* Ric., we are relying upon the comparison by Dr. Marshall of specimens sent to London (E.W.F.) under the name *T. hackeri*, these specimens having been kindly given us by the Queensland Museum authorities. In his letter Dr. Marshall states "*T. hackeri*, Taylor—very close to the unique type of *T. nemopunctatus* Ric., and doubtfully distinct." These specimens of *T. hackeri* have also been compared with what is practically a paratype of *T. nemopunctatus* in Mr. Froggatt's collection, and also with the original description and we cannot find any reason to separate them. The identity of *T. aurihirtus* Ric. with *T. nemopunctatus* Ric. is more open to question. The only difference apparently is that *T. nemopunctatus* has no callus, while one is described in *T. aurihirtus*. Miss Ricardo, however, notes that the callus may possibly be covered by the pubescence in very fresh specimens.

The series of *T. aurihirtus* before us was originally determined as *T. townsvillei* Ric. from comparison with the specimens in the British Museum referred to above. Comparison with our series of *T. hackeri* Taylor shows that the two series are certainly conspecific.

Hab.—Our series includes specimens from the following localities:—Queensland: Palm Island, Townsville, Masthead Island, Bribie Island; New South Wales: Richmond River. The species thus appears to be purely a coastal form.

Note.—Further information on the identity of the two species has been received from Major E. E. Austen, who states definitely from a comparison of the types that *T. aurihirtus* Ric. is a synonym of *T. nemopunctatus* Ric.

Tabanus laticallosus Ric.

T. laticallosus, Ricardo, Ann. Mag. Nat. Hist., (8), xiv., 1914, p. 395.—*T. rufoabdominalis,* Taylor, Proc. Linn. Soc. N.S. Wales, xlii., 1917, p. 525.—? var. *T. heroni,* Ferguson, Rec. S. Aust. Mus., Vol. 1, No. 4, 1921, p. 372.

This species was described on three females from Moreton Island and a male from Stradbroke Island, Moreton Bay.

T. rufoabdominalis Taylor was described on both sexes from Stradbroke Island. We have under examination a series from Stradbroke Island (5 ♂, 1 ♀) which includes specimens received from the Queensland Museum as Taylor's species. The female specimen was sent to London and has been returned identified as *T. laticallosus* Ric. by Dr. G. A. K. Marshall.

We have also a specimen of *T. laticallosus* kindly sent out by Major E. E. Austen and bearing a label M.I., probably for Moreton Island, and evidently one of the specimens Miss Ricardo had under examination. This specimen measures 17 mm. as against 13-15 mm. for the series of *T. rufoabdominalis,* and agrees with a series from Byron Bay measuring from 17-19 mm. This latter series leads up to *T. heroni* (20 mm.) of which the type has been kindly loaned by the South Australian Museum authorities for the purpose of comparison. In *T. heroni* and in most of the Byron Bay series there is a continuous dark median abdominal stripe, and the clothing is generally white, though in some of the Byron Bay series it is golden as in *T. laticallosus.* Apart from size and the above-mentioned differences in clothing and colour, there seems no difference between *T. heroni* and *T. laticallosus,* while the Byron Bay series is intermediate. Further series will probably be necessary to settle the status of these various names, but from the available evidence it seems likely that *T. laticallosus* and *T. rufoabdominalis* are synonymous, while *T. heroni* is only a large variety of the same species.

Structurally, *T. laticallosus* is not closely allied to *parvicallosus* Ric., but is much closer to *T. victoriensis* Ric.; the latter species is hardly separable from *T. heroni* except on colour, though both species occur together.

The specimens recorded by Taylor (Proc. Linn. Soc. N.S.W., xlii., 1917, p. 524) as *T. laticallosus* do not belong to this species, but apparently to an undescribed species near *T. aprepes* Taylor.

Tabanus pseudopalpalis, n.sp.

T. nemopunctatus, Taylor (*nec* Ricardo), Proc. Linn. Soc. N.S. Wales, xli., part 4, 1916, p. 754.

Closely allied to *T. neopalpalis* Ferg. & Hill, (= *palpalis* Taylor), differing in the absence of callus and in the shape of the palpi.

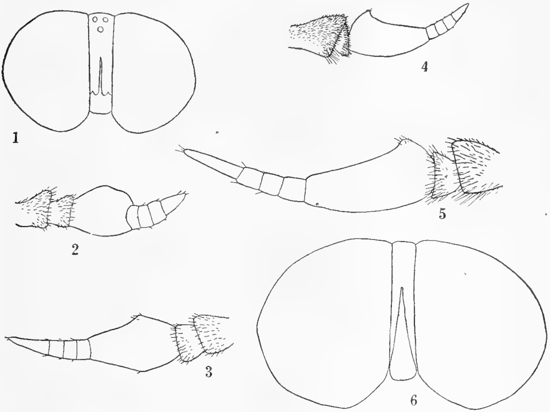
Face, cheeks and subcallus similar to *T. neopalpalis.* Palpi shorter, the second joint stouter, though not greatly thickened at base, and slightly curved, ending in a blunt point, yellow, clothed on outer side with pale hairs with an occasional darker one. Antennae similar to *T. neopalpalis,* slightly lighter in colour. Forehead of same colour as face and clothed with similar tomentum, slightly but definitely narrower than in *T. neopalpalis,* very feebly narrowed to vertex, with sparse pubescence mostly pale; callus apparently absent in type, an inconspicuous hardly elevated laevigate area in this position in another specimen, possibly due to abrasion. Eyes bare.

Thorax as in *T. neopalpalis* with rather sparse golden decumbent pubescence.

Abdomen as in *T. neopalpalis,* apical segments somewhat darker; mainly with black pubescence with some golden pubescence in midline and at sides of segments.

Legs as in *T. neopalpalis.*

Wings with anterior border pale yellow, stigma inconspicuous, appendix present.



Text-figs. 1,2.—*Silvius equinus*, n.sp. 1. Head, frontal view; 2. Antenna.
Text-fig. 3.—*Tabanus pseudocallosus,* n.sp. Antenna.
Text-fig. 4.—*Tabanus breinli*, n.sp. Antenna.
Text-figs. 5,6.—*Tabanus palmensis*, n.sp. 5. Antenna: 6. Head, frontal view.
(All figures drawn from types).

Dimensions: Long, 8 mm.; wing, 9 mm.; width of head, 3.5 mm.; width of frons at widest part, 0.45 mm.

Hab.—N. Territory: Batchelor (Hill No. 1405). Type in Coll. Hill; paratypes in Coll. Aust. Institute of Tropical Medicine and Dept. of Public Health, Sydney. We have hesitated before describing this species as new on account of the great resemblance to *T. neopalpalis* from the same locality. The differences might conceivably be due to variation within the one species, but it seems unlikely that there should be variation in four different characters, such as there are in the length of the palpi, in the frontal callus, in the width of the forehead, and in the costal cell of the wings.

It might be noted that the type of *T. neopalpalis* is much abraded, the abdomen and thorax being practically destitute of clothing. The present species is either one of a group of closely related species or else a form of a very variable species, which would include *T. neopalpalis, T. pseudopalpalis,* the following species and possibly even *T. nemotuberculatus.* Until long series are available it seems better to maintain these forms as distinct species and, in giving names to this and the following, we are doing so with the knowledge that in the future it is quite possible that our names will be relegated to synonymy.

TABANUS PSEUDOCALLOSUS, n.sp. (Text-fig. 3).

Closely allied to *T. nemotuberculatus* and to *T. neopalpalis.*

♀. Face and cheeks honey yellow, clothed with similar coloured tomentum and with a few scattered brown hairs; beard scanty, yellowish. Palpi coloured as face, second joint slender, ending in a long point, first joint with long grey and brown hairs beneath, second joint with mostly black hairs. Antennae (Text-fig. 3) reddish-yellow, first and second joints concolourous with face and clothed with black hairs; first segment greatly wider than second. Third segment moderate, broad at base, obtusely angulate without any tooth, annuli short. Forehead broader than in *T. nemotuberculatus,* slightly narrowed to vertex, rather darker than face, densely clothed with ochreous tomentum and with black hairs; callus small pyriform with short extension inconspicuous, of a chamois colour, not much contrasted with general colouration of forehead, resting on subcallus which is bare in middle and similarly coloured. Eyes bare.

Thorax dark brown, densely clothed with yellow tomentum with scattered golden decumbent pubescence and semi-erect black hairs. Sides with hair-tufts brown above, lighter creamy yellow below and posteriorly. Scutellum similar to dorsum.

Abdomen tawny, clothed with black pubescence with a few scattered golden hairs on mid-line and on segmentations. Venter similar but with fine creamy decumbent pubescence.

Legs yellowish, tarsi somewhat infuscate, clothed with yellowish pubescence, black on tibiae. Wings brownish yellow along fore-border, otherwise hyaline. Stigma light brown elongate inconspicuous. Appendix present.

Dimensions: Long, 10.5 mm.; wing, 9 mm.; width of head, 4 mm.; width of frons at widest part, 0.60 mm.

Allied to *T. nemotuberculatus,* but differs in wider front with small though inconspicuous callus, more slender palpi, third antennal joint with less pronounced angulation and in the abdomen hairs being black, not yellow.

The present species also shows a decided approach to *T. neopalpalis*; the forehead is about of equal width and the palpi are similar, it differs however in the generally darker colour, in the different callus and in the dark anterior border of the wings.

Hab.—Northern Territory: Darwin. Type in Coll. Hill; paratypes in Collection of Department of Public Health, N.S. Wales.

TABANUS LEUCOPTERUS der Wulp.

Van der Wulp, Tijdsch. voor Entom., xi., 1868, p. 98.

This species is found on, or near, the sea coast, but on several occasions it has been taken attacking the occupants of boats several miles from the shore (Melville Island, Northern Territory, October 1916 and 1921).

Additional locality: Townsville, N.Q. (12.11.20 and 1.12.21) on child's head whilst bathing near sea beach.

TABANUS DAVIDSONI Taylor.

Taylor, Proc. Linn. Soc. N.S.W., xliv., 1919, p. 65.

Additional localities: Cairns District, N.Q. (Dr. J. F. Illingworth); Lake Macquarie, N.S.W. (Filmer).

TABANUS BREINLI, n.sp. (Text-fig. 4.)

Allied to *T. queenslandi* Ric. but with a narrower forehead.

Face and lower portion of cheeks covered with grey tomentum, and with long rather scanty whitish pubescence, subcallus and upper part of facial triangle with yellow-brown tomentum. Beard white. Palpi with second joint stout at base, ending in a moderately long acute point, yellowish clothed with moderately long appressed black pubescence; first joint with long white hairs below. Antennae (Text-fig. 4) reddish-yellow, with annuli darker, basal joints slightly paler; first joint almost as wide at apex as base of third joint, set with rather conspicuous black pubescence, thickest at upper apical angle; second joint much shorter than first joint, almost disc-shaped, partially overhung by the first joint; third joint moderately broad at base with conspicuous angle, annuli short. Forehead narrow, and narrower anteriorly than at vertex, clothed with yellow-brown tomentum, similar to clothing of subcallus, with short scanty dark pubescence; callus narrow, oblong, not reaching eyes, with a long linear extension to beyond middle. Eyes bare.

Thorax black, clothed with dark brown tomentum, more greyish towards sides and posteriorly with semi-erect black hairs and a few depressed pale ones, more evident behind wing-roots; shoulders reddish-brown with black hair-tufts; pleurae clothed with grey tomentum with long fine whitish hair-tufts, darker above. Scutellum similar to dorsum with a few pale hairs on free margin. Abdomen with first and second segments reddish-yellow, the remainder reddish-brown, becoming darker towards apex, with a pale median longitudinal vitta extending from base of second to sixth segments inclusive, somewhat lighter in colour than the first two segments and with traces of grey tomentum. Pubescence black on all the segments with vestiges of pale golden pubescence on the median vitta. Venter yellowish, somewhat darker towards apex, with pale pubescence and a few dark hairs in the middle of the segments. Legs yellowish, the anterior femora reddish-brown, the other femora darker at base, anterior tibiae dark in apical half, tarsi infuscate, the base of first tarsal joint of middle and hind tarsi lighter.

Wings hyaline, the fore-border shaded with brown; this shading extends almost to tip of wing and is slightly intensified at end of second and upper branch of third longitudinal veins, the bifurcation of the third longitudinal also shaded; stigma yellowish-brown, not very conspicuous; no appendix present.

Dimensions: Type ♀, long, 12 mm., other specimens long, 13-14 mm.; wing, 11 mm.; width of head, 4.5 mm.; width of frons at widest part, 0.35 mm.

Hab.—North Queensland: Palm Island (Dr. Breinl, Hill No. 1401), Torres Strait, Moa Island (G. A. Luscombe).

Described from 4 females.

The stripe on the abdomen seems to extend further towards the base in some specimens than in others; in the type the stripe cannot be traced further forwards than the base of the second segment, in the others this segment is darker and the stripe extends the full length of the segment. The difference may be due to abrasion, as all the specimens (4) are abraded to some extent.

The species is allied to *T. queenslandi* Ric. and *T. strangmani* Ric. but differs from both, *inter alia,* in the much narrower forehead. The extent of the abdominal yitta varies in the three species.

Type in Australian Institute of Tropical Medicine, Townsville.

TABANUS STRANGMANI Ricardo.

Ricardo, Ann. Mag. Nat. Hist., (8), xiv., 1914, p. 393.

Additional Locality: Moa Island, Torres Strait (Rev. G. A. Luscombe, March).

TABANUS PALMENSIS, n.sp. (Text-figs. 5 and 6).

A medium-sized dark brown species with white spots on abdomen.

♀. Face and cheeks clothed with hoary grey tomentum, with a few scanty fine whitish hairs; beard white; subcallus not prominent, clothed with yellowish-brown tomentum in middle and grey at sides. Palpi dark brown, lighter on inner surface; second joint rather feebly thickened at base, ending in a long point, with rather dense dark pubescence. Antennae (Text-fig. 5) yellowish-brown, the first joint somewhat darker and the annuli infuscate; first joint about twice as long as second, not concealing it, both set with black hairs. Third joint moderately broad at base with small obtuse tooth with a few black hairs. Forehead (Text-fig. 6) narrow, parallel-sided, densely clothed with brown tomentum and rather scanty dark pubescence; callus greatly elongate, broad at base, not quite reaching eyes, gradually narrowed to a long linear extension reaching to beyond middle. Eyes bare.

Thorax brown, with slight, very indefinite traces of darker markings, clothed with erect dark hairs and with scattered pale appressed pubescence, shoulders with long dark hairs; pleurae clothed with grey tomentum with tufts of long white hairs. Scutellum similar to dorsum, slightly darker in middle, with erect dark hairs and a somewhat scanty fringe of rather short pale pubescence. Abdomen deep brown, almost black, the segmentations very narrowly edged with grey, expanding in centre to form a series of triangular spots with apex pointed forwards on segments 1-5, with dark appressed pubescence on all the segments, the median row of spots clothed with whitish pubescence; lateral margins of segments grey, with grey pubescence. Venter clothed with dark brown tomentum, rather broadly banded on segmentations, with hoary grey expanding laterally, the pubescence dark in the basal portions, pale on the segmentations and lateral expansions. Legs reddish-brown, the anterior femora and tibiae darker except the basal third of tibiae, the other tibiae infuscate at apices; tarsi dark. Wings dark grey, hyaline, slightly darker along the fore-border and very indistinctly shaded along the longitudinal veins; veins dark brown, stigma dark, conspicuous, no appendix.

Dimensions: Type ♀, 14 mm.; other specimens, 12-13 mm. Wing, 12 mm.; width of head, 4.5 mm.; width of frons, 0.40 mm.

Hab.—Palm Island, N. Queensland. (1.12.20, Hill No. 1361).

Described from 6 females.

This species does not agree with any known to us, nor with the descriptions of any of the outstanding species. It is perhaps most nearly allied to *T. doddi,* but it is smaller and of a somewhat narrower form, though small specimens of *T. doddi* are not unlike it in shape. The antennae and wings are, however, very different.

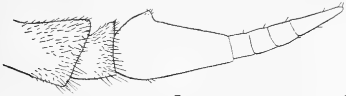
To the naked eye the wings appear practically uniformly dark grey, without any intensification along the veins, but very slight indications of this can be seen with a lens.

To some extent the present species shows a relation to *T. pseudoardens*, but the colouration and clothing are very different. The species would fall into Miss Ricardo's group viii. Type in Australian Institute of Tropical Medicine, Townsville.

Tabanus torresi, n.sp. (Text-figs. 7 and 8).

A moderate-sized brown species with narrow parallel-sided forehead.

♀. Face densely clothed with greyish white tomentum, with fine scanty white pubescence; subcallus reddish-brown, almost bare, with scanty brown tomentum at sides. Beard white. Palpi black, second joint moderately stout, rather slightly curved, and about three-quarters length of proboscis, clothed with black decumbent pubescence. Antennae (Text-fig. 7) yellowish-brown, the first joint reddish-brown and the annuli black; first joint not greatly widened at apex, set with black hairs on upper and lower margins, second short, third elongate, moderately dilatate at base, with a short tooth on upper surface, annuli about as long as rest of joint. Forehead (Text-fig. 8) comparatively narrow, parallel-sided; clothed with brown tomentum and a few dark hairs; callus reddish-brown to black, shiny, oblong, not quite reaching sides, with a long linear extension to vertex. Eyes bare.



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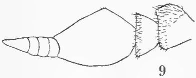

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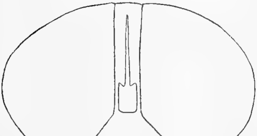

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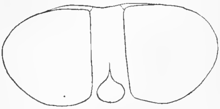

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Text-figs. 7,8.—*Tabanus torresi*, n.sp. 7. Antenna. 8. Head, frontal view.
Text-figs. 9,10.—*Tabanus griseicolor*, n.sp. 9. Antenna: 10. Head, frontal view.
(All figures drawn from types).

Thorax black, densely clothed with brown tomentum, with a lighter band on sides extending above wing-roots and on to scutellum; with sparse creamy depressed pubescence, denser on the lateral band and extending on to the sides and more thinly across base of scutellum, disc also with semi-erect dark hairs. Pleurae with grey tomentum and long tufts of silky white pubescence.

Abdomen with two basal segments reddish-brown, the remainder blackish, all the segmentations pale; clothed with black pubescence, with rather sparse creamy pubescence along segmentations extending slightly forwards in the median line on each segment. Venter light reddish-brown on basal segments, the remainder black, segmentations pale, pubescence black, pale on segmentations. Femora blackish, the apices of the intermediate and posterior somewhat lighter; tibiae yellowish-brown, infuscate at apex, the anterior tibiae only pale in basal third; tarsi dark. Wings hyaline, with yellowish-brown along anterior margin and feeble shading along longitudinal veins; stigma rather large, elongate, black; veins light brown, no appendix present.

Dimensions: Type, 12.5 mm. long; wing, 11 mm.; width of head, 4.5 mm.; width of frons, 0.40 mm.

Hab.—Moa or Banks Island, Torres Strait.

Allied to *T. palmensis* Ferg. & Hill, but readily distinguished by the pale lateral margin of prothorax, forming a distinct band from in front of wing-roots round to scutellum. The shape of the callus is somewhat different, while the subcallus is more prominent and almost bare. The palpi are stouter and shorter. The abdomen is banded and very feebly maculate along middle. The clothing of the under surface is also different.

Of the species, we possess a single ♀ kindly sent by H. C. White and taken by one of his collectors on 30.11.19, and a short series sent by Rev. G. A. Luscombe, taken on 19.11.20 and February, 1921.

A specimen was sent to the British Museum for determination but was returned as not being in that collection. Type in collection of Australian Institute of Tropical Medicine, Townsville. Paratypes in Collection of Department of Public Health, Sydney.

TABANUS ALTERNATUS, nov. nom.

Tabanus limbatinevris, Macq., Dipt. Exot., Suppl. iv., 1850, p. 29 (nom. praeocc.).—*Tabanus macquarti*, Ricardo, Ann. Mag. Nat. Hist., (8), xv., 1915, p. 277, (nec *T. macquarti* Schiner, Reise der Novara, Dipt., 1868, p. 89 = *T. bigoti* Bellardi, 1859).

The range of this species is from about Camden Haven in New South Wales to Eidsvold in Queensland. Specimens have recently been taken on Magnetic Island, Townsville, which appear to represent a melanistic variety. The typical form is very variable in clothing and in the colouration of the abdomen, the pubescence varying from pure white to golden, and some of the darker white-haired specimens approach closely to the Magnetic Island form, but there appears to be a constant difference in the shape of the callus.

Var. MAGNETICUS, n.var.

Face, palpi and antennae as in *T. alternatus*, forehead with callus slightly wider, more rounded, not tapering above, but with a long linear extension to beyond middle. Thorax as in typical specimens, but with sparse white in place of golden decumbent pubescence; pleurae with hoary white hair-tufts.

Abdomen black, lateral portion of first segment greyish, the posterior margin of segments 2—4 narrowly margined with grey, broadened out at sides and with a series of median triangular spots on segments 1—4, not reaching to the anterior borders of the segments; pubescence black, white on the median spots and on the lateral portions of the segmentations of segments 1—4, continued along the posterior margin of the fourth and sometimes of the third segment to connect up with the median spot, segments 5—7 entirely black.

Venter black, with the posterior margins of the second, third, and fourth segments distinctly banded with light grey.

Legs as in typical specimens.

Wings as in typical specimens, except that the black colouration is more intense.

Dimensions: Long, 15 mm.; wings, 14.5 mm.; width of head, 5.75 mm.; width of frons, 0.5 mm.

Hab.—North Queensland: Magnetic Island (Hill No. 1358).

A name has been attached to the variety as, though the typical species is variable in colouration, all the specimens from Magnetic Island are remarkably constant in this respect. The type specimen of the variety is in the collection of the Australian Institute of Tropical Medicine.

Messrs. Paskin Bros., to whom we are indebted for the specimens we have had for examination, informed us that these flies, and *T. avidus* Bigot, appeared in great numbers after heavy rain about the middle of September and for some weeks after their attacks upon man and horses seriously interfered with operations on the farm. Their numbers decreased gradually until the last week in November, when one of us visited the island to find only one fly during several days collecting. During the following year (1921) this species was very scarce indeed in the same locality.

TABANUS WENTWORTHI, n.sp.

A moderate-sized dark species allied to *T. alternatus* and *T. doddi.*

♀. Face dark, clothed with slaty-grey tomentum and with sparse dark pubescence; cheeks and subcallus with more yellowish-grey tomentum, the cheeks with somewhat denser dark pubescence. Beard white, rather scanty. Palpi yellow, somewhat infuscate; second joint moderately long, comparatively slender, somewhat thicker at base and moderately curved, ending in a straight obtuse point; clothed with dark pubescence. Antennae black, with black hairs on first and second joints; first joint not concealing second, third joint with distinct tooth at base, and moderately long annulate portion. Forehead comparatively narrow, clothed with greyish-yellow tomentum and scanty dark pubescence; callus large, elongate pear-shaped, not reaching eyes, with a long extension almost to vertex. Eyes bare.

Thorax black with narrow pale submedian and lateral lines only distinct in anterior portion; pubescence dark, a few pale hairs present posteriorly; pleurae clothed with grey tomentum, and rather sparse dark pubescence, pale posteriorly. Scutellum black, with a rather sparse fringe of pale straw-coloured hairs. Abdomen black, portion of first and second segments feebly diluted with brown; clothed with black pubescence, with a median line of transverse spots clothed with whitish hairs on the posterior margins of the first to fifth segments, and a similar line on each side at lateral margins. Venter dark brown with lighter segmentations, clothed with black pubescence with traces of lighter on the segmentations. Legs dark; femora black, tibiae reddish-brown, the anterior dark on apical two-thirds; tarsi infuscate. Wings dark grey, suffused with brown along the course of both longitudinal and transverse veins, the suffusion most marked in the region of the discal cell; stigma small, elongate, dark brown; no appendix present.

♂. Similar to ♀ in general appearance. Face and cheeks clothed with greyish-yellow tomentum, rather densely covered with dark hairs with some paler hairs intermingled; beard whitish. Palpi tawny, second joint rather short, oval-shaped, rather densely clothed with mingled dark and light pubescence. Antennae black as in ♀. Eyes large, holoptic, bare, with facets rather small, equal. Thorax as in ♀ but with more conspicuous pubescence, the pale straw-coloured hairs scantily present on anterior as well as posterior portion and more evident around scutellum. Abdomen with first three segments more evidently diluted with reddish-brown at the sides, pubescence more distinct.

Dimensions: ♀ holotype. Length, 14 mm.; wing, 13 mm.; width across eyes, 4.5 mm.; ♂ autotype, 15 mm.

Range of variation: ♀ 14-16 mm. (5 specimens); ♂ 13-15 mm. (2 specimens).

Holotype ♀ and autotype ♂ presented to Australian Museum.

Hab.—New South Wales: Blue Mountains.

Specimens are under examination from the following localities: Leura, 2 ♀, January, 1920 (Dr. A. L. Maclean); Blackheath, 2 ♀, 12.2.22, 4.2.22 and 2 ♂, 22.2.22 (E. W. Ferguson); Blue Mts. (no locality) 1 ♀, January, 1922 (Deuquet). A specimen of this species is also in the South Australian Museum from Wentworth Falls. This specimen was commented upon by one of us (E. W.F., under *T. macquarti* Ric.) in a paper on the Tabanidae in that Institution (Records of South Australian Museum, Vol. 1, No. 4, 1921, p. 373).

In general appearance the species approaches closely to *T. alternatus* (= *T. macquarti* Ric.), but differs in the wing pattern which resembles that of *T. doddi* Taylor, though less marked. From the latter species it differs in the much shorter "tooth" on the base of the third antennal joint.

The species can hardly be *T. funebris* Macq., from the description of which it differs in size, palpi not black, and the absence of a recurrent appendix to the third longitudinal vein.

Tabanus praepositus Walker.

Tabanus praepositus, Walker, List Dipt. Brit. Mus., 1, 1848, p. 158; Ricardo, Ann. Mag. Nat. Hist., (8), xv., 1915, p. 273.—*Tabanus obscurimaculatus*, Taylor, Proc. Linn. Soc. N.S. Wales, xliv., part 1, 1919, p. 51.

A specimen of Walker's species was recently received by one of us (E.W.F.) from the British Museum, and proved to be the same as *T. obscurimaculatus* Taylor.

A specimen of Taylor's species was also sent to the British Museum (G.F.H.) and compared with the type of *T. praepositus* Walk.

Tabanus aprepes Taylor.

Taylor, Proc. Linn. Soc. N.S.W., xliv., 1919, p. 56.

Egg-masses were found at Magnetic Island, N.Q., (24th and 25th November) on twigs and grass overhanging small pools in the sandy bed of a creek, which had the appearance of those of the above species described in an earlier paper (Hill, Bull. Ent. Res., xii., 1921, p. 41). Three of these batches of eggs were subsequently reared to the final larval stages and proved to be referable to the above. The third batch produced larvae of a species not known to us in the immature stages. The history of the two batches of eggs of *T. aprepes* is as follows:—

(a). This mass was found at 5 p.m. on 24th November on a flower-head of *Juncea*, 5 inches above clean, wet sand at the margin of a small pool in creek-bed. When found the eggs were creamy white, but at 7 p.m. a few detached eggs and lower tiers of the main mass began to turn greyish, indicating that they were then about three hours old (see paper referred to above). The majority of the eggs hatched between 11 p.m. on 28th and 6 a.m. on 29th, the young larvae having already passed through their first moult in the interval.

(b). This mass was laid between 3.30 p.m. on 24th November and 9.30 a.m. on 25th November on a blade of grass 3 inches above the level of a small pool in the sandy creek-bed. As they were slightly greyish in colour when found, it is probable that they were laid late on the previous afternoon (the plant was examined at 3.30 p.m., when the eggs were certainly not present). Most of the eggs hatched between 11 p.m. on 28th November and 6 a.m. on 29th November, but a few did not free themselves from the mass until 10 p.m. on latter date.

The two batches were placed in large concrete troughs containing clean sand piled up at one end, and water at the other. Each trough was supplied with some water-lily leaves to which very small molluscs and other animals were adhering, and a large number of young mosquito larvae. The leaves were removed on the following day, and thereafter no food was given other than that provided by mosquito larvae (*Stegomyia fasciata*) which bred naturally in the trough. In order to make the mosquito larvae accessible to the young Tabanus larvae, the troughs were tilted up every few days so as to cause some of the former to become stranded on the sand. The water was changed weekly by pouring a fresh supply in at one end and siphoning it out at the other after filtration through the sand. On 31st January following, some of the larvae were 22 mm. in length and were evidently prospering, judging by the number seen during a cursory examination of the troughs. At this stage, through forgetting to keep ant-guards in efficient order, the entire contents of the three troughs were destroyed, but as specimens had been secured at intervals it was possible to establish the identity of two out of the three lots.

TABANUS OBSCURILINEATUS Taylor.

Taylor, Proc. Linn. Soc. N.S.W., xliv., 1919, p. 50.
Additional locality: Townsville District, N.Q.

TABANUS INNOTABILIS Walker.

Walker, List Dipt. Brit. Mus., i., 1848, p. 177.

Specimens have been received for identification from Moa Island (Torres Strait) and Port Moresby District (New Guinea).

TABANUS SEQUENS Walker.

Walker, List Dipt. Brit. Mus., i., 1848, p. 178.

These flies were plentiful on Magnetic Island and Palm Island, N.Q., during November and December, 1920. In the former locality they were very troublesome to horses which, it was noticed, were invariably bitten about the coronet and lower parts of legs.

TABANUS NEOGERMANICUS Ricardo.

Ricardo, Ann. Mag. Nat. Hist., (8), xv., 1915, p. 283.

This is a very common species on Palm Island, N.Q., and has been captured also on Magnetic Island and near Townsville, N.Q., November, 1920.

In life the eyes are emerald-green with copper-coloured iridescence.

TABANUS GRISEICOLOR, n.sp. (Text-figs. 9 and 10.)

A moderately small grey species allied to *T. clavicallosus* Ric. but with wider forehead.

Face and cheeks densely clothed with greyish-yellow tomentum, with sparse whitish hairs; beard white, rather scanty. Palpi yellow, with moderately dense pale pubescence on outside, and with a few short dark hairs near apex; second joint moderately long, rather strongly curved, moderately thick at base. Antennae (Text-fig. 9) yellow, the third joint, except base, somewhat infuscate, first joint longer but not greatly wider than second, third joint with basal portion expanded, obtusely angulate above but without tooth, annuli short. Forehead (Text-fig. 10) broad, about three times as long as broad, almost parallel-sided, very slightly narrower at vertex; densely clothed with somewhat more yellowish tomentum than face, with scanty pale pubescence and with erect dark hairs most marked at vertex; callus rather large, transversely oval, not reaching eyes, with a short linear extension. Eyes bare.

Thorax densely covered with light greyish-yellow tomentum with indistinct traces of darker brown longitudinal stripes, with scattered pale pubescence, and semi-erect dark hairs; pleurae similar, with tufts of long white pubescence. Scutellum similar to dorsum.

Abdomen thickly clothed with similar coloured tomentum to thorax; where denuded, the derm appears black, lighter on the segmentations; rather densely clothed with pale decumbent pubescence. Venter similar.

Legs with femora dark brown, tibiae yellowish-brown, the apical third of anterior tibiae infuscate. Tarsi infuscate.

Wings hyaline, costal cell and all the veins lightly suffused with brown; stigma elongate, rather dark; no appendix present.

Dimensions: Long, 9.5—10 mm.; wings, 9 mm.; width of head, 3.5 mm.; width of frons at widest part, 0.60 mm.

Hab.—Queensland: Hughenden. (March, 1921, Geo. Brady, Hill, No. 1445). The type and paratype respectively are in the Collection of the Aust. Institute of Tropical Medicine and Dept. of Public Health, N.S.W.

Described from two specimens. In one the abdomen appears darker and more conspicuously banded; this is apparently due to the clothing being more or less abraded on the basal portion of the segments. The general colour of the insect appears nearest to the dark olive of Ridgeway's standard colours.

The species is allied to *T. clavicallosus*, but differs in the somewhat wider forehead with differently shaped callus, and in its general lighter colouration.

TABANUS CLAVICALLOSUS Ric.

Ricardo, Ann. Mag. Nat. Hist., (8), xix., 1917, p. 219.—*T. griseus*, Taylor, Proc. Linn. Soc. N.S. Wales, xliv., 1919, p. 55.

A specimen was compared with the type of *T. griseus* in the Queensland Museum and afterwards compared with a paratype of *T. clavicallosus* Ric. No difference could be detected.

Specimens from Moa or Banks Island in Torres Strait appear to represent a geographical race if not a distinct species.

Var. BANKSIENSIS, n.var.

♀. Face, palpi, antennae, forehead, frontal callus and thorax as in *T. clavicallosus* Ric. Abdomen dark brown with lighter segmentations, the anterior border of the second segment also lighter; clothed with black pubescence, with a few pale golden hairs along posterior margins, extending somewhat farther forwards in median line, but not producing definite spots. Venter dark brown with rather broad lighter segmentations, clothed with dark pubescence and with rather sparse pale pubescence mostly on the segmentations.

Legs as in *T. clavicallosus.*

Wings with anterior margins clouded with brown, this colour lightly suffusing the longitudinal veins and more markedly the cross veins at base of discal cell; stigma large and dark; appendix present. Long, 9 mm.; other females long, 8.5, 10.5, 11 mm.; wing, 9 mm.; width of head, 4 mm.; width of frons, 0.50 mm.

Four specimens under examination, two of which are larger than the others, and have a more reddish-brown abdomen. These specimens differ from typical specimens of *T. clavicallosus* Ric. in the evident banding of the abdominal segments and in the more intensely shaded anterior margin and veins of the wings. The differences hardly appear sufficient to justify specific separation, as in some specimens of *T. clavicallosus* the segmentations appear very slightly lighter than the rest of the derm, while the costal cell is slightly shaded.

T. darwinensis Taylor is also closely allied to *T. clavicallosus* Ric., and we were at first inclined to sink the name as a synonym. The abdomen is however unicolourous, the wings perfectly clear and the antennae are somewhat different in shape.

Compared with the form described above from Moa Island, *T. darwinensis* appears certainly distinct, but when compared with typical specimens of *T. clavicallosus* the distinctions are less obvious.

One might be inclined to regard the three forms as geographical races of *T. clavicallosus,* but for the fact that specimens of *darwinensis* have also been taken on Moa Island.

Tabanus palmerstoni, nov. nom.

Tabanus minusculus, Ferg. and Hill, Proc. Linn. Soc. N.S. Wales, xlv., 1920, p. 466 (nec *T. minusculus* Hine, 1907).—*Tabanus minor,* Taylor, Proc. Linn. Soc. N.S. Wales, xliv., 1919, p. 64 (nec *T. minor* Macq., 1850).

The substitute name *T. minusculus* was proposed by us to replace *T. minor* Taylor, a name previously used by Macquart. It is now necessary to replace our name for the species as it has already been used by Hine (Ohio Nat., (2), Vol. 8, 1907, p. 227) for a North American insect.

The new substitute name is taken from the old name (Palmerston) for Darwin, the type locality of the species.

Tabanus germanicus Ricardo.

Ricardo, Ann. Mag. Nat. Hist., (8), xv., 1915, p. 282.

We have received examples of this species from Moa Island, Torres Strait (Rev. G. A. Luscombe, March) and from Mackay, Queensland (W. G. Harvey, 10.2.20).

Tabanus quadratus Taylor.

Taylor, Proc. Linn. Soc. N.S.W., xliv., 1919, p. 52.

Numerous examples were captured (6.10.21) whilst attempting to bite persons travelling in a motor boat between Port Darwin and Melville Island (Northern Territory). The first flies were noticed when the boat was about four miles off one of the Vernon Group of Islands and were afterwards captured at intervals until a landing was made on Melville Island. Several of the above species, as well as two examples of *Silvius indistinctus* Ricardo, were captured at a distance of not less than 10 miles from the nearest land (Melville Island), and upon going ashore at about 6 p.m., both species were found to be fairly plentiful, but far less so than *T. cinerascens* King and *T. neogermanicus* Ricardo.

TABANUS RIVULARIS, nov. nom.

Tabanus pygmaeus, Ferg. and Henry, Proc. Linn. Soc. N.S. Wales, xliv., 1919 (1920), p. 842, Pl. xliv., Fig. 2 (nec *T. pygmaeus* Williston, 1887).

A change of name is necessary, as *T. pygmaeus* has been already used by Williston for a North American species (Trans. Kansas Acad. Sc., Vol. 10, 1887, p. 141).

The present name is suggested by the habits of the adult insect. The original specimens came from Camden Haven; since then the species has been discovered at Eccleston on the Allyn River, a branch of the Patterson, on the north side of the Hunter River Valley. The species was found confined to the banks of the stream and attacking the heads of swimmers in the river (March, 1921).

TABANUS MORETONENSIS, nov. nom.

T. confusus, Taylor, Proc. Linn. Soc. N.S. Wales, xlii., 1917, p. 523 (*nom. praeocc.*).

The type of *T. confusus* Taylor in the Queensland Museum was examined (E.W.F.) recently, and found to be incorrectly placed in Miss Ricardo's Group iv. of the genus. The eyes are hairy, which places the species in Group xi. (*Therioplectes*), while the frontal callus is not absent, but is transverse, occupying the whole front and little prominent; owing to abrasion it would appear at first sight as if the callus were absent. The species belongs to the difficult *circumdatus-edentulus* group, but appears to be distinct.

A change of name is necessary as *T. confusus* has already been employed by Walker (List Dipt. Brit. Mus., i., 1848, p. 147) for a species from North America.

TABANUS CIRRUS Ricardo.

Ricardo, Ann. Mag. Nat. Hist., (8), xix., 1917, p. 222.—*T. robustus*, Taylor, Proc. Linn. Soc. N.S.W., xliv., 1919, p. 69.

A specimen from Palm Island, N.Q. (26.9.20) has been compared with Taylor's type by Mr. H. Hacker, and afterwards with Ricardo's type by Dr. G. A. K. Marshall.

TABANUS NEOLATIFRONS, nov. nom.

Tabanus latifrons, Ferg., Proc. Roy. Soc. Victoria, xxxiii., 1920 (1921), p. 19, Pl. ii., Fig. 1 (nec *T. latifrons* Zetterstedt, 1842).

The previous use of the name *T. latifrons* Zetterstedt (Dipt. Scand., Vol. i., 1842, p. 106) was quite overlooked in describing the Australian species. Zetterstedt's name is a synonym of *T. cordiger* Meigen (Syst. Beschr., Vol. 2, 1820, p. 47) from the Mediterranean region.

TABANUS ADELAIDAE, nov. nom.

Tabanus meridionalis, Ferg., Records South Aust. Mus., Vol. 1, No. 4, 1921, p. 376 (nec *T. meridionalis* Thunberg, Nova Arta Upsal., Vol. 9, 1827, p. 58).

The previous use of the name *T. meridionalis* by Thunberg was also overlooked in describing the South Australian species. Thunberg's species is from an unknown locality.

TABANUS MILSONIENSIS, nov. nom.

Tabanus milsoni, Taylor, Proc. Linn. Soc. N.S. Wales, xli., 1916 (1917), p. 760 (nec *T. milsonis* Ric., Ann. Mag. Nat. Hist., (8), xix., 1917, p. 220).

Taylor's use of the name *T. milsoni* is antedated by Miss Ricardo's *T. milsonis* from the same locality by about two months.

We understood that Mr. Taylor was altering the name of this species, but as no substitute has so far been proposed we suggest the above name for the species.

TABANUS OCULATUS Ric.

Tabanus pusillus, Macquart, Dipt. Exot., Supp. v., 1854, p. 49 (*nom. praeocc.*).—*Tabanus oculatus,* Ricardo, Ann. Mag. Nat. Hist., (8), xvi., 1915, p. 276.—*Tabanus kendallensis,* Taylor, Proc. Linn. Soc. N.S. Wales, xliv., 1919, p. 68; Ferguson and Henry, Proc. Linn. Soc. N.S. Wales, xliv., 1919 (1920), p. 848.

We have examined a large number of specimens of *T. oculatus* from various parts of New South Wales, and cannot separate the Kendall species as distinct. The clothing of the thorax is very readily abraded and is really only seen in fresh specimens; the comparative width of the forehead also varies.

Hab.—N.S. Wales: Byron Bay, Richmond River, Dorrigo, Kendall, Comboyne, Wingham, Hawkesbury River, Sydney, Cronulla, Penrith, Burragorang, Nattai River, Dubbo, Wolseley Park; Queensland: Brisbane (Oct., Dec., H. Hacker), Palm Island (1.12.20, Dr. Breinl).

A REMARKABLE NEW GALL-THRIPS FROM AUSTRALIA.

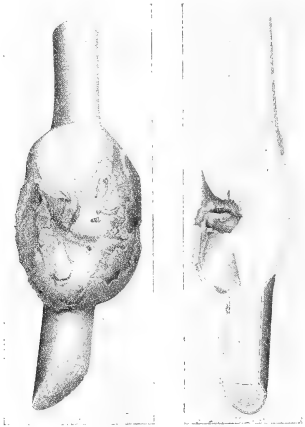
By H. H. Karny, Ph.D. (*Communicated by W. W. Froggatt.*)

(Six Text-figures.)

[Read 26th July, 1922.]

Mr. W. W. Froggatt discovered recently a very interesting thrips-gall on the Belah (*Casuarina Cambagei*) growing in the western scrub at Trangie, N.S.W., which he was good enough to send me for determination of the gall-former.

The galls (Text-fig. 1) represent a very remarkable type, hitherto not known as caused by thrips. The twigs are swollen at some places and form



a b

Text-fig. 1. *Thaumatothrips froggatti*, n.gen. et. sp.
Gall on a *Casuarina* twig. a. outside; b. inside. Natural size.

large, knob-shaped thickenings, inside of which are cavities, full of all stages of the gall-former. These cavities communicate with the exterior by small holes through which the thrips are able to come out.

It is a very interesting fact, that the thrips-galls of Australia belong frequently to highly specialised types, similar to those of the European Cynipidae, whilst in the tropics (e.g. in Java) only leaf-rolls caused by thrips are known.

From Australia there have been recorded only three species of Thysanoptera which form hard tumors on the phylloclades of *Acacia,* communicating with the outside by a narrow split. Mr. Froggatt described, in 1906, such a gall caused by *Kladothrips rugosus* (Agric. Gaz. N.S.W., Misc. Publ. No. 1,025, Plate, fig. 5), very remarkable by its rough surface. Similar galls, but with a more or less smooth surface, were described later by the author (Centralbl. Bakteriol, ii. Abt., xxx., 1911, pp. 564, 570; *Oncothrips tepperi*) and by Hardy (Proc. Roy. Soc. Tasm., 1915, p. 102; *Oncothrips rodwayi**).

Onychothrips tepperi (Uzel, Act. Soc. Ent. Bohem., ii., 4, 1905; Karny, *l.c.*) finally forms roundish, subspherical galls on the thinnest twigs of *Acacia aneura.* But there is no gall hitherto recorded of the remarkable type discovered by Mr. Froggatt and here described.

In these galls are to be found many specimens of a Tubuliferous thrips, which proved to represent a new genus. I name it on account of some remarkable morphological characters and of its curious galls.

THAUMATOTHRIPS, n.gen.

Head not distinctly longer than prothorax, but considerably longer than wide, broadest near the eyes. Cheeks slightly converging backwards, finely granulated, set with some short, stiff hairs, but without spines. Antennae somewhat longer than head. Mouth-cone short, broadly rounded, with short and thick palpi. Prothorax very large, behind more than twice as wide as in front, with very long bristles. Fore-legs very large; their femora considerably longer than head, and nearly half as wide as long; in both sexes with a few teeth on the inner margin. Fore-tibiae short and very stout, widened to the end, on the inner apex with a sharp, but not protruding angle, lying close to the tarsus. This with two sharp tooth-like processes, the larger of which is longer than the whole tarsus itself. Pterothorax broader than long, with laterally protruding fore angles. Wings, if present, not constricted near the middle. Tube very short and thick, only slightly more than half as long as the head.

This remarkable new genus comes by its large, scutiform prothorax and by the form of fore-tibiae and tarsi into the subfamily *Kladothripinae* (Karny, Treubia, i., 4, 1921, pp. 227, 251). The sharp angle of the fore-tibia, however, does not protrude tooth-like as in *Onychothrips,* but lies close to the tarsus, as in *Oncothrips.* It may be distinguished at once from all hitherto-known *Kladothripinae,* and also from some similar *Trichothripinae* and *Cryptothripinae,* by its greatly enlarged fore-femora, set with some teeth along the inner margin. Such an armature of fore-legs was hitherto recorded only from some genera of *Macrothripinae* (*Machatothrips, Ischyrothrips* and *Eulophothrips*); from these, *Thaumatothrips* differs by the cheeks not set with spines, but only with short hairs, by the far smaller number of duplicated cilia on fore-wings, and by its much shorter tube.

Only one species known.

*I am very obliged to Messrs. Hardy and Rodway, from whom I got material of this interesting thrips and its galls. The species was originally described as a *Kladothrips*, but it should perhaps rather belong to *Oncothrips* because the antennae are 8-jointed—the two last joints closely united—and the other characters also agree very well with *Oncothrips.*

THAUMATOTHRIPS FROGGATTI, n.sp.

♀, ♂.—Total length of body, 2.3—3.7 mm.

General colour dark, blackish brown. Fore-femora at apex and fore-tibiae at base yellowish-brown, the latter gradually somewhat darker brown to apex. Middle and hind tibiae, and all tarsi yellowish-brown. First and second antennal segment as dark as the body; third joint yellow, somewhat darker at apex; fourth segment brownish-yellow in the basal half, dark grey in the apical half; fifth joint dark grey-brown, in the basal half somewhat paler; the following ones uniformly blackish-brown, at most the sixth joint a little paler at base. Freshly emerged specimens bright lemon-yellow, with uniformly pale antennae, the legs somewhat shaded with grey; abdominal tergites 3—8 with a broad, dark brown cross-band; tube reddish-brown.

Head distinctly longer than wide across the eyes. Cheeks beginning with a small protruding angle behind the eyes, then slightly converging posteriorly, throughout their whole length finely granulated and set with short, stiff hairs. Eyes black, occupying about a fourth of the length of head, transverse truncate behind. Between the eyes and the insertion of antennae only a very small interval; fore margin of head between the antennae scarcely produced. Ocelli always present, arranged in a rectangular triangle; the anterior one forwardly directed, the posterior ones touching the midst of the inner margin of eyes. Between the anterior and each posterior ocellus a short, hair-like bristle, another behind each posterior ocellus. Dorsal surface of head finely reticulated. Post-ocular bristles inserted near cheeks, about in the middle of length of head, long, hyaline, curved forward, somewhat dilated at apex. A little behind these bristles a second similar pair on the dorsal surface near the middle line.

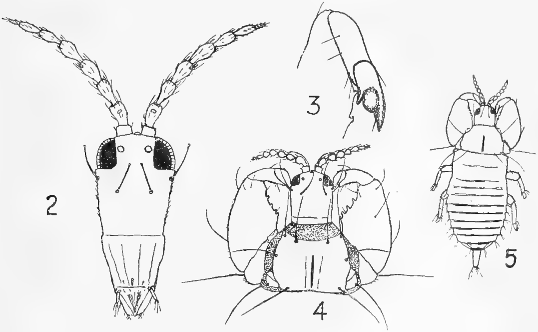
Antennae (Text-fig. 2) considerably longer than head, with stout segments. First joint wider than long, cylindrical; the following ones longer than wide, the second cup-shaped, the other club-shaped or subglobular, but always distinctly constricted at the base; the third longest, the following ones gradually diminishing towards the apex. Segments 7 and 8 broadly united with one another, together fusiform. Eighth joint considerably smaller than seventh.

First joint with a few bristles near apex. Second with a transverse row of bristles near base, and another of longer ones near apex. Segments 3—5 with such a row just before their middle, and a second one before the end. The bristles of third joint especially long and stout. Sixth segment with a crown of bristles near the apex. The following segments set only with a few weak setae. The median line of bristles on the ventral surface reaching from about the middle of seventh segment to apex of eighth.

Sense-area of the second joint transversely ovate, placed just behind the middle. Sense-cones of the following segments short and thick, blunt at apex, only a little overreaching the end of their segments. Fourth joint, in addition to the lateral pair, with one accessory sense-cone in the middle of the dorsal surface, and another on ventral surface near the posterior margin. On the fifth and sixth segments the sense-cone of posterior margin often short, nearly abortive. On the seventh joint I cannot distinguish the usual median sense-cone.

Front set with very short hairs (smaller than those of the cheeks) on the whole surface and, in addition, only a pair of short, weak bristles below the insertion of antennae. Mouth-cone short, rounded at apex, reaching at most to the middle of prosternum, usually still shorter. Palpi very short, stout, with a styliform apical and an annular basal joint. Labial palpi still shorter than the maxillary ones.

Prothorax very large, about as long as head, with a median longitudinal wrinkle on the disc, much widened from base to middle, thereafter with nearly parallel, but obtusely-angulate emarginate sides. Connecting hide between head and prothorax with distinct, dotted sculpture; a similar area on each side at the widest place of prothorax. Behind this area a triangular and then a trapezoidal, smooth, strongly chitinized area, separated from the disc by distinct sutures, of which the posterior field bears the postero-lateral bristles. All setae extraordinarily long. The antero-lateral ones inserted near the fore-angle, forwardly directed. Antero-marginal bristles from the middle of fore-margin somewhat



Text-figs. 2-5. *Thaumatothrips froggatti,* n.gen. et. sp. (nat. size.)

2. Head of macropterous form. 3. Fore-tibia and tarsus; seen in front. 4. Head and prothorax of apterous form. 5. Apterous form with contracted segments.

more distant than from the antero-lateral ones. Medio-lateral setae inserted at the end of basal third of the disc-sides. Postero-lateral bristles very long, curved, backwardly directed; postero-marginal ones as far distant from them as from the middle of hind-margin. Further, some short hairs on surface of the disc, and a pair of weak bristles near the middle of hind-margin. Surface of prosternum with a distinct, dotted sculpture. Only a few strongly chitinized, smooth plates; one longitudinally placed, elliptical at each fore-angle; one pair of large, semicircular plates before the hind-margin, with strongly convex fore-side and transversely truncate, nearly straight hind-side. Behind them a small, median, transversely-placed, elliptical plate.

Fore-coxae very large, ovate, with a strong bristle at the outer hind angle, still longer than the postero-lateral ones of prothorax, and behind it a few short hairs. Fore-femora greatly enlarged, considerably longer than head, and nearly half as wide as long; on the outer margin with some short hairs and, in addition, a very long bristle before the middle and a second shorter one before the knee;

on the inner margin with 3—5 thick teeth, the number of which often varies in the same specimen on the right and left legs; after the last tooth, just before the knee-joint, a long bristle. Fore-tibiae short and very thick, not considerably more than half as long as the femur, constricted at base, and distinctly broadened towards the apex; on the inner margin a row of small tubercles and, before the acute apex, a long bristle; on the outer margin a somewhat shorter subapical bristle. Fore-tarsus with a very large, acute, tooth-like process, and a second smaller one, between them the apical bubble of the tarsus (Text-fig. 3).

Pterothorax very stout, distinctly wider than long, with sinuated, somewhat backwardly converging sides. Behind the transverse suture, separating meso- and metanotum, a pair of backwardly directed bristles. Sutures of meso- and metasternum—besides the transverse limit between these two segments—apparently abortive, even in lightly coloured specimens not definitely distinguishable. Middle coxae cylindrical, the hind ones somewhat tumid; the former more widely separated from one another than the latter. Middle and hind legs stout, set along both margins with some short hairs and a few longer bristles. Tarsi without teeth.

Abdomen a little narrower than pterothorax, about four times as long as wide. First segment with three smooth, strongly chitinized, triangular plates, the median narrower, with the acute angle forwardly directed, the lateral ones broader and more blunt, their apex directed backwards. The space between them with a distinct, dotted sculpture. The following segments with 3 (except only 2 on the second) long bristles at each hind angle, and with some shorter hairs along the hind margin and one on the lateral margins. Wing retaining spines weak and slender, the space between the tips of the hind pair about four times as long as the spines themselves; fore pair not distinguishable on account of the dark colour of body. Bristles of the ninth segment nearly as long as the tube. This latter short, only slightly more than half as long as head, with straight, distinctly converging sides; at base about half as wide as long, and somewhat more than twice as wide as at apex. The longer terminal bristles a little shorter than the tube itself, the shorter ones not yet half as long as the others.

I have allowed myself the pleasure of naming this remarkable new species after its discoverer, Mr. Walter W. Froggatt, who has kindly sent it to me for description.

There are no morphological differences between the two sexes, well distinct forms occurring equally in both sexes.

Forma aptera (Text-fig. 4). It is not unusual amongst Thysanoptera, that a macropterous and an apterous form of a species may be found although, of gall-thrips especially, very few apterous forms are known. But it seems very remarkable and exceptional that the apterous form here described differs from the macropterous form, not only by the absence of wings, by smaller eyes and ocelli, a shorter pterothorax and abortive wing retaining spines, but also by other characters. Therefore, I find it necessary to describe it somewhat extensively.

Head somewhat shorter, about one and one-third times as long as wide. Eyes and ocelli smaller than in the macropterous form, the former occupying only one-fifth of the length of head. Antennae very stout, their middle joints not or hardly longer than broad. All bristles of the whole body exceedingly long, acutely pointed at apex, not knobbed. The inner ones of first antennal joint reaching about to the end of third joint. Both pairs on the dorsal surface of head distinctly overreaching the end of first antennal joint. Bristles of abdomen longer than the segments themselves. Fore-femora somewhat more than half as wide as long. Pterothorax comparatively shorter and wider than in the macropterous form. Wings absent. Wing retaining spines reduced to simple bristles.

Measurements of an apterous female of middle size: Total length of antennae, 0.35 mm.; joint 1, 0.04 mm. long, 0.05 mm. wide; joint 2, 0.055 mm. long, 0.045 mm. wide; joint 3, 0.055 mm. long, 0.04 mm. wide; joint 4, 0.045 mm. long, 0.04 mm. wide; joint 5, 0.04 mm. long, 0.04 mm. wide; joint 6, 0.04 mm. long, 0.035 mm. wide; joint 7, 0.04 mm. long, 0.03 mm. wide; joint 8, 0.03 mm. long, 0.015 mm. wide. Head 0.28 mm. long, 0.22 mm. wide. Prothorax 0.35 mm. long, 0.50 mm. wide without fore-coxae, 0.68 mm. wide including fore-coxae. Fore-femora 0.48 mm. long, 0.26 mm. wide; fore-tibiae (including tarsi) 0.24 mm. long, 0.08 mm. wide. Pterothorax 0.42 mm. long, 0.56 mm. wide. Middle femora 0.18 mm. long, 0.07 mm. wide; middle tibiae (including tarsi) 0.21 mm. long, 0.05 mm. wide. Hind-femora 0.21 mm. long, 0.09 mm. wide; hind-tibiae (including tarsi) 0.28 mm. long, 0.06 mm. wide. Abdomen (including tube) 1.8 mm. long, 0.55 mm. wide. Length of tube 0.17 mm., width at base 0.10 mm., at apex 0.04 mm.

Forma macroptera. Head distinctly longer, at least one and a half times as long as wide. Eyes occupying a little more than one-fourth of the length of head. Ocelli also larger than in the apterous form. Antennae distinctly longer, their middle joints at least one and a half times as long as wide. All bristles long and stout, but shorter than in the apterous form, distinctly dilated at apex, knobbed; only those of the ninth abdominal segment and of tube sharply pointed. The inner bristle of first antennal joint not considerably overreaching the end of this segment. Fore-femora somewhat less than half as wide as long. Wings present, reaching about to base of sixth abdominal segment, not constricted in the middle, nor dilated before the apex, clear, hyaline, with long, dense fringe. Fore pair with three long, knobbed, equidistant bristles near the fore-margin at base, a little longer than the wing is broad; hind-margin near apex with a dozen duplicated cilia. Wing retaining spines weak, but distinctly S-shaped, inwardly directed.

Besides the macropterous and apterous forms, there are larger and smaller ones.

Forma major. Larger. Fore-femora somewhat larger, more than one and a half times as long as head.

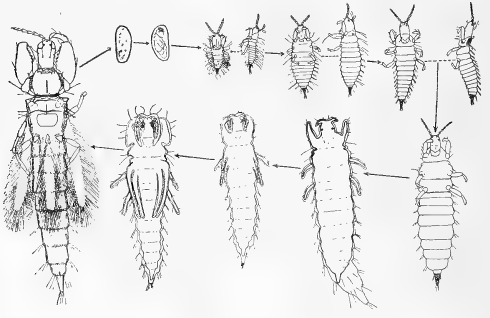
Measurements of a large macropterous female: Total length of antennae 0.49 mm.; joint 1, 0.04 mm. long, 0.05 mm. wide; joint 2, 0.06 mm. long, 0.05 mm. wide; joint 3, 0.08 mm. long, 0.045 mm. wide; joint 4, 0.08 mm. long, 0.05 mm. wide; joint 5, 0.075 mm. long, 0.04 mm. wide; joint 6, 0.07 mm. long, 0.035 mm. wide; joint 7, 0.06 mm. long, 0.025 mm. wide; joint 8, 0.03 mm. long, 0.015 mm. wide. Head 0.38 mm. long, 0.24 mm. wide. Prothorax 0.40 mm. long, 0.51 mm. wide without fore-coxae, 0.68 wide including fore-coxae. Fore-femora 0.58 mm. long, 0.26 mm. wide; fore-tibiae (including tarsi) 0.32 mm. long, 0.08 mm. wide. Pterothorax 0.55 mm. long, 0.61 mm. wide. Middle femora 0.17 mm. long, 0.07 mm. wide; middle tibiae (including tarsi) 0.25 mm. long, 0.055 mm. wide. Hind-femora 0.26 mm. long, 0.09 mm. wide; hind-tibiae (including tarsi) 0.31 mm. long, 0.06 mm. wide. Length of wings (without fringe) 1.4 mm. Abdomen (including tube) 2.3 mm. long, 0.53 mm. wide. Length of tube 0.21 mm., width at base 0.11 mm., at apex 0.04 mm.

Forma debilis. Smaller. Fore-femora less than one and a half times as long as head. These two forms correspond to already known forms of some Tubulifera, e.g., the Australian *Haplothrips braccatus* ♂ (Karny, Treubia, ii., 1, 1921, p. 30) or the Javanese *Mesothrips pyctes* (Karny, Zeitschr. wiss. Ins. Biol., xii., 1916, p. 191).

Measurements of a small macropterous female: Total length of antennae 0.38 mm.; joint 1, 0.025 mm. long, 0.04 mm. wide; joint 2, 0.045 mm. long, 0.035 mm. wide; joint 3, 0.06 mm. long, 0.035 mm. wide; joint 4, 0.06 mm. long, 0.04 mm. wide; joint 5, 0.06 mm. long, 0.035 mm. wide; joint 6, 0.055 mm. long, 0.03 mm. wide; joint 7, 0.05 mm. long, 0.022 mm. wide; joint 8, 0.025 mm. long, 0.013 mm. wide. Head 0.27 mm. long, 0.18 mm. wide. Prothorax 0.25 mm. long, 0.33 mm. wide without fore-coxae, 0.45 mm. wide including fore-coxae. Fore-femora 0.37 mm. long, 0.16 mm. wide; fore-tibiae (including tarsi) 0.20 mm. long, 0.06 mm. wide. Pterothorax 0.35 mm. long, 0.42 mm. wide. Middle femora 0.16 mm. long, 0.06 mm. wide; middle tibiae (including tarsi) 0.22 mm. long, 0.05 mm. wide. Hind-femora 0.18 mm. long, 0.07 mm. wide; hind-tibiae (including tarsi) 0.23 mm. long, 0.055 mm. wide. Length of wings (without fringe) 1.0 mm. Abdomen (including tube) 1.5 mm. long, 0.38 mm. wide. Length of tube 0.14 mm., width at base 0.07 mm., at apex 0.03 mm.

I have given here the measurement of all forms from female specimens, in order to show that all these differences occur in the same sex, and may not be mistaken for sexual dimorphism. All these forms are to be found in the galls together.

There are further, in the material before me, specimens with extraordinary contracted segments of body and antennae (Text-fig. 5), the head therefore



Text-fig. 6. *Thaumatothrips froggatti*, n.gen. et. sp.
Life-cycle of macropterous form. (x 2/3.)

appearing still shorter than in the above-described apterous form, and the abdomen greatly dilated, resembling somewhat the Australian Liothripine genus *Aspidothrips* (Karny, Act. Soc. Ent. Cech., xvii., 1920, p. 38). But these may not be mistaken for a different form. These specimens are only a product of the methods of preservation; they were probably all dead when they came into alcohol.

The thrips undergo their whole development in their galls, and all stages (Text-fig. 6) are therefore present in these cavities. There is only one species of Australian Tubulifera, as far as known to the author, namely *Idolothrips spectrum* Haliday, of which we already know the whole development (Froggatt, Proc. Linn. Soc. N.S.W., xxix., 1904, pp. 54-57, Plate iii.). But this is an Idolothripid and agrees therefore with the Phloeothripid *Thaumatothrips* only in the general characters common for all Tubulifera, but diverges in some special differences according to development of antennae and end of abdomen, to colour of the stages, etc. The life-cycle of *Thaumatothrips* agrees somewhat more closely with that of some Javanese Phloeothripidae, as described by the author (Bull. Jard. Bot. Buitenzorg, (2) x., 1913, pp. 79, 85, 101).

Eggs ovate, about 500 μ (or a little more) long, and 250 μ (or a little less) wide, rounded at both ends, but somewhat broader near the head of embryo, somewhat tapering towards its hind end. The shell of the egg shows a distinct, polygonal structure, as already known from the European *Trichothrips ulmi* (Ahlberg, Ark. Zool., xiii., 17, 1920, p. 9) and the African *Gynaikothrips ebneri* (Karny, Denkschr. Akad. Wiss. Wien, 98, 1921, sep. p. 22). The one side (dorsal of embryo) of egg is somewhat more rounded, the other (ventral of embryo) nearly straight. Colour lemon- to orange-yellow. Before emergence of larva, it is already very well visible through the egg-shell.

First larval stage somewhat longer than egg, because the hind end of embryo in the egg is ventrally curved forwards. General colour pale yellow, without a red hypodermal pigment. Antennae very short and stout, nearly as long as the head (including mouth-cone); their middle joints about as long as wide. Basal three segments very pale yellowish, scarcely perceptibly shaded with greyish; fourth a very little more greyish; 5—7 still more shaded with grey. Head in the anterior part near the insertion of antennae distinctly greyish, with two pairs of long bristles. Mouth-cone reaching to base of prosternum, broadly rounded at apex. Thorax on each segment laterally with a very long bristle, nearly as long as the head (including mouth-cone). Abdomen short, with very long bristles on each segment, only a little shorter than those of thorax, and about twice as long as the tube. Ninth segment transversely dark grey in the apical half. Tube short, broad at base, much tapering to apex, dark grey, with two longer and some smaller bristles at the end.

Second stage of the same general colour as the first; but prothorax a little shaded with grey. Antennae nearly as in the first stage. Mouth-cone not fully reaching to base of prosternum. Bristles of thorax very long, but comparatively shorter than in the first stage, shorter than the head (including mouth-cone). Abdomen long and wide; its bristles about half as long as those of thorax and only a little longer than the tube; but the seventh segment on each side with a very long bristle, only a little shorter than those of the thorax. Ninth segment and tube as in the first stage.

Third stage coloured as the preceding ones, without hypodermal pigment, but with a well-defined, transverse, rhomboidal, greyish spot behind the insertion of antennae, and with two larger scutiform ones on the disc of pronotum. Antennae longer and slenderer than in the preceding stages, their middle joints considerably longer than wide; the three basal joints pale yellowish, the four apical ones very dark grey. Mouth-cone only a little overreaching the midst of prosternum. Bristles arranged as in the preceding stages, but comparatively shorter; those of the seventh segment not sensibly longer than the others, nearly as long as those of the thorax. Abdomen long and slender, sides of each segment arched, only the tube truncate-conical. Colour and chaetotaxy of the end of abdomen as in the preceding stages.

Fourth stage of a similar colour to third, but somewhat darker, brownish-yellow. Also without red pigment. Antennae as in the preceding stage, but their three basal segments brownish-yellow, not or only a little paler than the four apical ones, which are a little paler grey than in the third stage. Mouth-cone not overreaching the middle of prosternum. Bristles of thorax not distinctly longer than those of abdomen; those of the seventh segment not longer than the others. Abdomen very long and broad, with arched margins of segments, but the ninth together with the tube truncate-conical. Bristles of these two last segments distinctly shorter than the others of abdomen.

Pre-pupa uniformly brownish-yellow. Cases of antennae shorter than the head, horn-shaped. Mouth-cone not fully reaching to the middle of prosternum. Bristles of prothorax considerably longer than those of meso- and metathorax, which are not longer than those of abdomen. Abdomen as in the last larval stage, but gradually tapering to apex, and with the two last segments of the same colour as the others.

First pupal stage brownish-yellow. Cases of antennae not yet reaching to the fore-margin of prothorax. Mouth-cone reaching about to the midst of prosternum. Fore-femora distinctly smaller than the head; fore-tarsi with a short, broad, obtuse tooth. Wing-cases reaching to the middle of the margins of second abdominal segment—in the apterous form naturally wanting. All bristles in both forms long and sharply pointed, but in the apterous form already distinctly longer than in the macropterous one.

Second pupal stage of the same colour as the preceding one. Chaetotaxy also the same. Cases of antennae distinctly overreaching the fore-margin of prothorax. Mouth-cone reaching about to the middle of prosternum. Fore-femora already enlarged, about as long as head or a little longer; fore-tarsus with a very large, sharp tooth. Wing cases, as present, reaching to the fourth abdominal segment. All other characters as in the first pupa.

A NEW AUSTRALIAN TERMITE.

By Gerald F. Hill.

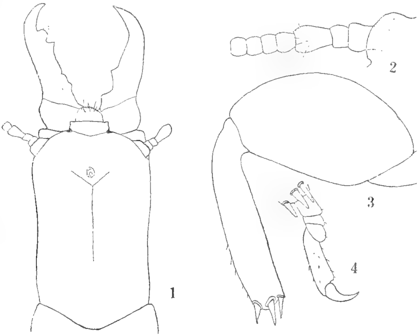
(With 4 Text-figures).

[Read 26th July, 1922.]

Calotermes (Calotermes) condonensis, n.sp. (Text-figs. 1-4.)

Colour: Head hazel, anterior part dark castaneous like base of mandibles; antennae hazel, third joint dark; labrum lighter in colour than rest of head; mandibles black excepting at base; thorax a little lighter than back of head; legs and abdomen buckthorn brown.

Head (Text-fig. 1) clothed with scanty, very short and fine setae as on thorax, legs and abdomen; large, slightly wider at the anterior third than across the middle, broadly rounded behind, front slightly concave, not glabrous like re-



Text-figs. 1-4. *Calotermes condonensis*, n.sp.
Soldier.—1. Head from above. 2. Antenna, proximal segments. 3. Hind femur and tibia. 4. Hind tarsi and claw

mainder of head. Eyes hyaline, indistinct. Mandibles very long and stout, broad at base, the left with two angular teeth at apex, the right with two broad angular teeth in the basal half. Labrum large, rounded in front, bearing about 8 setae near the apex. Clypeus large, straight in front and on the sides. Antennae (Text-fig. 2) 14-jointed, first short and broad, the proximal half obscured by projecting dorsal margin of antennal foveola, second much narrower and shorter, these two without setae, third very large, strongly chitinised, narrow at the base, swollen towards the apex, setaceous like remaining joints, fourth very small, rather larger than fifth, fifth and following joints moniliform. Gula long, much narrowed in the middle, where it is one-fifth the width of the head.

Thorax: Pronotum a little wider than head, markedly arched, almost semicircular in transverse section, anterior border deeply concave, antero-lateral angles rounded and projecting well over posterior-lateral area of the head, sides receding to the broadly rounded posterior margin, the latter slightly arcuate in the middle. Meso- and metanotum a little narrower than pronotum, with sides and posterior margins less rounded. No evidence of wing-pads.

Legs (Text-figs. 3 and 4) short and stout, femora greatly thickened, with few setae; tibial spurs 3:3:3, short, stout, serrate.

Abdomen short, a little longer than thorax, tapered to the apex. Cerci present.

Measurements:

Total length, 11.00 mm.
Head and mandibles, long 5.00.
Abdomen and thorax, long 6.00.
Head: from base to labral suture, long 3.29; wide 1.92; deep 1.64.
Mandibles, from apex to external articulation, long 1.88.
Pronotum: long* 1.36; wide 2.06.
Tibia iii. long 1.27.

Nymph.

Colour: Head mars yellow with dark russet area at articulation of mandibles; antennae, legs and thorax antimony yellow.

Head clothed with a few, short, pale setae, nearly circular, widest midway between the base of clypeus and posterior margin, the antero-lateral areas sloping abruptly from the posterior margin of the antennal fossae to the articulation of the mandibles, flat on the summit. Clypeus as in soldier; labrum short, strongly convex, rounded in front, bearing a few short pale-coloured setae. Antennae 17-jointed, first joint short and broad, second about half as long but nearly as wide, slightly narrowed at the base, third nearly as long as second and a little wider at the apex, nearly quadrate, fourth nearly as wide as third but only half as long, nearly rectangular, fifth a little longer and wider than fourth, widest in the middle, sixth as long and wide as fifth but more rounded, seventh to seventeenth moniliform.

Pronotum as in soldier, with very few setae; wing-pads short and thick, projecting but little.

Legs short and stout, with scanty setae, femora thickened, tibial spurs 3:3:3, serrate.

Abdomen moderately short and broad, with few setae; cerci very short and stout at the base; styli rather stout, broad at the base.

Measurements:

Head: from base to labral suture, long 1.83 mm.; wide 1.50.

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*In this, as in all earlier papers, I have given the maximum pronotum length, not the length along the median line (Light, 1921, p. 29). The difference is considerable in species with deeply notched pronotum. In all other respects my measurements correspond with those defined by the above author.

Pronotum: long 0.90; wide 1.50.

Tibia iii. 0.09.

Described from a small nest series of soldiers and nymphs, collected during 1907-8 by Mr. H. M. Giles and forwarded to me recently by Mr. J. Clark.

Affinities.—The above species is quite distinct from any hitherto described Australian species, being easily distinguished in the soldier caste by its long narrow head, large mandibles, dentition, third joint of antennae, and enlarged femora. The two last characters are typical of the subgenus *Calotermes* as defined by Holmgren, while the majority of the described Australian species are grouped under the subgenera *Glyptotermes* and *Neotermes*. The subgenus *Cryptotermes* is represented in Australia, as far as is known at present, by one described and one undescribed species.

Types in G. F. Hill's collection. Paratypes in Mr. Clark's collection.

Locality.—Western Australia: near Condon.

Additional reference.

LIGHT, S. F., 1921.—Notes on Philippine Termites, ii. *Philippine Journal of Science*, Vol. 19, No. 1, July, 1921.

A NEW GASTEROPOD (FAM. *EUOMPHALIDAE*) FROM THE LOWER MARINE SERIES OF NEW SOUTH WALES.

By John Mitchell, late Principal of the Newcastle Technical College.

(Plate xxxv.)

[Read 28th June, 1922.]

Platyschisma allandalensis, n.sp. (Pl. xxxv.)

Spec. chars.—Trochiform, large; spire consists of four whorls, first two depressed and convolved so as to be subdiscoidal, penultimate and ultimate rapidly increase in size and become spirate, the latter whorl relatively large. The transverse growth lines are separated by rather wide, shallow, irregularly-spaced sulci, and have a backward curve to the periphery; on the under side, the trend is reversed to the wide shallow umbilicus. As the shell reaches maturity the growth lines and striae become almost straight between the whorl sutures and the periphery. The outer lip has a shallow notch or gape, as in *Ianthina* and in *Platyschisma oculus.* Upper and under surfaces of the whorls are convex. The mouth is very large, suboval or subconical and horizontal; the test was thin. Diameter 4½ inches.

Obs.—The differences between *Platyschisma oculus* Sowerby, and the present species are as follow:—The whorls of the latter are convex above and below, the periodical growth lines are wider apart and more definite, the notch of the outer lip is less deep, aperture horizontal instead of oblique as is the case in the former; umbilicus shallower and the callosity or thickening of the lower lip less pronounced, the body whorl increases in width more rapidly during its last stages of growth than does that of *Platyschisma* (*Keeneia ?*) *oculus* Sowerby or with *Keeneia platyschismoida* Etheridge which I assume to be identical with *Platyschisma oculus* Sowerby, in part at least.

In several respects this shell agrees with species of the present day *Ianthina,* but compared with them it was of gigantic size. It would appear to have been a very rare shell in the Lower Marine Series at Allandale, N.S.W., where it is associated with *Platyschisma oculus* Sowerby, *Eurydesma cordàtum, Aviculopecten mitchelli* Eth. and Dun and many other palaeopectens, etc.

Locality and horizon.—Railway cutting near Allandale railway station. Lower Marine Series, Permo-carboniferous.

DESCRIPTION OF PLATE XXXV.

Platyschisma allandalensis, n.sp.

Upper figure.—View from the under side, showing the wide shallow umbilicus, and widely spaced growth lines. The specimen is almost completely non-testiferous; but otherwise nearly perfect.

Lower figure.—View from above, showing the increasingly backward curve of the growth lines as they approach the periphery, to form the gape in the outer margin of the mouth, also mild convexity of the whorls, etc.

(Both figures two-thirds natural size.)

SOME NEW PERMIAN INSECTS FROM BELMONT, N.S.W., IN THE COLLECTION OF MR. JOHN MITCHELL.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), C.M.Z.S., F.L.S., F.E.S.

(Plates xxxiii.-xxxiv. and six Text-figures.)

[Read 28th June, 1922.]

In a previous paper (These Proceedings, xlii., pt. 4, 1917, pp. 729-741) I described the first insects discovered by Mr. Mitchell in the Upper Permian Insect Beds of Belmont, consisting of a single genus and species belonging to the new family Permofulgoridae, of the Order Homoptera, and one genus and two species belonging to the new family Permochoristidae, of the Order Mecoptera. In another paper (These Proceedings, xliv., pt. 2, 1919, pp. 231-256) I also described a remarkable wing, also discovered at Belmont by Mr. Mitchell, which forms the type of a new Order Paramecoptera, ancestral to the Trichoptera and Lepidoptera; this insect was named *Belmontia mitchelli*. Since that time, Mr. Mitchell has visited Belmont on a number of occasions, and has recently been accompanied by his friends Mr. and Mrs. T. H. Pincombe of New Lambton. The result of these excursions has been that a considerable area of the strata around the original finds has been thoroughly investigated, and a number of insect wings have been unearthed. The present paper deals with those added to Mr. Mitchell's Collection prior to my recent visit to Belmont in November, 1921. Further finds made during and since that visit will be dealt with in a later paper.

An analysis of the Insect Fauna of Belmont can now be made, on a basis of some twenty wings discovered to date. This shows that the dominant insect type there was undoubtedly a family of Scorpion-flies, the Permochoristidae, which are very closely allied to our existing Australian Scorpion-flies of the family Choristidae, and especially to the genus *Taeniochorista* E.-P., which is to be found around the shores of Lake Macquarie at the present day. Nearly one-half of the specimens of insect wings unearthed at Belmont to date consists of examples belonging to this family. In association with these are two other Mecopteroid types, viz. *Belmontia* Till., placed in the Order Paramecoptera, and a very interesting new type, described in this paper, which stands in the same relation to the Order Diptera that *Belmontia* does to the Trichoptera and Lepidoptera. In addition to these Mecopteroid types, we are now able to record the first discovery of a true Lacewing (Order Neuroptera Planipennia) of Palaeozoic times; this also is dealt with in this paper. The remainder of the fauna consists of Homoptera, both divisions of that Order being represented at Belmont, the Auchenorrhyncha by the Permofulgoridae and Scytinopteridae (the latter not dealt with in this paper) and the Sternorrhyncha by a perfect wing found by Mr. Pincombe, and here dedicated to its discoverer.

With the exception of a fragment of a large Mecopteroid wing, described in this paper, all the insects so far found at Belmont are of small to medium size, and indicate by far the most highly specialized fauna so far found in any Palaeozoic strata. It would appear to have been a fauna developed in association with the fern *Glossopteris,* in which primitive Scorpion-flies took the place of the Cockroaches dominant in the Carboniferous and Permian beds of the Northern Hemisphere, and Plant-hoppers sucked the juices of the fern-stems. As in the case of the present-day Choristidae, the larvae of the Scorpion-flies probably fed omnivorously on the moist débris scattered on the ground. The discovery of a lacewing of very primitive type shows that the Homoptera already had their enemies; for the larvae of the more primitive Planipennia still feed chiefly on the young of that Order.

The earliest records of insects occurring in Australia are those from the Upper Permian of Newcastle and Belmont. This enables us to draw the striking conclusions that Australia became populated with insects long after the Northern Hemisphere, and that the first insect immigrants were not by any means primitive types by comparison, but representatives of the two most highly specialised divisions of the Pterygota yet evolved, viz. the Hemipteroidea and the Holometabola. From this we may conclude that Australia lay far away from the region of the earth in which insects first became evolved. From what direction the first insect colonists came it is not possible to say with certainty; but it seems reasonable to assume that they were an offshoot of the Gondwanaland fauna, and came in with the associated *Glossopteris*-flora.

I should like to express my grateful thanks to Mr. Mitchell for the opportunity of studying and describing these fine fossils, and my admiration of the keenness and energy which still actuates him, at his advanced age, in carrying on the heavy work necessary in the search for them. I also desire to thank Mr. W. C. Davies, Curator of the Cawthron Institute, for the fine photographs from which Plates xxxiii.-xxxiv. have been prepared.

Order **HOMOPTERA.**

Division *AUCHENORRHYNCHA.*

Family PERMOFULGORIDAE.

PERMOFULGOR INDISTINCTUS, n.sp. (Text-fig. 1.)

A fragment of a forewing, *total length* 11.5 mm., *greatest breadth* 3.1 mm. The impression is a very faint one, on pale grey cherty shale. All the veins are very indistinct, except only the vena dividens and the three anal veins; these latter are very strongly marked. The species differs from the genotype, *P. belmontensis* Till. in the following points:—Wing narrower, apparently somewhat pointed, though the apex is missing. Only two cubito-anal cross-veins, instead of four. Cu_1 with three main branches, and with a very weak oblique branch or cross-vein descending from near the first dichotomy to the apex of Cu_2; in *P. belmontensis* this branch appears as a definite oblique cross-vein leaving Cu_1 considerably distad from the first dichotomy, and reaching Cu_2 well before its apex; the second dichotomy of Cu_1 occurs much closer to the first in the new species than it does in *P. belmontensis.* M appears to be definitely fused basally with R, and the arrangement of the cross-veins between R, M and Cu_1 shows considerable differences from the condition seen in *P. belmontensis.*

In comparing the new species with *P. belmontensis* (*op. cit.*, p. 730 and Text-fig. 3), it is necessary to point out that, in my former paper, I had considered the vena dividens to be 1A, and consequently assumed 3A to be two-branched. This was an error, and the description and Text-fig. of my former paper need to be altered so that the vena dividens becomes Cu_2, as in all Homoptera, the three anal or claval veins becoming 1A, 2A and 3A respectively.

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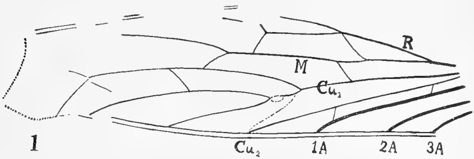

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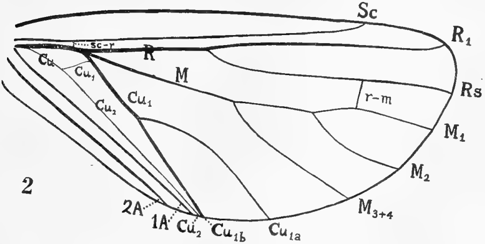


Text-fig. 1. *Permofulgor indistinctus*, n.sp. (x 8.6).
Text-fig. 2. *Pincombea mirabilis*, n.g. et sp. (x 33).
For lettering see p. 260.

T y p e, Unnumbered specimen in Mr. Mitchell's Collection. Label:—"Wing, Newcastle Measures" (in ink); "Loc. Nr. Belmont" (in pencil).

Horizon.—Upper Permian of Belmont, N.S.W.

I think it very probable that Specimen No. 25, described briefly on pp. 740-741 of my previous paper, belongs to this species, though I have not had an opportunity of further studying the specimen.

It does not seem possible to say anything very definite about the affinities of the Permofulgoridae at present, owing to the poor preservation and incompleteness of the specimens so far discovered. It is clear that the venation of the forewing, with the exception of the clavus, is very feebly developed. This is a condition not infrequently met with in the Auchenorrhyncha, but it is usually associated with a considerable thickening of the membrane of the tegmen. The genus *Permofulgor,* however, does not seem to have had a thickened tegmen, and we must wait until a more perfect specimen is discovered before we shall be in a position to discuss its affinities with any certainty.

Division *STERNORRHYNCHA.*

Family PINCOMBEIDAE, n.fam.

Small insects with broad forewings having a long, narrow clavus ending about half-way along the posterior border, with two strong, sub-parallel anal veins. R, M and Cu_1 all arising not far from base from a single strong principal vein, at the same point.

Genus PINCOMBEA, n.g. (Plate xxxiv., fig. 4; Text-fig. 2).

Forewing with nearly straight costa, the apex almost in line with it. Sc a nearly straight, unbranched vein, running close to and just above R to end up on the costa about four-fifths from base. R_1 and Rs both unbranched, the former ending up just above, the latter a little below the apex; Rs arising just before half-way along the wing-length. M three-branched, M_{3+4} being unbranched and arising from M at about the middle of the wing, while M_{1+2} is forked dichotomically considerably further distad. Cu_1 a very strong vein running obliquely downwards across the basal half of the wing; before half-way, it forks strongly; the anterior branch, Cu_{1a}, arches outwards, and ends up on the posterior border well beyond end of clavus; the posterior branch, Cu_{1b}, continues the straight line of the basal portion of the vein, and ends up exceedingly close to Cu_2. Cu_2 a weakly formed, almost straight, furrow vein. 1A and 2A very strongly formed. Distal border of wing from R_1 to end of clavus wide and well rounded. Only two cross-veins present, viz. a short basal one (*sc-r*) connecting Sc with R, and a longer one (*r-m*) distally between Rs and M_1, at right angles to both. An apparent cross-vein joining Cu_1 and Cu_2 basally, and very weakly formed, is almost certainly the true basal piece of Cu_1 as marked in Text-fig. 2, in which case the strong stump of Cu_1 arising from the principal vein must be actually M_5, as in Paramecoptera.

Genotype, *Pincombea mirabilis,* n.sp.

The genus is dedicated to its discoverer, Mr. Torrington H. Pincombe, of New Lambton, near Newcastle, N.S.W., who has been assisting Mr. Mitchell in the exploration of the Belmont Beds.

PINCOMBEA MIRABILIS, n.sp. (Plate xxxiv., fig. 4; Text-fig. 2.)

Total length 3 mm.; *greatest breadth* 1.2 mm.

A perfect specimen of a forewing, and certainly the smallest Palaeozoic insect wing yet discovered. The impression is on the smooth surface of a pale grey cherty shale, and is remarkably clear. R_1, Cu_1 and the anal veins stand up as strong ridges, Cu_2 and Sc lying in deep furrows. This shows that the impression is the obverse or cast of a right forewing. Unfortunately the reverse was lost, although a careful search was made for it.

Type, Specimen No. P. 2 in Mr. John Mitchell's Collection.

Horizon.—Upper Permian of Belmont, N.S.W.

At first sight, this wing appears to be nothing more than a slight smudge on the rock surface, and it is only with the aid of a lens of considerable power that the perfection of the venation can be made out.

This is the first Sternorrhynchous wing discovered at Belmont. The other known Sternorrhynchous wing from the Upper Permian Beds of New South Wales is *Lophioneura ustulata* Till., recently described from Merewether Beach, near Newcastle (These Proceedings, xlvi., pt. 4, 1921, p. 420), and therefore probably somewhat older in geologic time than the present species. A comparison of the two wings shows considerable differences, sufficient, in my opinion, to justify the formation of a separate family for each. In *Lophioneura,* the costal area is wide and short, Sc ending up well before half-way along the costa, R_1 ending up a little beyond half-way, and the whole shape of the wing being widely different from that of *Pincombea. Lophioneura* has Rs forked, M also only once forked, Cu_1 with a very weak distal fork, and the clavus very short, excessively narrow, and without any anal veins upon it; there are also no cross-veins. Both wings are very primitive, for Sternorrhynchous types, in having the veins M and Cu_1 arising from the principal vein so close to the base. But, whereas in *Lophioneura* the three veins Cu_1, M and Rs come off from the principal vein separately in order, from the base outwards, at short intervals, in *Pincombea* Cu_1 and M come off at the same point, with Rs arising much further distad from R_1.

The simple Rs and three-branched M of *Pincombea* can be paralleled in many present-day Aphiidae. This latter family could certainly be derived from the Pincombeidae by the fusion of Sc with R, together with very strong distal movement of all the veins coming off from the principal vein, general narrowing of the wing, and especially strong narrowing of the basal portion, leading to complete elimination of any distinct clavus and anal veins. These immense differences only show us how much older *Pincombea* is than any existing Sternorrhynchous type.

A more useful comparison may perhaps be made with the incomplete forewing which I have named *Triassopsylla plecioides,* from the Upper Triassic Wianamatta Shale Beds of Glenlee, N.S.W. (These Proceedings, xlii., pt. 4, 1917 (1918), p. 754). Though only the distal half of this wing is preserved, it agrees with *Pincombea* in having M forked in almost exactly the same way, in having Rs simple, and Sc running very close to R. It differs in having R_1 distally forked, the apical border of the wing more evenly rounded, and two cross-veins between R_1 and Rs, while the cross-vein between Rs and M, though present, is more basally placed than in *Pincombea. Triassopsylla plecioides* was placed by me, with some doubt, in the family Psyllidae. Until we know the venation of the basal half of the wing, that doubt must remain; but it is at any rate significant that the distal portions of the two wings show so much similarity.

In the perfection of the clavus, *Pincombea* is certainly the most generalised Sternorrhynchous type yet discovered, and in its general structure it stands closer to the Auchenorrhyncha than any other known type, and serves to bridge over partially the wide gap which now separates the two main divisions of the Homoptera.

Order **PROTOMECOPTERA.**

Family ARCHIPANORPIDAE.

ARCHIPANORPA (?) BAIRDAE, n.sp. (Plate xxxiii., fig. 1.)

A fragment of a very large wing. *Total length* 12 mm., *greatest breadth* 10 mm., representing portion of a complete wing probably 30 mm. long. The specimen is cracked obliquely across near the middle, but all the veins are only slightly displaced, and can be followed across the crack. The uppermost vein would appear to be Sc, followed in order by the unbranched R_1, the dichotomically branched Rs, of which eight branches are shown distally, the three-branched M, and finally by Cu_1, carrying a peculiar closed cell towards its distal end. The manner of branching of the veins, and the system of weak cross-vein struts here and there at irregular intervals, strongly suggests a close resemblance to the Upper Triassic Archipanorpidae; but there is scarcely enough of this large wing represented to enable it to be placed with any certainty. It might conceivably be a very ancient type of the Order Planipennia.

Type, Specimen No. P. 1 in Mr. Mitchell's Collection.

This species is dedicated to Mrs. Pincombe (née Baird) who discovered it at Belmont.

It is much to be regretted that this fine wing is not more completely preserved, so as to allow of a more certain determination of its affinities.

Order **PARAMECOPTERA.**

Family PARABELMONTIIDAE, n. fam.

Insects having the same general type of venation as *Belmontia* Till., but with the wings somewhat broader, more rounded apically, Rs and M having six branches each, and Cu_1 *without any distal forking.*

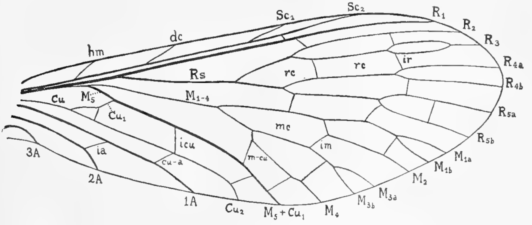
The discovery of this new type of wing necessitates a change in the definition of the Order Paramecoptera as originally given by me (These Proceedings, xliv., pt. 2, 1919, p. 234). The portions dealing with Rs, M and Cu should be altered to read as follows:—

Rs dichotomically branched, with six or more separate branches on the wing-margin. M dichotomically branched, with five or more separate branches on the wing-margin. Cu_1 either simple, as in Mecoptera and Diptera, or having an apical fork, as in Megaloptera, Trichoptera and Lepidoptera; Cu_2 a weak, concave, simple vein.

It will be seen that, by this alteration, the differences between the Paramecoptera and true Mecoptera are considerably narrowed, one of the chief distinctions hitherto having been the presence of the apical fork of Cu_1 in the former Order. However, I think it wise to keep the Paramecoptera as a distinct Order, since it is clear that the general plan of their venation is not truly Mecopterous, but more of the type found in primitive Trichoptera, Lepidoptera and Diptera, though with more branches to both Rs and M. The Parabelmontiidae would seem to stand in much the same relationship to the Order Diptera as the Belmontiidae do to the Trichoptera and Lepidoptera. It is evident that, in these generalised types, we have come upon a point in the evolution of the Panorpoid Orders in which the venational differences which later led to the Trichopterous and Lepidopterous types on the one hand, and to the Dipterous type on the other (through the intermediate Order Paratrichoptera) are just beginning to form. If we had the full fossil record, it would be impossible to set any arbitrary limits to the various Orders, for each type would merge by small degrees into the next. As matters stand, the chain of types already discovered is practically complete enough for us to indicate the courses of the various lines of evolution without any doubt; the more complete it may become, by discovery of new intermediate types, the more difficult it will be to uphold any one of these new fossil Orders as a separate entity. Yet we may not place these types within recent Orders, without leaving it to be inferred that we believe them to have belonged morphologically to such Orders in other characters besides the wing-venation. *Belmontia* and *Parabelmontia* were plainly, from their venation alone, not true Scorpion-flies, but more generalised insects, probably combining the more archaic characters of the true Mecoptera with those of the Megaloptera.

Genus PARABELMONTIA, n.g. (Plate xxxiii., fig. 2; Text-fig. 3.)

Forewing.—Costal space narrow, with humeral (*hm*) and distal (*dc*) veinlets present, and Sc forked distally into Sc_1 and Sc_2. R_1 a strong, straight, unbranched vein, connected with Sc_2 distally by a short cross-vein, and with R_2 by another one, close to the former. Rs arising from R at about one-fifth of the wing-length, and dividing into R_{2+3} and R_{4+5} slightly before half-way. R_{2+3} divides into R_2 and R_3 at a level only slightly distad from that at which R_{4+5} divides; R_2 is simple, but R_3, though ending simply on the wing-margin, divides to form a small elongated cell, which is closed again not far from the margin, by fusion of the two branches. R_4 and R_5 both divide again about half-way along their lengths, and their branches run free to the margin, R_{4b} being at the apex of the wing. The radial cell (*rc*) may be considered closed, much as in *Bel-*



Text-fig. 3. *Parabelmontia permiana*, n.g. et sp. (x 6). For lettering, see p.260,

montia, by the cross-vein placed distally between R_3 and R_{4a}, and is also crossed, about its middle, by another cross-vein. M is fused basally with R, but leaves it below *hm*, and shortly afterwards divides into M_{1-4} and M_5, the latter being a very strongly formed convex vein forming the upper arm of a large cubito-median Y-vein closely resembling that of *Belmontia*; the lower arm, or basal piece of Cu_1, is broken near its middle at a point where a cross-vein descends from it on to Cu_2. M_{1-4} divides slightly before the level of the first dichotomy of Rs, and each branch again divides into two, of which the upper branch in each case (M_1 and M_3) is again forked distally, while the lower (M_2 and M_4) remains simple, so that there are altogether six branches of M_{1-4} ending on the wing-margin. The median cell (*mc*) is closed by a strong cross-vein, and both forks are sessile upon it. The main stem of the cubito-median Y-vein, M_5+Cu_1, is a strong convex vein resembling that of *Belmontia,* but *without any distal forking*; in its connections with M_4 and Cu_2, it strongly recalls the formation of Cu_1 in the Upper Triassic Paratrichoptera, such as *Aristopsyche.* Cu_2 is curved distally, as in *Belmontia,* and connected with the straight, strong 1A by a single cross-vein, *cu-a.* 2A is little more than half as long as 1A, is bent distally as in *Belmontia,* and is connected with 1A above the bend by a single cross-vein, *ia.* 3A is a short, much-curved vein, isolating, between itself and the border, a small convex jugal area.

Genotype, *Parabelmontia permiana,* n.sp.

Closely related to *Belmontia,* from which it differs chiefly in the unforked Cu_1, the different number of branches of Rs and M, the somewhat different arrangement of the cross-veins, and the different position of the forking of R_{4+5}, which, in *Belmontia,* is placed very close up to the primary forking of Rs.

The origin of the Trichoptera and Lepidoptera from forms resembling *Belmontia* has already been dealt with in a previous paper (*op. cit.* pp. 242-8). In the same work (pp. 248-250) I also discussed the affinities of *Belmontia* with the Paratrichoptera and Diptera, and concluded that there was no direct ancestral connection between them. In the case of *Parabelmontia,* we can say with certainty, owing to the formation of Cu_1, that this genus is *not* ancestral to the Trichoptera and Lepidoptera; but, for the same reason, it comes into the direct ancestral line of the Paratrichoptera and Diptera, in which the formation of Cu_1 is very closely similar. If we postulate the existence of other types, closely allied to *Parabelmontia,* but with the short costal vein still not fully reduced to a veinlet (*hm*), as seen, for instance, in the genus *Aristopsyche* of the Paratrichoptera, then we could say with certainty that, from such a type, this latter Order is derivable simply by reduction of the number of branches of Rs and M to four each; and it would follow that the Diptera were also to be derived from it by further reduction. Or we may regard *Aristopsyche* as an archaic side-branch, which preserved the separate short costal vein, long after the rest of the group had lost it, and may then derive those of the Paratrichoptera which have no costal vein direct from forms like *Parabelmontia,* and the whole of the Diptera from those more specialised Paratrichoptera themselves.

PARABELMONTIA PERMIANA, n.sp. (Plate xxxiii., fig. 2; Text-fig. 3.)

An almost perfect forewing; *total length* 17 mm., *greatest breadth* 7 mm. The impression is the reverse or mould of the wing, as is proved by the fact that R_1, Cu_1 and 1A appear as deep furrows; as the apex lies to the right, the impression must be the cast of a left forewing. The wing lies upon the smooth surface of a grey cherty shale, the whole wing being pale ochreous in colour, and stained fulvous along the costa and posterior border of clavus. There are slight abrasions of the apex and tornus, and the course of the distal margin is very faint in consequence; otherwise the venation is practically perfect. The system of cross-veins, as will be seen from Text-fig. 3, is very like that of *Belmontia.* The closure of the small cell on R_3 may perhaps be considered a specific rather than a generic character.

Type, Specimen No. 54 in Mr. Mitchell's Collection.

Horizon.—Upper Permian of Belmont, N.S.W.

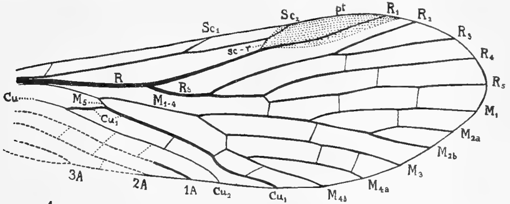
This is the first specimen of an insect wing found at Belmont stained an ochreous colour, and thus standing out clearly from the grey rock on which it is impressed.

Order **MECOPTERA.**

Family PERMOCHORISTIDAE.

PERMOCHORISTA SINUATA, n.sp. (Plate xxxiv., figs. 5, 6; Text-fig. 4.)

Two specimens of forewings referable to this species are present in the Collection. Specimen No. 55 (Plate xxxiv., fig. 5) is a very clear impression, being both the obverse and reverse of a right forewing, the obverse with R and Cu_1 standing up as high ridge-veins, and the apex being to the right. The wing is perfect except for the loss of most of the clavus or anal area. *Total length*



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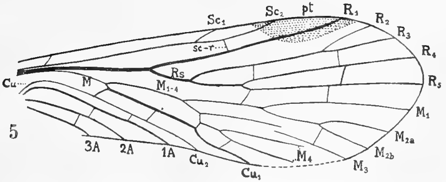

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Text-fig. 4. *Permochorista sinuata*, n.sp. (x 13.3). Dotted veins restored from the paratype, all the rest representing the holotype.

Text-fig. 5. *Permochorista affinis*, n.sp. (x 13.3).

For lettering, see p.260.

8 mm.; *greatest breadth* 3 mm. Specimen No. 51 (Plate xxxiv., fig. 6) is a slightly larger wing, obverse only, also on a medium grey cherty shale, but not so clearly impressed as No. 55. *Total length* 8.3 mm. It is not quite perfect, the extreme base being broken off, a considerable piece removed from the

pterostigmatic area, and a smaller piece from the border of the clavus. But it shows most of the three anal veins, which are absent from No. 55.

This species may be distinguished at once from *P. australica* Till. and *P. mitchelli* Till., already described from Belmont (*op. cit.*, pp. 733-6) by the very marked sinuous curvature of Cu_1 distally, by the condition of Sc, which only gives off the humeral veinlet (*hm*) basally and then divides into Sc_1 and Sc_2 distally, without any additional veinlets being present, and by the peculiar condition of the basal piece of M_4, which is specialised to resemble a cross-vein. The positions of the forkings of the main veins are closely similar to those of *P. australica,* while the formation of the cubito-median Y-vein, completely revealed for the first time in this species, shows that the interpretation placed by me on the same partially preserved area in *P. mitchelli* was substantially correct. Of the two arms of the Y-vein, the upper, M_5, is much shorter and also not so strongly formed as the lower, Cu_1; this may be profitably contrasted with the condition shown in *Parabelmontia* (Text-fig. 3). The system of cross-veins is very weakly developed, and much less numerous than in the previously described species.

T y p e s, Holotype, Specimen No. 55, of which both the obverse and reverse impressions have been preserved; the obverse being in Mr. Mitchell's Collection, the reverse in the Collection of the Cawthron Institute, Nelson, N.Z. (presented to me by Mr. Mitchell). Paratype, Specimen No. 51, in Mr. Mitchell's Collection (obverse only).

In Text-fig. 4, the dotted anal veins are restored from Specimen No. 51, while the rest of the wing is drawn from Specimen No. 55.

PERMOCHORISTA AFFINIS, n.sp. (Plate xxxiv., fig. 6; Text-fig. 5.)

Total length 6.6 mm.; *greatest breadth* 2.5 mm. An almost perfect obverse of a right forewing on medium grey cherty shale, but with the end of the clavus slightly buckled and the veins above it broken.

Closely allied to *P. sinuata,* n.sp., from which it differs in the following points:—Size considerably smaller, wing somewhat broader towards apex, Sc with its two distal branches closer together, Sc_1 arising half-way along the wing-length instead of well before it as in *P. sinuata*; *sc-r* placed closer to Sc_1 and running in a different direction from what it does in *P. sinuata*; pterostigma much shorter and differently shaped; fork of R_{2+3} much shorter; cubito-anal Y-vein differently formed, with both upper and lower arms much shorter; cross-veins differently arranged, as may be seen by comparing Text-figs. 4 and 5.

T y p e, Specimen No. P. 3. in Mr. Mitchell's Collection. This specimen was discovered by Mr. T. H. Pincombe.

It is possible that the differences between the two species here described, on the one hand, and those previously described by me, on the other, (viz. the formation of Sc and its veinlets, and the curvature of the distal end of Cu_1), might justify the removal of the two new species to a new genus. As more material is sure to come to hand later on in this family, this question is best left over until the fullest information is available on the subject.

It might be suggested that *P. affinis* is only the hindwing of *P. sinuata.* I have decided against this; firstly, because the impression of *P. affinis* is a very clear one, strongly suggestive of a forewing; and secondly, because it has all three anal veins separate. All known Mecoptera have 1A partially fused with Cu_2 in the hindwing; and it will be seen from my previous figure of *P. mitchelli.* (*op. cit.,* p. 735) that this fusion was almost certainly present in hindwings of the family Permochoristidae.

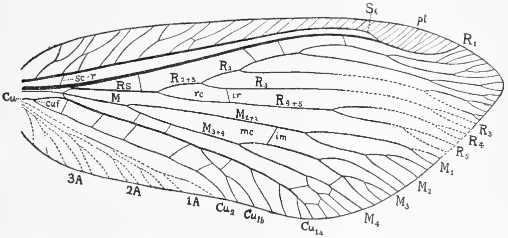
Order **PLANIPENNIA.**

Family PERMITHONIDAE, n. fam.

Rather small insects with the forewing fairly broad, the apex rather pointed. Sc fusing with R_1 distally. Rs pectinately branched, but with the original dichotomy of R_{4+5} preserved. Four cross-veins between R_1 and Rs. Radial cell (*rc*) present, closed by a crossvein (*ir*). M with its original dichotomic branching preserved, and the branches not crushed closely together as in recent Planipennia owing to increase in the number of branches of Rs. Median cell (*mc*) present, closed by a cross-vein (*im*). Fairly numerous additional distal forkings on the branches of Rs and M, including small terminal twiggings. Cubito-median Y-vein still preserved, the upper branch, M_5, very short in comparison with the lower, Cu_1. Primary cubital fork (*cuf*) very close to base. Cu_1 a fairly strong convex vein pectinately branched. Cu_2 a simple, weak, concave vein. (Anal veins not preserved).

Genus P e r m i t h o n e, n.g. (Plate xxxiii., fig. 3; Text-fig. 6.)

Characters as for the family, with the following additions:—Costal area moderately broadened near base, the series of costal veinlets not closely crowded together, mostly simple, but a few forked or connected together by short cross-veins. Pterostigmatic veinlets much closer together. A single cross-vein, *sc-r*,



Text-fig. 6. *Permithone belmontensis*, n.g. et sp. (x 12). For lettering, see p.260. Wing restored by the removal of the overfold (missing veins shown by dotted lines) and placed with apex to the right.

connects Sc with R basally. Five pectinate branches to Rs. Radial cell rather short. Median cell very long; the fork of M_{1+2} stalked from the cell, that of M_{3+4} sessile upon it. Cu_{1a} with four short branches; Cu_{1b} distally forked. Two medio-cubital cross-veins situated before half-way. A series of inter-cubital cross-veins present.

G e n o t y p e, *Permithone belmontensis*, n.sp.

This is the first true Lacewing to be discovered in Palaeozoic strata, and is noteworthy in being in some respects even more archaic than the hypothetical Archetype which I postulated for this Order in my previous work on the Panorpoid Complex (These Proceedings, xliv., pt. 3, 1919, p. 699). Apart from the distal fusion of Sc with R_1, which, though apparently a specialisation, may be due, as in the Perlaria, to a partial fusion only of Sc_2 with R_1, and may therefore be the original condition in the Planipennia, the wing before us is an absolutely generalised Planipennian, with primitive terminal twigging of the veins, primitive pectination of R_{2+3}, an absolutely primitive condition of M, primitive pectination of Cu_1, and even two characters which one could scarcely have suspected ever to have been present within the Order, viz. the closure of the radial and median cells by special cross-veins. The wing also stands very close to the Archetype of the Megaloptera, but the terminal twigging places it definitely within the Planipennia, as also does the position of the primary cubital fork very close to the base of the wing. It is to be distinguished from the more densely veined Corydalid types, of which *Protohermes davidi* Weele (*op. cit.*, p. 696) is a good example, by the much smaller number of costal veinlets and interradial cross-veins, as well as by the much more basal position of the primary cubital fork. It is, however, possible to derive the whole of the Megaloptera as well as the whole of the Planipennia from this wing-type, provided we assume that the Megaloptera are an aquatic offshoot from the very base of the terrestrial Planipennia, and that the Corydalidae are an older type than the Sialidae. These assumptions are, however, scarcely justified, and it seems more logical to assume that definite Megalopterous types were in existence in the Upper Permian, though not necessarily in Australia, and that the present fossil is a true Planipennian, from which the Mesozoic Prohemerobiidae, and consequently the whole Order as we know it at present, are easily derivable by further specialisations. The relationship of the present-day Ithonidae of Australia to the fossil type is so evident that I have selected a generic name for the fossil to indicate it as the Permian ancestor of that family; but it is scarcely less easy to derive from it such families as the Psychopsidae, Berothidae and Hemerobiidae, not to mention the Dilaridae, which do not occur in Australia.

PERMITHONE BELMONTENSIS, n.sp. (Plate xxxiii., fig. 3; Text-fig. 6.)

The specimen is the obverse or cast of a left forewing, showing R_1 as a strongly formed convex vein, Cu_1 as a slightly less strong, similar vein. The impression is on cherty shale stained with iron (ochreous), the wing itself being of an ochreous colour, shading to fulvous along the distal portion of the posterior margin, from half-way up to apex. The anal area is missing, and there is a slight overfold of the membrane a little below the apex. This appears to have been brought about by a tearing of the wing from near the end of M_1 across R_{4+5}, followed by a slight buckling of the apical portion, so that the lower side of the tear came to overlap the upper slightly. In Text-fig. 6, I have restored the wing, adding the missing veins covered up by the overlapping, and turning the apex to the right. *Total length* 9.4 mm.; *greatest breadth* 4 mm.

It should be noted that the terminal furrows so characteristic of the Order Planipennia, situated between the terminal twigs of the main veins, are clearly to be seen in this fossil around and above the apex, as are also the swollen bases of the tufts of hairs situated along the wing-margin between the twigs.

Type, Specimen No. 52, in Mr. Mitchell's Collection. Label "New Insect Wing, Belmont, N.S.W., Coll. Mitchell."

Mr. Mitchell is heartily to be congratulated on this wonderful find, which brings the record of the Lacewings right back from the Upper Triassic of Ipswich to the Upper Permian. We may express the hope that other representatives of the Order may yet be found at Belmont.

In concluding this paper, we may briefly review the position of the Panorpoid Orders as revealed to us in Upper Permian times by these fossils. At the present day, the six main Orders fall into three groups of two each, viz.

(*a*) Mecoptera and Diptera, characterised by simple Cu_1 and dichotomic branching of Rs.

(*b*) Trichoptera and Lepidoptera, characterised by forked Cu_1 and dichotomic branching of Rs.

(*c*) Megaloptera and Planipennia, characterised by forked Cu_1 and pectinate branching of Rs.

Each of these groups is now seen to have been represented by Upper Permian ancestors in Australia,

(*a*) by true Mecoptera of the family Permochoristidae, and by the genus *Parabelmontia* of the Paramecoptera.

(*b*) by the genus *Belmontia* of the Paramecoptera.

(*c*) by the genus *Permithone* of the Planipennia.

We are able, from this, to see that two Orders, the Mecoptera and Planipennia, were already in existence in Australia in Upper Permian times. On morphological grounds, we may also postulate the existence of true Megaloptera somewhere in the world at the same period, though not necessarily in Australia.

The history of the three more specialised Orders is now fairly plain. The type represented by *Parabelmontia* gave origin, in the Triassic period, to the main mass of the Paratrichoptera, from which the Diptera arose directly by reduction of the hindwing. The type represented by *Belmontia* gave origin, probably also in the Trias, to the common Trichoptero-Lepidopterous stem (almost certainly far outside Australia), and the two Orders became differentiated either in the Upper Trias or Lower Lias, the Lepidoptera remaining as an obscure group of Homoneurous types until the rise of the Flowering Plants in the Cretaceous brought with it the great development of the Heteroneura.

If the whole of the Insecta Holometabola had a common origin, as I believe to be the case, then it follows that both the Coleoptera and the Hymenoptera must have been represented by primitive types in the Upper Permian, or even earlier; since both these Orders are, morphologically, older in some respects than the Panorpoid Orders. Consequently we should expect to find, though not necessarily in Australia, primitive fossil beetles, allied probably to the Cupedidae, and primitive fossil Tenthredinoid Hymenoptera, somewhere in the higher Palaeozoic strata, in some part of the world.

Cawthron Institute, 20.2.22.

EXPLANATION OF PLATES XXXIII.-XXXIV.

Plate xxxiii.

Fig. 1. *Archipanorpa (?) bairdae*, n.sp. (x 7).
Fig. 2. *Parabelmontia permiana*, n.g. et sp. (x 5.8).
Fig. 3. *Permithone belmontensis*, n.g. et sp. (x 11.5).

Plate xxxiv.

Fig. 4. *Pincombea mirabilis*, n.g. et sp. (x 15.6).
Fig. 5. *Permochorista sinuata*, n.sp. Holotype obverse. (x 11.5).
Fig. 6. *Permochorista sinuata*, n.sp. Paratype. (x 11.5).
Fig. 7. *Permochorista affinis*, n.sp. (x 11.5).

Lettering of Text-figures.

1A, 2A, 3A, the three anal veins. Cu, cubitus; Cu_1, its anterior branch, dividing into Cu_{1a} and Cu_{1b}; Cu_2, its posterior branch, the vena dividens. *cu-a,* cubito-anal cross-vein. *cuf.,* primary cubital fork. *dc,* distal costal veinlet; *hm,* humeral veinlet. *ia,* inter-anal cross-vein. *icu,* inter-cubital cross-vein. *im,* inter-median cross-vein. *ir,* inter-radial cross-vein. M, media, dividing into M_{1-4} above and M_5 below, the latter forming the upper arm of the cubito-median Y-vein; M_1, M_2, M_3, M_4, branches of the media. M_5+Cu_1, main stem of the cubito-median Y-vein, usually denoted as Cu_1. *mc,* median cell. *pt,* pterostigma. R, radius; R_1, its anterior branch or main stem; Rs, radial sector; R_2, R_3, R_4, R_5, its branches. *r-m,* radio-median cross-vein. *rc,* radial or discoidal cell. Sc, subcosta; Sc_1, Sc_2, its distal branches. *sc-r,* subcosto-radial cross-vein.

STUDIES IN SYMBIOSIS.

I. The Mycorhiza of Dipodium punctatum R. Br.

By John McLuckie, M.A., D.Sc., Lecturer in Plant Physiology, University of Sydney.

Introduction.

As investigation into the nature and physiological significance of mycorhiza proceeds, it is becoming more and more convincing that many of the higher land plants of the Bush and the Forest derive some substances from the humus of the soil in a highly organised state—that the roots of a plant not only supply it with water and inorganic salts, but also, with dissolved organic matter. Acton (1889) has shown that carbohydrates and similar organic substances, and other organic constituents of humus may be absorbed by the root of an ordinary green plant. This absorption is probably independent of light and chlorophyll as in the holosaprophytes, e.g., *Thismia* (Groom, 1895), *Monotropa*, etc. Saprophytic fungi which have no relation to the roots of plants must derive their carbohydrate from the humus constituents of the soil, and when they are associated with higher plants in the formation of exotrophic or endotrophic mycorhiza, they would appear to supply some of the carbonaceous food and the nitrogenous food for the higher symbiont.

In cases of complete saprophytism amongst higher plants, the loss of chlorophyll is probably the result rather than the cause of the association with the mycorhizic fungus, for, when a plant obtains part of its food, especially carbohydrate food, from the soil, there is not the same necessity for a very vigorous photosynthesis. In shaded situations, light may be too feeble for active photosynthesis and the higher plant tends to depend more and more upon a saprophytic mode of nutrition. It is probably in this way that holosaprophytism has originated amongst Phanerogams.

The green plant is essentially adapted to the synthesis of its food from simple compounds with the assistance of radiant energy. Any deviation from this normal mode of nutrition results in the modification of the chlorophyll organs, the absorbing organs or both. Generally speaking the absorbing organs are the first to show indications of reduction or modification as the probable attendant of the facility of obtaining supplies of complex organic compounds. As the dependence upon already synthesised organic matter becomes more pronounced, the chlorophyll-bearing structures undergo modification either by the loss of chlorophyll or by the elimination of the photosynthetic leaves, as in *Galeola cassythoides* and *Dipodium punctatum,* or by reduction in the leaf surface.

When the roots of higher plants avail themselves of the organic matter in the soil, certain changes must occur in the absorbing cells or hairs to permit of the absorption of these substances—for example, the plasmatic membranes of the cells must be modified to permit of the osmotic diffusion into the cell vacuole —the osmotic pressure of the cells must increase temporarily or permanently to cause an inward flow of larger molecules of organic substances. Such changes are similar to those which are generally supposed to occur during the translocation of soluble foods from one cell to another, for example, from the endosperm to the embryo, etc.

Fungal hyphae which enter into the closest association with the humus constituents of the soil have a much greater power of digestion and solution of the organic matter than the root hairs of a higher flowering plant, so that, when the mycorhizic fungus becomes associated with the higher plant, it is able to provide the latter with greater supplies of organised food than the root hairs. In consequence root hairs cease to develop—their function and usefulness are subserved by the fungal hyphae, which can and do supply, not only organic matter, but water and ash constituents as well.

Since the researches on mycorhiza by Frank (1892), the number of plants with a similar condition of the root has proved very considerable. The number of such plants is so great, and they belong to such varied affinities and phyla, that it would appear that the host-plant must derive some considerable benefit from its association with the fungus. Its occurrence has been demonstrated in Dicotyledons, Monocotyledons, Conifers, Ferns, and Liverworts.

Wahrlich (1885) found mycorhiza in 500 species of Orchids in cultivation at Moscow; McDougall (1899) and Groom (1895a) and numerous other researchers have described other symbiotic saprophytes. Lawson (1917) has found an endophytic fungus in the prothalli of *Tmesipteris* and *Psilotum* which do not contain chlorophyll and are saprophytic and subterranean. Many of the cells of the prothallus contain a mycorhizal fungus which apparently provides all the food necessary for its host. The loss of chlorophyll and the association with the fungus, if not the result of the subterranean habitat, are at any rate in complete harmony with it. In this instance it is stated that the fungus ultimately causes the death and disintegration of the host cells which are infected. The nucleus undergoes a gradual change, and disintegrates with the other protoplasmic contents of the cell. It is significant that the fungus remains within the protoplasm of the host-cells without causing immediate destruction; and it seems to me that the subsequent destruction is partly associated with the naturally transitory existence of the prothallus. *Lycopodium, Botrychium* and other Pteridophytes have subterranean and saprophytic prothalli. Lang (1899) describes an endophytic fungus in the prothallus of *Lycopodium clavatum.* It is highly probable that in all these Pteridophytes, but especially in *Tmesipteris* and *Psilotum,* the prothallus is infected with the fungus early in its development, indeed shortly after germination of the spore. The spores of these Pteridophytes germinate in such shaded situations that it is not surprising that chlorophyll is absent, that the ever-present mycorhizal fungus should become associated with the prothalli, and that the prothalli should become saprophytic.

While numerous hypotheses have been formulated to explain the relation between the fungus and the higher plant, the physiological association of the two organisms is far from being clearly understood. A brief statement of these hypotheses may not be out of place here—

(1) Frank (1892) considers endophytic mycorhiza as a case of the higher plant trapping the fungus and living parasitically upon it.

(2) Fixation of nitrogen hypothesis.—The tubercules of *Podocarpus* are inhabited by the hyphae of a fungus, and it is stated that the Conifer cannot be cultivated without the fungus. Nobbe and Hiltner (1899) claim to have grown *Podocarpus* for five years in quartz sand from which nitrogen was absent. From this experiment it is concluded that the fungus of the tubercles of *Podocarpus* enables the plant to fix atmospheric nitrogen. Spratt (1912) has proved that the tubercular bacteria fix free nitrogen.

The investigations of Hiltner, Vogl and Nestler on *Lolium temulentum* with which a mycorhizic fungus is associated suggest the probable fixation of Nitrogen here also.

Hiltner claims that the luxuriant growth of many plants affected by a mycorhizic fungus supports the "Fixation of Nitrogen" hypothesis.

(3) Proteid hypothesis.—Magnus (1901) in his investigation of *Neottia* observed that the fungus within certain host-cells was partly digested, and suggests that the abundant proteid constituents of the hyphae furnished nourishment for the host.

Shibata (1902) observed similar digestion of the fungal hyphae in the cells of *Psilotum* rhizomes.

This process of digestion of the hyphae of the mycorhizic fungus is similar to the digestion of the bacteroids in Leguminous tubercles. The inference drawn from these observations is that the host-plant obtains its proteid from the fungal hyphae by their digestion, while the hyphae assimilate free atmospheric nitrogen, or poorly oxygenated nitrogen compounds of humus—the higher plant, in other words, obtains its supplies of nitrogen from a soil relatively poor in combined nitrogen through the agency of the fungus.

(4) In green plants possessing mycorhiza, the fungus probably supplies the nitrogen and the higher plant the carbon, but the relationship of two non-chlorophyll-bearing organisms may be essentially different. The higher plant would appear to be a parasite upon the fungus. After all, the symbiosis of a green plant and a fungus is little removed from the true parasitism of a fungus on a higher green plant. Certain cases of holosaprophytism in Angiosperms, e.g., *Thismia,* have all the appearance of parasitism of the higher plant upon the fungus, since, as far as present investigation shows, both the supplies of C. and N. are obtained by the fungus.

(5) Peptone-Asparagin hypothesis.—That the higher plants growing in the humus soils of the forest are peptone or asparagin organisms, and that the fungus is indispensable in manufacturing these nitrogenous compounds from the materials of the humus.

(6) Materials of the Ash hypothesis.—In 1900 Stahl put forward the theory that the fungus does not supply the higher plant with nitrogen at all, but its function is to provide it with the *materials of the ash.* Fungi collect ash constituents with great avidity and therefore are vigorous competitors with phanerogams in the humus soil which contains little nutritive salts. He claims that higher plants grow more vigorously in humus which has been deprived of

the fungi normally present. When the fungi are present, the higher plants show signs of "mineral starvation." The cases of known mycorhiza, according to Stahl, occur in such plants which grow in humus or, for other reasons, show feeble intake of mineral substances. He also asserts that the fungus not only absorbs but transforms the mineral salts for the higher symbiont. He comes to this conclusion from the observation that most mycotrophic plants do not contain calcium oxalate, which is associated with the assimilation of nutritive salts. In regard to the absence of calcium oxalate, I can definitely state that in *Dipodium,* which possesses an endophytic mycorhiza communicating with the hyphae outside the plant, there are large numbers of raphide-crystals in the cells of the cortex.

The Plant.

Dipodium punctatum is a terrestrial orchid which has very small scale-leaves. From a few large fleshy, succulent roots which penetrate the substratum in various directions, there develops the single upright flowering axis. The most favourable habitat of this orchid is the shaded humus soil of the Australian Bush, where there is a considerable accumulation of decaying leaves amongst a rich black sand. It occurs in a more stunted form on clay soils. Various species of *Eucalyptus,* and *Angophora lanceolata* provide a certain amount of shade when growing fairly closely together.

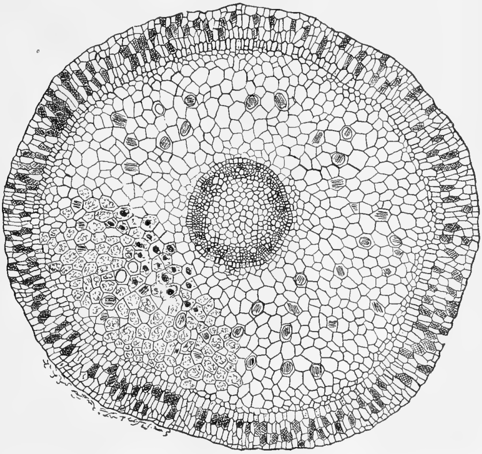
Moore and Betche (Flora of New South Wales) record *Dipodium punctatum* as a parasite on roots of neighbouring plants, but, although I have made most careful investigation of the root system in the soil, and have excavated it in its entirety I have not found any evidence to warrant the statement that it is a parasite on roots. I found no connection with the roots of other plants, and the statement that this orchid is a parasite has probably been made on account of the practically leafless, chlorophyll-less, aerial, flowering shoot.

Beccari (1871) has described a Monocotyledon, *Petrosavia stellaris,* as a parasite on roots, but Groom (1895a) has described a plant which he provisionally named *Protolirion paradoxum* which is very like the *Petrosavia* of Beccari. Groom found that his plant, *Protolirion,* was a saprophyte, and suspects that *Petrosavia* of Beccari is also a saprophyte. The existence of Phanerogamic holosaprophytes was not recognised at the time and it was assumed that non-chlorophylliferous forms were parasitic.

It is highly probable that the assertion that *Dipodium punctatum* is a parasite upon roots was based upon this assumption, and the non-recognition of holosaprophytism amongst Angiosperms. All the Monocotyledons devoid of chlorophyll, represented by all the Triuridaceae, etc., nearly all the Burmanniaceae, and several Orchidaceae are saprophytic. The probability is, therefore, from theoretical grounds, that *Dipodium punctatum* is saprophytic. From investigation I can confirm this view.

The flowering stems are from one to two feet high, and of a reddish colour, the leaves are small and scale-like, almost membranaceous. The flowers arise in the axils of the scale-leaves forming an extended terminal raceme. The plant is devoid of chlorophyll, and the leaves have no power of photosynthesis. They probably protect the young flower-buds.

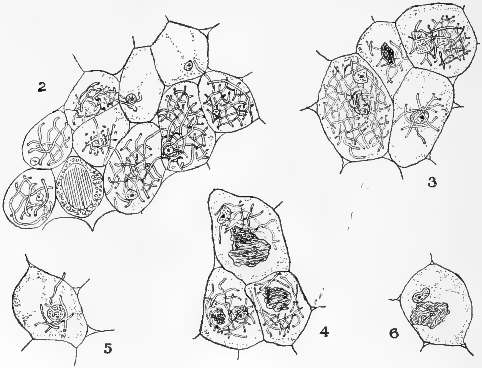
Structure of the root.—The root is covered superficially by a distinctive zone, of three or four layers, of colourless thin-walled cells elongated radially. There are no root hairs. The cells contain very little protoplasm, which is confined to the periphery of the cells; they fit together closely, leaving only the narrowest radial intercellular spaces. The cells have thin walls which are strengthened by means of spiral thickening fibres such as are characteristic of the tracheidal cells of the roots of many aerial Orchids. These fibres enclose meshes of varying width. No starch occurs in the cells, which have the general appearance of an aqueous tissue. This zone may be designated as the "sheath" or velamen (Text-fig. 11). In certain cells of the sheath there occur numerous fine hyphae which pass through from the periphery of the root, where they are abundant in the surrounding soil. In this zone the hyphae do not mass in the cells as in other cells of the root, but appear to take the shortest course from the surface to the internal storage cells of the root. Branching of the hyphae is infrequent. These hyphae are connected to others in the adjacent humus in which the root is embedded; occasional tangles of hyphae occur on the root surface from which distributing branches develop into and through the sheath (Text-fig. 1).



Text-fig. 1.—A transverse section of the root of *Dipodium punctatum*, showing internal anatomy and the distribution of the endophytic fungus (x 15).

Within the sheath there is a very regularly developed exodermis. The cells of this layer are elongated radially and the outer walls are strongly suberised. Thin-walled passage cells occur at frequent intervals, and these are very much smaller than the other exodermal cells; the larger exodermal cells have little protoplasm; the passage cells have considerable protoplasm and a large nucleus. The fungal hyphae passing from the sheath to the inner tissues of the root traverse the passage-cells (Text-figs. 11, 12, 24). The thin cellulose wall of these cells is readily perforated while the density of the protoplasmic contents and the presence of nutritive substances probably furnish a chemotropic attraction upon the hyphae. I have not observed any case where the hyphae entered the thick-walled exodermal cells direct, but numerous cases have been seen where the passage cells were penetrated, and branches entered the other exodermal cells through their thin radial walls, in association with the passage-cells. The hyphae seldom branch until they enter the cells of the cortex just within. When they enter an exodermal cell from the passage-cell they take the shortest course through the base of the cell into the cortex (Text-fig. 12).

Within the exodermis there is a broad zone of large rounded or oval-shaped



Text-fig. 2.—A group of cells of the cortex of root showing the coiled mycelium in some, and the early infection of others (x 167).

Text-fig. 3.—A group of cells of cortex showing a partial disintegration of the central hyphae of the endophyte (x 167).

Text-fig. 4.—Three host cells with disorganizing hyphae (x 167).

Text-fig. 5.—The growth of the hyphae towards the nucleus of the cell is shown in this figure (x 167).

Text-fig. 6.—Cell of cortex showing fungal mass which is undergoing digestion (x 167).

cells, which have thin cellulose walls, comparatively large nuclei, and are separated from each other by large intercellular spaces. Many of the cells of this zone have raphide-crystals, and starch occurs in practically all cells. Large numbers of the cells contain a mycorhizic fungus; the infected cells occur in groups (Text-figs. 2, 3) throughout the entire zone from the exodermis to the endodermis. This zone is the cortex of the root; its cells contain much more protoplasm than the sheath cells, but it is mainly confined to the periphery of the cells. Thin cytoplasmic threads extend through the cell-cavity. There is a considerable amount of cell-sap and the cells are normally very turgid. The hyphae in some of the cells are arranged in a loose tangle throughout the cell; in others in a dense mass, staining deeply, around the nucleus or in contact with it. In such cells the majority of the hyphae appear to lose their individuality and mass together, while a few loose ones strike out towards adjacent cells (Text-figs. 4, 5, 6). It would appear that one infected cell leads to the rapid infection of neighbouring cells. As a general rule only the cells on the one side of the root are infected, while those on the other half may be entirely (or almost so) free from the fungus (Text-fig. 1).

In some cells the identity of the fungal hyphae is completely lost, and there remains in the centre of the cell a dense, deeply staining, irregular mass in which all trace of hyphal structure has disappeared (Text-figs. 20, 25). The protoplasm and nucleus of the host-cells are still alive; the nucleus appears greatly enlarged (Text-figs. 21, 22).

No starch is found in cells infected with hyphae. It disappears soon after the infecting mycorhiza enters, but reappears in the host cells when the fungus becomes disorganised. Starch is abundant in all uninfected cells. It occurs in the form of small spherical grains and stains pink with iodine.* The hyphae stain much more deeply just prior to disorganisation than on entry into a host cell, and appear to contain much protoplasm of a fine granular nature. In newly-infected cells the hyphae are very slender, but their thickness increases somewhat after they have been associated with the host cell for a time. The protoplasmic content of such hyphae increases; it stains more deeply, and becomes dense and granular; the vacuoles which are frequent and relatively large in hyphae which have just entered cells, become small and few (Text-figs. 8, 9).

The innermost cortical cells are smaller than the central series, and in contrast with infected cells contain abundant starch grains.

The *endodermis* consists of a single layer of small cells, containing little protoplasm, and having thin suberised walls. Passage-cells occur generally in groups of two or three opposite the xylem groups; the endodermal cells opposite the phloem are thickened. The cells are elongated longitudinally. In transverse section they are almost isodiametric.

The stele is very small compared with the remainder of the root. There is a single-layered parenchymatous pericycle surrounding 15 or 16 groups of phloem and the same number of xylem groups. Conjunctive parenchyma occurs between the phloem and xylem groups stretching inwards towards the pith. The phloem is composed of very small elements, namely, thin-walled sieve tubes and companion cells. The xylem consists of a few protoxylem vessels (annular and spiral) and two or three small vessels with reticulate-scalariform thickening.

There is a fairly large pith composed of large thin-walled cells with sparse protoplasmic contents and distinct intercellular spaces. No mycorhiza is present in the pith-cells, in fact the fungus is confined to the cortex and sheath of the root. Abundant starch occurs in the pith-cells.

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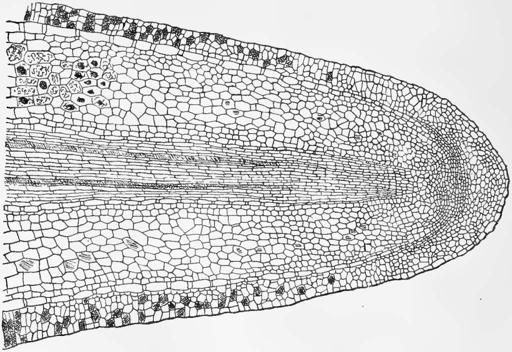
*This reaction of starch to iodine in *Dipodium punctatum* is fairly typical of saprophytic Phanerogams.

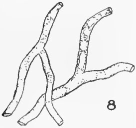
In a longitudinal section of the root apex it is seen that the sheath passes over the tip (Text-fig. 7). None of the cells of the sheath are developed like root-hairs as is common in some forms of saprophyte (e.g., *Thismia*). The cells of this sheath arise from the primordial meristem cells at the apex; the exodermis, cortex and central cylinder all merge imperceptibly into the primordium, the cells of which are very small and numerous. Raphide cells occur almost to this meristematic zone, but the endophytic fungus does not approach its vicinity. The infected cells occur in the zone of differentiation where the tissues have assumed their final form. Fungal hyphae do not enter the meristematic zone,

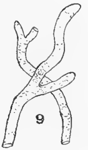


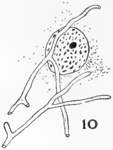
Text-fig. 7.—A longitudinal section of the root apex showing the meristems, and the fact that the endophyte does not develop near the meristematic zone (x 15).

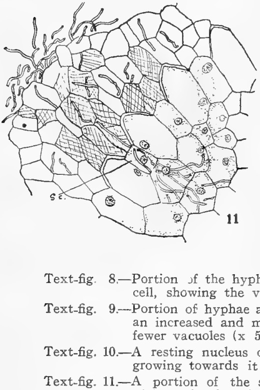
nor do they cause any hypertrophy of the host-tissues. All the tissues of the host are directly traceable to the primordial meristem which is uninfected by the fungus.

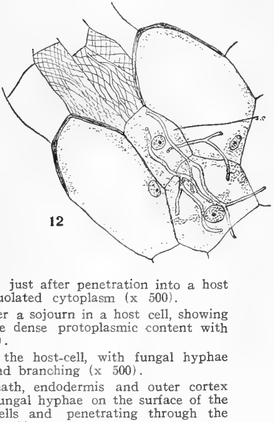
The fungus occurs in the soil surrounding the root in the form of numerous branching, fine hyphae, many of which form a close tangle on the surface of the root from which hyphae pass inwards through the sheath and outwards into the humus. I have observed numerous cases of the hyphae in the sheath-cells; generally only one hypha occurs in a cell, but I have seen two or three cases where more than one hypha was present. The hyphae pass straight towards the endodermis. Many may continue their course directly into the cortex through a passage-cell, but it sometimes happens that the hyphae have to pass obliquely through the inner cells of the sheath to reach the passage-cells. Branching of the hyphae occurs in the cells of the cortex immediately within the passage-cells; very occasionally in the passage-cell itself. I have observed the connection of the hyphae in the cortex with the hyphae in the soil by means of these infecting hyphae through the sheath and the passage-cells. The passage-cells lend themselves to the easy penetration of the fungus, in so far as they have thin walls, and dense granular contents, which probably both attract chemotropically and nourish the hyphae. Lang (1899), in *Lycopodium clavatum,* describes a sheath











Text-fig. 8.—Portion of the hyphae just after penetration into a host cell, showing the vacuolated cytoplasm (x 500).

Text-fig. 9.—Portion of hyphae after a sojourn in a host cell, showing an increased and more dense protoplasmic content with fewer vacuoles (x 500).

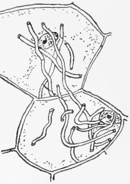
Text-fig. 10.—A resting nucleus of the host-cell, with fungal hyphae growing towards it and branching (x 500).

Text-fig. 11.—A portion of the sheath, endodermis and outer cortex of host showing the fungal hyphae on the surface of the root, in the sheath-cells and penetrating through the passage-cells (s.c.) (x 167).

Text-fig. 12.—Another section showing the fungal hyphae in the passage-cell (s.c.) and penetrating the outer cortical cells (x 500).

around the hyphae formed from the wall of the cell being penetrated by the fungus, but I have seen no such structure in *Dipodium.* The hyphae appear to penetrate through portions of the wall which have probably been dissolved by their enzymes. A structure of the nature of an appressorium is formed where the hypha abuts against a wall. From this swollen end, one or more thin hyphae penetrate an adjoining cell (Text-figs. 23, 24, 25).

The Mycelium in the Cortex.—The infecting hypha enters a cortical cell and passes towards the nucleus which is surrounded by a thick zone of the cell's cytoplasm. It then branches and coils round the nucleus or close to it. At first the cytoplasm of the hypha is sparse and stains very lightly with methyl violet; it is vacuolated to a large extent. The hypha is very thin (Text-figs. 13, 14, 23). As the nucleus moves in the cell, the hyphae grow with it and branch so that,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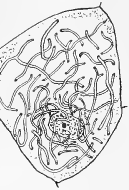
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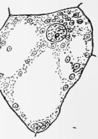
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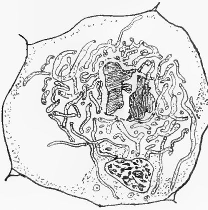
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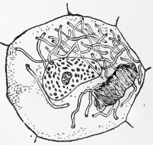
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Text-fig. 13.—Two cells of cortex with an early stage of infection. The hyphae are clearly associated with the cell nucleus (x 167).

Text-fig. 14.—Aggregation of the hyphae around the nucleus (x 500).

Text-fig. 15.—A normal cortical cell showing the nucleus, cytoplasm and spherical starch-grains (x 400).

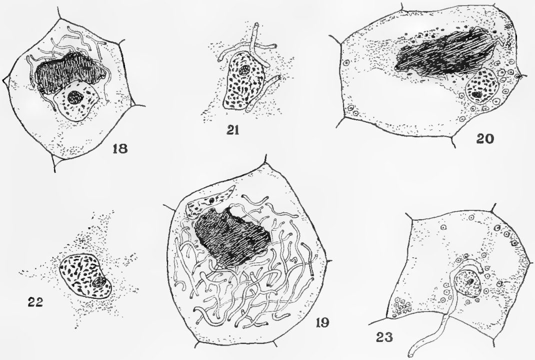
Text-fig. 16.—Partial digestion of the central hyphae, and the slight enlargement of others around. The nucleus enlarges and stains deeply (x 500).

Text-fig. 17.—Further stage in disorganization of the fungus,—nucleus enlarged (x 500).

while the hyphae of the fungus seldom completely surround the nucleus, they are invariably closely associated with it. The starch grains gradually disappear from the cell soon after infection by the fungus. No hypertrophy of the hyphae takes place. They do not form vesicles or bladders in association with the nucleus, but their contents become more abundant, and stain more deeply with methyl violet. Vacuoles become less numerous in the hyphae which soon appear densely charged with protoplasm or proteid. While as a rule the hyphae maintain their normal regularity of width, occasionally I have seen hyphae which were distinctly irregular in their diameter, especially near the end in association with the nucleus (Text-figs. 16, 26).

In certain cells which have been filled with the fungus for some time, the highly nourished hyphae begin to disorganize. They become closely associated and lose their individuality, forming a deeply-staining mass in the centre of the hyphal tangle surrounded by numbers of lightly-stained normal hyphae, some of which spread into other cells (Text-figs. 16, 17, 18, 19).

The nucleus of the infected cell gradually enlarges until it becomes twice or three times its normal size. The chromatin stains more deeply and indeed ap-



Text-figs. 18, 19, 20.—Stages in the digestion of the fungal hyphae. In Fig. 20 this is nearly completed, and starch-grains are reappearing in the cell (x 450)

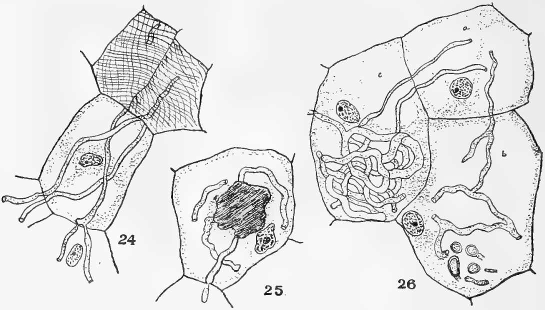
Text-figs. 21, 22.—Enlarged nuclei of host-cells, showing the irregular shape and indentations of the nuclear membrane caused by the pressure of the fungal hyphae (x 510).

Text-fig. 23.—First hyphae growing into a cortical cell containing starch. The appressorium-like structure of the hypha in contact with the wall is indicated (x 450).

pears more abundant; the nucleolus enlarges. The whole appearance of the nucleus about this time is suggestive of a high state of nutrition.

The shape of the nucleus is also irregular in infected cells, the membrane being pushed in by hyphae growing in close contact with it (Text-figs. 21, 22).

The cytoplasm of the host-cells still appears quite normal after the digestion of the hyphae. Starch grains reappear during the disintegration of the fungus, becoming more abundant as the process of disorganization of the hyphae continues. The final appearance of the fungus is an irregular mass of no definite structure, but staining deeply as if considerable proteid were present (Text-figs. 20, 25). At this stage of destruction of the mycelium I could not distinguish any definite hyphae, but in some cases of final destruction, small droplets of a yellowish highly-refractive substance were present in the host-cells. The whole appearance of the host-cell with its mycelium suggests the hypothesis that the cytoplasm of the cell digests and causes the gradual destruction of the fungus. This destruction of the mycelium is particularly apparent just prior to and dur-



Text-fig. 24.—Hyphae penetrating from passage-cell into the cortex. The appressorium-like swelling of the hyphae where it abuts against the cell-wall is distinctly shown. The hypha entering the inner cell shows a pronounced constriction at the point of perforation (x 450).

Text-fig. 25.—A cortical cell containing the disintegrating fungus—a few hyphae are growing towards adjacent cells. The appressorium-like structure is shown in one of them (x 450).

Text-fig. 26.—A group of outer cortical cells containing very swollen hyphae and spore-like bodies which form upon the ends of these hyphae. The normal hyphae pass from the inner cell (a) to the outer cells (b) and (c), hence certain hyphae pass outwards from the cortex for reproduction of the fungus (x 450).

ing the development of the flowering shoot, as if an extra supply of proteid were necessary during this active period.

The digestion * and disintegration of the hyphae in the host-cell begins in the centre of the mass and gradually extends outwards.

*The term "digestion" is here used in the same sense as in the case of Leguminous bacteroids. The organic structure of the mycelium is destroyed, and this is probably the result of partial solution, or transformation by means of an enzyme produced by the host-cell.

The hyphae, when stained with methyl violet and cleared in eosinclove oil, stained blue. The density of the cytoplasm of the fungus depends upon the period of infection of the host-cell; numerous nuclei were present, and occasionally what I interpreted as septa were seen. In certain cells of the outer cortex and in the sheath, I found spore-like bodies which had a comparatively thick wall (Text-fig. 26b).

The hyphae never enter cells of the cortex which contain raphides. I have seen immune raphide-cells surrounded by a number of ordinary cortical cells infected by the fungus (Text-fig. 2).

The Physiological Aspect of the Mycorhiza of Dipodium punctatum.

The first important fact in regard to the endophytic fungus of *Dipodium* is that hyphae from the soil traverse the sheath-cells which contain little nutritive matter, and enter the cortex of the root by means of the thin-walled, densely protoplasmic passage-cells. These cells with their thin walls and cytoplasm and nutritive contents must be regarded as attractive centres for the invading hyphae. Some passage-cells contain numerous straight hyphae which pass directly into the cortex within. They do not coil in the passage-cells or in the smaller cortical cells immediately beneath the exodermis.

The next important fact in regard to this fungus is that the young infecting hypha enters a cortical cell and grows towards the nucleus of the cell. Groom (1895) in his work on *Thismia* has pointed out that this tendency of growth may be due to mechanical reasons, because the cell-currents converge upon the nucleus, or to a chemotropic attraction emanating from the nucleus. It is not probable that the rheotropic effect of cell-currents towards the nucleus is great enough to influence the direction of growth of the hyphae. The work of Miyoshi on the chemotropic effect of chemical solutions upon the growth of fungal hyphae, rather suggests that the growth of hyphae in a host-cell containing organic compounds of different kinds may be chemotropic. Moreover it is believed by physiologists that the nucleus is an active agent in the regulation of the chemical processes accomplished in plant cells, and that around the nucleus there is probably a greater concentration of nutritive or chemotropic substances. The more highly nourished condition of the hyphae and the greater density of their cytoplasm, after a sojourn in relation to the nucleus and its surrounding cytoplasm, seem to support the view of active absorption of nutritive substances by the fungus. The infecting hypha grows into the closest contact with the nucleus, and branches and coils in contact with it. The nuclear membrane is frequently pushed inwards by the growing hyphae.

In uninfected cells of *Dipodium* there is an aggregation of small spherical starch grains around the nucleus of the cell. The occurrence of such a quantity of starch around the nucleus suggests vigorous chemical changes; sugar is probably present in quantity, and this substance is known to attract fungal hyphae chemotropically, and is an important nutritive substance for a fungus. When such a cell becomes infected by the fungus, the starch grains gradually disappear from the cell, and always from the nuclear cytoplasmic sheath first. The disappearance of starch suggests a process of solution which may be due to enzymes produced by the fungus or by the host-cells, but at any rate stimulated by the presence of the fungus. The disappearance of the starch from the host-cell, and the more dense appearance of the hyphae, suggests absorption by the fungus, and the probable synthesis of proteid or protoplasm in the hyphae.

During this phase of the mycorhizic fungus, it is evidently parasitic. be-having like the mycelium of an ordinary fungal parasite, depriving the host-cell of certain nutritive substances.

The early coiling of the hyphae around and in contact with the nucleus of a cell, the absence of the fungus from raphide-cells, and from the active meristematic region of the root tend to confirm the hypothesis that the growth of the fungus from cell to cell and towards the cell-nucleus is controlled by chemotropic substances in the cells, and particularly in the region of the nucleus. The absence of the fungus from the meristematic zone may be explained by the fact that the chemotropic substance or substances which accumulate in the cortical cells (essentially a storage zone in orchid roots) are not allowed to do so in cells which are actively dividing or growing. The substances are consumed in the process of cell-division and cell-growth, in the production of new cell-walls, new protoplasm, in the provision of energy, etc., as fast as it is received from the storage cells. In the case of the raphide-cells it is probably the excess of oxalic acid which inhibits the infection of the cell by repelling the fungal hyphae.

After a period of active nutrition, when the fungal hyphae absorb from the host-cell (probably the chemotropic substance—sugar*) and increase their protoplasm or proteid as indicated by the densely-staining granular contents of the hyphae, they become gradually disorganised. No hyphal structure can be seen in the disintegrating mass; certain free hyphae around the periphery of this mass and passing out from it spread into neighbouring cells (Text-figs. 3, 26) as if to avoid destruction also. A few starch grains appear in the cell-cytoplasm, but most of the carbohydrate which is liberated during the disorganization and digestion of the fungal hyphae is probably conducted directly to the flowering axis. At any rate it does not appear in the same quantity as exists in normal uninfected cells. The migration of the free peripheral hyphae from the disorganizing central mass is probably due to the greater chemotropism of the contents of neighbouring uninfected cells. For the attraction of a fungal hypha there is a definite optimum concentration of a chemical substance, and Miyoshi (1894) has proved that hyphae will always tend to grow towards the solution which approaches most nearly to the optimum concentration.

The progressive development of the hyphae from the periphery of the root towards the cortical cells, and from one cortical cell to another, may be explained on the assumption that the chemotropic substance required by and attracting the fungus increases towards the inner tissues.

In previous studies on mycorhiza, very few facts have been ascertained in regard to the reciprocal interchange of nutritive substances between the host-cells and the endophytic fungus. Several hypotheses have been put forward to explain the significance of both endophytic and exophytic mycorhiza. It seems to me that each case of endophytic mycorhiza in a plant or group of related plants may have its own peculiarities, which can only be revealed in a close study. Frank gives different interpretations of ectotrophic and endotrophic mycorhiza —the ectotrophic fungus assimilates, partly for the benefit of the host, humus constituents; while the endotrophic fungus is an organism captured by the host. There are probably numerous cases of such physiological relations between the

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*Sections of fresh material were mounted in a few drops of the following solution:—2 grams phenylhydrazine, with 2c.c. of 50% glacial acetic acid and 10c.c. of H_2O, which had been shaken till clear. They were then warmed for an hour in a bath at a temperature of 100°C. Fine yellowish crystals separated out in cells free from the fungus, and a few in the infected cells. The starch is converted into sugar, which is precipitated by the above solution as a phenylhydrazone.

higher plant and the fungus, but in regard to endophytic mycorhiza especially, it would appear that in certain cases the cytoplasmic contents of the host-cells are destroyed, while in others the fungus suffers destruction. In *Dipodium* I have shown that the fungus absorbs nutritive substances from the cortical cells of the host which it invades, and the protoplasm or proteid of the fungal hyphae increases at the expense of starch which disappears from the infected host-cells. The adjacent uninfected cells of the host contain starch even after its disappearance from the infected cells. The starch reappears in smaller quantity after the destruction of the hyphae. As the starch disappears the proteid and protoplasmic contents of the hyphae increase, hence the carbohydrate of the host-cell would appear to be used in the synthesis of nitrogenous food in the mycelium.

The nitrogen for this process is probably derived from the soil by the hyphae which occur on the surface of the roots, and which are connected with the hyphae in the cells of the cortex of the host. Thus far there has been a gain in nitrogenous food by the fungus at the expense of the carbohydrate of the host-cells. After a time the hyphae disorganise, their contents are digested, the walls are dissolved, the nucleus of the host-cell enlarges, the chromatin stains more deeply, the nucleolus grows, starch reappears in the cell (in smaller quantities however); there is finally an excretion of yellowish highly-refractive drops of waste matter in the cell. From these series of changes the inference is that the nutritive exchange on this occasion is from the fungus to the host-cell; the fungus is destroyed, probably by the agency of enzymes secreted by the host-cytoplasm. The host-cell gains in nitrogenous food—in proteid which has been synthesised by the cytoplasm of the fungus.

It seems that in *Dipodium* the preponderance of the physiological advantage of the mycorhizic association rests with the higher plant. Much of the fungus becomes digested in the host-cells, but the cortex always contains cells with the fungus in all stages of development. The mycelium is never extinguished, and it is always connected to the superficial mycelia through the passage-cells.

In *Dipodium* it seems that the fungal hyphae forming the mycorhiza are indispensable to the host for, while the surface of the root may be capable of absorbing soil constituents, e.g., water, salts, organic substances, yet the absence of root-hairs, and the consequent small absorbing surface points to its ineffectiveness as an absorbing organ. The host-plant, being devoid of chlorophyll, is incapable of photosynthesis; being devoid of root-hairs it is dependent upon the fungus for its supplies of H_2O, C, N, etc.

The humus of the soil in which *Dipodium* grows contains carbonaceous and nitrogenous matter, and the host-plant derives these through the agency of the mycelium. Acton (1889) has demonstrated that carbohydrates and extract of humus, etc., may be absorbed by the roots of ordinary green flowering plants and assimilated. It is likewise probable that non-chlorophylliferous flowering plants, may absorb similar organic substances, and supply themselves with carbohydrates. In *Dipodium* the fungus could, therefore, obtain for the higher plant the carbonaceous constituents of the humus from which the starch would be manufactured, and the less-oxygenated nitrogenous constituents of humus which would be built up with the starch into proteid by the fungus, this proteid subsequently being absorbed by the host-cytoplasm during the digestion of the endophyte. The appearance of starch grains during the digestion of the fungus may be due to the breaking up of the proteid into carbohydrate and nitrogenous compounds of less complexity, or to the synthesis of starch by the host-cell directly from the carbonaceous substances derived by the fungus from the humus.

The next problem to be solved is why does the fungus enter the root of this saprophyte? The mycelium of the fungus occurs in the soil and in tangles on the surface of the root; hyphae from these tangles enter as far as the cortex of the root. This penetration is probably the result of chemotropism; the hyphae penetrate more deeply into the root tissues because of the directive attraction of substances in the cells. These substances must be present in greater quantity in the root than in the soil. The substance concerned in this case is probably sugar (or starch), which I have already indicated is present in the host-cells and disappears after infection. The starch present cannot be the product of photosynthesis; it is probably manufactured by the host-cells from carbonaceous substances absorbed from the humus by the mycelium of the fungus in some other infected part of the root. The starch (or sugar) could be formed in uninfected cells from materials carried by the mycelium to neighbouring infected cells. At any rate it seems to me that in Angiospermic holosaprophytes, the fungus is of the greatest possible significance to the higher plant, and that the latter is dependent upon the fungus for its nitrogenous, and probably for its carbonaceous needs.

Groom (1895) expresses the opinion that many of the hyphae passing through the sheath are deserting the host, not entering it. This is no doubt true in many cases of the endophytic mycorhiza, the hyphae leaving the host being derived from hyphae which enter a different part of the root; they are probably leaving the host in order to establish another communication between the soil and the endophytic hyphae, and not to act as haustoria for the supply of food to the more superficial hyphae. Groom also believes that many of these hyphae are deserting the host to form spores in the superficial root-cells, especially when they die. I have seen spore-like bodies in the sheath-cells and outer cortex of *Dipodium*, and from my observations I have formed the opinion that many hyphae pass outwards from the central cortex into more superficial cells for reproduction (Text-fig. 26).

Is mycorhiza a highly developed and specialised community beneficial to both symbionts, or is the fungus simply a parasite which the host is constantly striving to suppress? These questions seem capable of different answers in different organisms. The entrance of an endophytic fungus into the cells of a host, is largely a matter of chemotropic stimulation; the host-cells contain something which offers a stronger attraction than the medium of the fungus, hence, at first, the endophytic fungus was probably a parasite, absorbing from the host something which it contained in greater abundance than the soil. The entrance of a fungus into a cell produces a reaction in the host's protoplasm, tending to retard or suppress the parasite. This reaction may have led to the exchange of something between fungus and host-protoplasm, e.g., proteid or nitrogenous matter, and the gradual establishment of a physiological equilibrium between host and endophyte. Gradually therefore, from the condition of pure parasitism, the fungus came to live in symbiotic association with the host-cell, each giving a certain benefit to the other. We know that fungi require carbonaceous foods, and that they are able to obtain readily from humus-soil the poorly oxygenated nitrogen compounds; it seems reasonable therefore to assume that the fungus gives nitrogenous compounds in return for carbonaceous food (starch or sugar) which is obtained more readily from the host than from the soil.

From this harmonious relationship we pass to the next phase which is shown in *Dipodium*, namely, the disorganization and digestion of the fungus in certain host-cells, and the yielding of all its proteid to the host-cell. In this case it appears that the host nourishes and nurtures the fungus for a time and then destroys part of it as its own requirements for proteid must be met. Much the same relation between host and fungus must subsist in lichens; the algae are permitted to multiply, to supply the carbonaecous food of the fungus, but some individuals are being constantly destroyed by the fungus. In *Dipodium* the host is the destroyer of the fungus, and in such a case, Frank's view that endophytic mycorhiza is simply fungus-trap (Pilzfalle) and that the host is a fungus-digesting plant is largely correct.

In this study of the nutritive relation between *Dipodium* and its endophytic fungus, I am of the opinion that the fungus supplies the host with water, mineral substances, and organic compounds from the humus; from these the host obtains the ash constituents, and manufactures the starch which is seen in the cells of the cortex and pith of the host. The nitrogen which occurs in humus in a poorly oxygenated condition, is also absorbed by the fungus, and converted into proteid which is assimilated by the host-cells during the digestion of the fungus. The fungus at first obtains larger and more suitable supplies of carbonaceous food from the host for growth and the synthesis of proteid.

The mycorhiza of *Dipodium,* and probably of many other holosaprophytic Angiosperms, is indispensable to the higher plant.

Summary.

Dipodium punctatum is a holosaprophytic orchid which grows in the humus under Eucalypts. It is not parasitic upon roots as is stated in Moore and Betche (Flora of New South Wales). It is non-chlorophylliferous, the leaves being reduced to small protective scales on the flowering axis.

The cortex of the root contains an endophytic fungus which forms close coils in the cytoplasm and in the vicinity of the nucleus.

The fungus enters the cortex through the passage cells in the exodermis. It penetrates the cortical cells and grows towards the nucleus where it branches and coils.

Starch is present in the uninfected host-cells, but disappears soon after the penetration of the fungus.

The protoplasmic contents of the hyphae stain more deeply with methyl violet; they become more granular and less vacuolated.

The nucleus of the host-cell shifts its position from time to time, but many hyphae maintain close contact with it. Its membrane is frequently pushed inwards and it may assume a peculiar shape.

The central hyphae gradually become disorganised, all structure disappearing. The nucleus of the host-cell enlarges; its nucleolus and chromatin stain more deeply. The nucleolus also increases in size.

When the hyphae are completely digested, droplets of a yellowish waste matter remain. Certain of the hyphae on the periphery of the cell and the disintegrating mass grow into neighbouring cells if these are not already infected.

No sporangioles, bladders or vesicles develop upon the hyphae as in *Thismia.*

The fungus does not enter raphide-cells or the meristematic zone of the root.

The penetration of the hyphae from cell to cell, and from the soil into the root is probably the result of a chemotropic stimulation due to the presence of a nutritive substance such as sugar in the host-cells. The growth of the hyphae towards the nucleus is probably the result of the greater concentration of this substance around the nucleus.

The fungus obtains carbohydrate from the host-cell; when it is disorganized the host-cell receives proteid. The absence of root-hairs and the lack of chlorophyll seem to suggest that the host receives all its requirements from the fungus —directly or indirectly—H_2O, ash constituents, and carbonaceous substances from the humus which are synthesised directly by the host into carbohydrates; nitrogen indirectly in the form of proteid from the fungus.

In *Dipodium* the "symbiotic saprophytism" has practically become a case of the higher plant being parasitic upon the endophyte.

I desire to record my very sincere thanks to Professor A. A. Lawson, in whose laboratory this work was conducted, for his helpful suggestions, advice and kindly criticism.

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A NEW NEMATODE PARASITE OF A LIZARD.

By Vera Irwin Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

(Seventeen Text-figures.)

[Read 30th August, 1922.]

Two specimens of a nematode, remarkable for the possession of an asymmetrical row of spines down one side, are included in Dr. J. B. Cleland's collection of helminths from Australian reptiles. They were preserved in 70% alcohol, in a phial with one specimen of a *Physaloptera* sp., and one Oxyurid, all taken from the alimentary tract of a small lizard, the enclosed label bearing the inscription "Nematodes from lizard (Hinulia) No. 2, alimentary canal. Flinders Is. 25/11/12. Dr. J. B. C."

In general appearance these worms are very like *Physaloptera* and, at first, they were taken to be identical with the small *Physaloptera* sp. found with them. A closer examination revealed the spine row, and proved the distinctive character of the specimens.

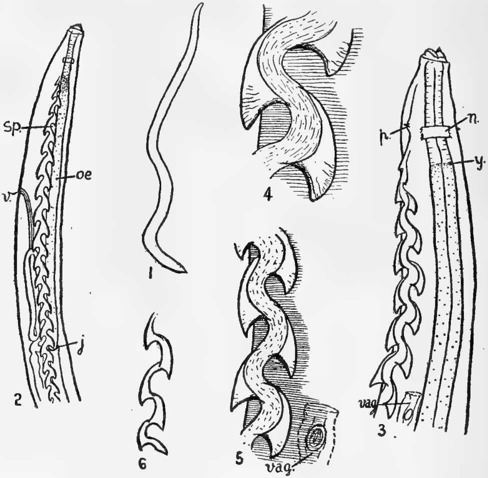
A cuticular ornamentation of spines is rare in reptilian nematodes, and the asymmetrical position of the row in this case gives an added interest and significance to the new form. So far as I am aware, nothing of the same kind has been described before. The nearest approach to it is found in the original descriptions of *Rictularia cristata* Froelich, the type species of a genus which has been recorded only from mammals, and the new nematode has been assigned, provisionally, to this genus, although it does not conform to the generic diagnosis as given by recent writers, Jagerskiold (1909) and Hall (1914). The discrepancies noted can be discussed better after the description of the new species, when its relationships and systematic position will be considered.

Unfortunately the only two specimens available are both females, so that the specific characters of the male can not be determined. There is also some doubt about the exact structure of the mouth parts in the two females examined, which are very small and not in good condition. Under the circumstances, it does not seem advisable to propose a new genus for the species at present, though this may be necessary when fuller information is obtainable.

Rictularia disparilis, n.sp.

Male unknown.

Female 7.9 to 8.7 mm. long. Colour whitish when preserved in alcohol, original colour not noted. Body slender, delicate, thickest in the posterior third, attenuating towards the anterior (Text-fig. 1). Maximum diameter 320 μ, diminishing to 64 μ at the base of the lips. Tail short, straight, and conical, with a mucronate tip; anus 112 μ from the extremity; caudal pores 55 μ distant from it (Text-fig. 17). Diameter of body at anus 128 μ. Details of the structure of the mouth and buccal cavity are not very clear in the two whole preparations, and the limited amount of the material prevents any other mode of examination. The mouth is in the form of a transverse cleft, which lies only very slightly, if



1. Female (× 7.5); 2. Anterior part of body, viewed from left side, showing spine ridge (sp.) (× 47.5); 3. Dorso-lateral view of anterior region (× 100); 4. Portion of spine ridge near anterior end (× 305); 5. Portion of spine ridge in region of vulva (× 190); 6. Posterior termination of spine ridge (× 100).

j., junction of oesophagus and intestine; n., nerve ring; oe., oesophagus; p., post-cervical papillae; v., vulva; vag., vulva and vagina on ventral side, seen through the transparent body; y., junction of muscular and glandular oesophagus.

at all, lateral of the dorso-ventral plane. The two lips which bound it are lateral in position, and asymmetrical (Text-figs. 7-9). The right is higher than the left, and is crowned by a stout conical median tooth, similar to the external labial tooth of the genus *Physaloptera*. The tooth is about 5 μ high, and 6 μ wide at base, and appears to have a very small denticle on its inner face, though this could not be definitely determined. The appearance of lobes on the inner face of the lip, with a row of denticles along their margin, is also indefinite. The lower, left, lip does not bear a large median tooth, but appears to consist of a series of three or more fairly sharply pointed lobes, having denticles on their summits. Applied externally to each lip is a thick, hemispherical pad, on which two large papillae are visible. The right lip is 13 μ from summit to base, the left lip 10 μ. The buccal cavity is short and narrow. A capsular armature, if present, is not discernible. Round the base of the lips, the cuticle projects slightly, forming a narrow cephalic collarette; and, at a distance of 11 to 18 μ behind the collarette, there is a prominent circular ridge, with a deep groove in front of it.

The oesophagus is long and slender, 1/4.9 to 1/5.3 of the total body length (Text-fig. 10). It is formed of two parts, a short muscular portion followed by a darker glandular oesophagus, the boundary between them being clearly marked. The total length of the oesophagus is 1.63 mm., the muscular oesophagus being .26 mm. long and 33 μ wide. The glandular oesophagus increases gradually in width posteriorly, to a maximum of 96 μ. Its base is rounded and the entrance to the intestine is protected by valves (Text-fig. 11).

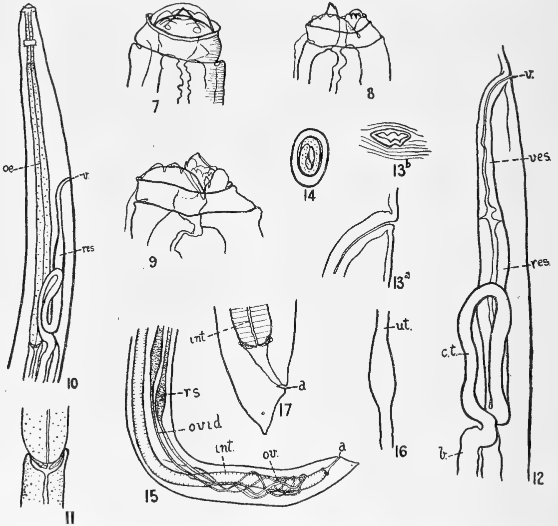
The vulva is situated ventrally at about the middle of the length of the oesophagus, .80 mm. from the anterior extremity of the body (Text-figs. 2, 10). The nerve-ring surrounds the muscular oesophagus a little behind its middle, at a distance of 185 μ from the anterior end, and, on a level with the nerve-ring, a pair of thorn-shaped post-cervical papillae are situated on the lateral lines (Text-fig. 3). The excretory pore opens on the mid-ventral line about 25 μ behind these.

Extending down the left side of the body, from just behind the left post-cervical papilla, and in the same plane with it, is a continuous, regular, wavy ridge, which bears, on the crest of each wave and therefore to right and left, alternately, of the ridge, an oblique, backwardly-directed cuticular spine (Text-figs. 2-6). No trace of a similar ridge, nor of any other spines exists on the right side, or elsewhere on the body. The spines may be regarded as forming a double row, since they point alternately in opposite directions; but the double row is quite certainly asymmetrical. Except on the spine ridge, the cuticular integument is everywhere transversely striate, the striae being very fine and dense, about 2 μ apart.

Anteriorly, the spines begin just on a level with the junction of muscular and glandular oesophagus, about 92 μ behind the left post-cervical papilla and 277 μ behind the anterior end of the body. Posteriorly, they extend to within 1.84 to 2 mm. of the tip of the tail. They are of the same character throughout the length of the row, having the shape of strongly curved, pointed thorns, slightly rugose along the crest, and standing up in low relief from the body. Being colourless and transparent, they can only be made out with difficulty when viewed against the background of the body, especially in the posterior region. Fifty-four spines are found on each side of the ridge, making a total of 108 spines in the double row. They vary a little in size, being smallest towards each end, gradually increasing to a maximum between the vulva and the posterior end of the oesophagus, i.e., from the seventh to the seventeenth pair of spines from the anterior end. Their maximum size is 48 μ in length, and 25 μ in height. At the anterior end of the row they measure 22 μ in length and 7 μ in height; at the fortieth pair 33 μ in length, and 18 μ in height. The width across the ridge, between the tips of the spines on each side, varies correspondingly from 55 μ at the seventh pair, in the region of the vulva, to 74 μ at the fifteenth pair, and 51 μ

at the fortieth pair. The interval between the tips of consecutive spines on the same side is 77 μ at the beginning of the row, 125 μ at the seventeenth spine, 136 μ at the twentieth, and 114 μ at the fortieth.

Both the specimens examined are mature females, having uteri crammed with eggs containing well-developed embryos. The genital system is situated posterior to the vulva, and almost entirely on the ventral side of the body. The very



7. Head end viewed from the right side ($\times$ 305); 8. The same, ventral view ($\times$ 305); 9. The same, dorso-lateral view ($\times$ 475); 10. Anterior part of body, viewed from right side ($\times$ 47.5); 11. Junction of oesophagus and intestine ($\times$ 100); 12. Terminal portion of female genital system ($\times$ 100); 13a. Vulva, side view. 13b. Vulva, face view ($\times$ 190); 14. Egg from uterus ($\times$ 305); 15. Posterior part of body ($\times$ 27); 16. Receptaculum seminis ($\times$ 100); 17. Caudal extremity of female ($\times$ 100).

a., anus; b., the two branches of the common trunk leading to the uteri; c.t., common trunk; int., intestine; oe., oesophagus; ov., ovary; ovid., oviduct; res., reservoir; r.s., receptaculum seminis; v., vulva; ves., vestibule.

anterior vulva, 1/9.5 to 1/11 of the body length from the anterior end, is bounded by non-salient lips with serrated margins (Text-figs. 13*a*, *b*). It leads into a straight, backwardly-directed vestibule, with thick musculo-cuticular walls, 320 μ long and 30 μ wide (Text-fig. 12). This passes abruptly into a broader tube, 55 μ wide, with walls lined by large epithelial cells, which appears to be of the nature of a reservoir, although only a few eggs are present in it. It is directed either straight back, or curved forward on the vestibule, and is followed by a common trunk 576 μ long and 37 μ wide, folded on itself and divided posteriorly into two branches which lead into the two posteriorly-directed uteri. These are distended with eggs and measure, at their maximum width, 92 μ. They are coiled in the middle region of the body, the most anterior loop being found at .85 to 1.52 mm. from the anterior extremity of the body, and the most posterior at 2 mm. from the posterior extremity. Each uterus terminates in a slight enlargement, dark in colour, the receptaculum seminis, which leads without abrupt transition into the oviduct (Text-fig. 16). The receptacula seminis are found at a distance of 1.5 mm. to 1.8 mm. from the posterior end, not far from the position of the posterior termination of the spine row (Text-fig. 15). The two ovaries are much coiled in the region between this and the anus, extending to within .35 mm. of the extremity of the body.

The eggs are broadly oval, with clear, thick shells, measuring 38 μ in length and 25 μ in transverse diameter (Text-fig. 14).

Host.—Hinulia sp. *Location.*—Alimentary canal. *Locality.*—Flinders Island, Bass Strait. Collected by Dr. J. B. Cleland, November 25, 1912.

Paratype in the Australian Museum, Sydney (Registered No. W. 923).

Hinulia, a subgenus of *Lygosoma,* is very widely distributed throughout Australia, the commonest species about Sydney being *Lygosoma* (*Hinulia*) *taeniolatum* Shaw. It was probably from this species that the above-described nematodes were taken. Two other specimens of *Hinulia,* species not determined, are represented in Dr. Cleland's collection as hosts for nematodes, one taken at North Bay in October, 1914, the other at Flinders Island on the same date as the specimen from which the *Rictularia disparilis* were obtained. The only nematodes collected from them are Oxyuriidae, one female from the North Bay specimen, and four females from "Hinulia No. 5, Flinders Is." There is, in addition, one female Oxyurid from "a small lizard, Flinders Is.," taken at the same time as the two Hinulia.

Dr. T. H. Johnston's catalogues of Australian reptilian Entozoa (1912 and 1916), contain records of Entozoa from three species of *Hinulia,* viz., *taeniolatum, quoyi* and *tenue*; but only one of these refers to a nematode, and that is a species of *Physaloptera* from *Hinulia tenue* Gray.

The other lizard hosts in the Cleland collection are *Varanus* sp., *Lialis burtoni* and *Gymnodactylus platurus,* and the nematodes from these all belong to the genus *Physaloptera.* The new form described here is, therefore, evidently rare. Apparently nothing like it has been observed before in any Australian reptile, the only nematodes listed in the catalogues being all species of the four genera *Ascaris, Strongylus, Filaria,* and *Physaloptera.*

Among birds, one nematode with a cuticular ornamentation of spines has been recorded in Australia. This was found in a sea-bird, *Daption capensis* (Cape Petrel), and was listed by Dr. T. H. Johnston as *Rictularia shipleyi* Stoss. (1912). However, Dr. Johnston adds the explanatory note—"This record is based upon material collected near Sydney by Mr. L. Harrison. His description of the parasite satisfies me that the worm was *Rictularia,* and most probably *R. shipleyi.* Unfortunately, the nematodes have been mislaid, and I am therefore, at present, unable to confirm the specific identity" (1912, p. 106). The species referred to was described originally by Stossich as *Gnathostoma shipleyi* (from the great albatross, *Diomedea exulans*), and has recently been raised to a new genus, *Seuratia*, by Skrjabin (1916). He places it in the family Acuariidae, subfamily Acuariinae, and points out that it is identical with the species described by Linstow as *Rictularia paradoxa* and by Seurat as *Acuaria pelagica*.

The spines in the new form, from the lizard, differ entirely in character and arrangement from those described for the genus *Seuratia*; and, in the general structure of the body, it presents closer affinities with the Physalopterinae than with the Acuariinae.

It agrees with the genera *Physaloptera* and *Rictularia* in the structure of the oesophagus, the position of the nerve-ring, post-cervical papillae and excretory pore, the anterior situation of the vulva, the conformation of the various parts of the female genital system, and the eggs containing well developed embryo when oviposited. The cephalic collarette, though poorly developed, and the lateral lips, especially the right lip with its median tooth, recall those of *Physaloptera*. But the asymmetrical character of the lips, and the presence of a cuticular ornamentation of spines on the body separate it from *Physaloptera*. The deep groove and ridge dividing the head end from the rest of the body suggest affinities with *Gnathostoma*, but the anterior end of the body is not swollen, and the spines are quite differently arranged, while the vulva is situated very anteriorly, instead of behind the middle of the body as it is in the Gnathostomidae.

As already noted, *Rictularia disparilis* agrees with the descriptions given by Froelich and Dujardin of the type species of the genus, *R. cristata*, in having a single row of spines, of uniform character, set close together and situated asymmetrically on one side of the body; it differs, however, in the continuity and length of the row, which is not confined to the region in front of the vulva, as described for *R. cristata*. Modern writers have doubted the correctness of the accounts given by Froelich and Dujardin, although Dujardin specially emphasises the statement "une rangée non symmétrique." All the other species assigned to the genus have two rows of combs and spines, one down each side of the body, with a distinct difference between anterior combs and posterior spines. Hall (1914, 1916) concludes that the original descriptions of the type species are based on imperfect observation, and that *R. cristata* had really two latero-ventral rows of spines, of which only the upper and nearer row was seen. Accordingly, Jagerskiold (1909) and Hall (1914), in their generic diagnoses include "two latero-ventral rows of comb or spine-like structures." But they point out that if Froelich's description should be confirmed, the generic diagnosis would need revision, and it would be necessary to establish a new genus for all the other species at present assigned to the genus.

Although Froelich's species was taken from a rodent, and the other species found in rodents, as well as in carnivores, possess two spine rows, the discovery of this new form from a lizard, which undoubtedly has only a single asymmetrical row, suggests the possibility that Froelich's and Dujardin's observations may have been correct.

Rictularia disparilis, however, differs from the other species included in the genus in another important character, namely, the structure of the buccal cavity and the position of its aperture.

It has been assumed that in Froelich's species the aperture is dorsal, as it is in the other species described. Accordingly, the diagnosis of the genus given by Hall defines the mouth opening as "more or less distinctly dorsal, and with its base armed with teeth and spines." In *R. disparilis*, owing to the asymmetry of the lips, the mouth is not quite terminal in position; but as the lips are lateral, and the lower lip is on the left side, the opening is towards the side instead of dorsal. A close study of Froelich's figures and Dujardin's description suggests that this is also the case in *R. cristata*. Dujardin himself shows some doubt and confusion about the position of the mouth, and queries his own statement in regard to it. His confusion is evidently due to his assumption that the spine row is dorsal, and the vulva to one side of it, "située latéralement, ou presque à la face dorsale (?)." The lips, then, which are lateral in relation to the vulva, are taken to be dorsal and ventral in position. But it is probable that the vulva was in the normal, ventral position and, in that case, the spine row and the lips would occupy the same relative positions to it as they do in *R. disparilis*.

Dujardin does not mention any elaborate buccal armature at the base of the capsule, such as is present in the more recently described species, and nothing of the kind has been observed in *R. disparilis*. It is unfortunate that the material available does not permit of a clear determination of all the details of the mouth structure. But the relationship to *Physaloptera* is evident, and it seems probable that *Rictularia disparilis* and, perhaps, *R. cristata* represent transition forms between the simple *Physaloptera* type and the more highly specialised types of *Rictularia* with well developed, armed buccal capsule and two or three rows of spines down the body.

Its suggested systematic position would, therefore, be

Superfamily Spiruroidea Railliet and Henry, 1915.

Family Acuariidae Seurat, 1913.

Subfamily Physalopterinae Seurat, 1913.

Genus Rictularia Froelich, 1802.

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Postscript, added 4th September, 1922.—While this paper was in the press, further information obtained from Professor Cleland indicates that the host was *Lygosoma* (*Liolepisma*) *entrecasteauxii,* of which two specimens were examined.

STUDIES IN SYMBIOSIS.

II. The Apogeotropic Roots of Macrozamia spiralis and their Physiological Significance.

By John McLuckie, M.A., D.Sc., Lecturer in Plant Physiology, University of Sydney.

[Read 26th July, 1922.]

Introduction.

Since Reinke (1872) published his account of the coral-like roots of *Cycas revoluta,* considerable interest has been taken in these peculiar structures. Reinke described an endophytic *Anabaena* associated with the root-tissues of *Cycas revoluta.* Schneider (1890) also studied these peculiar roots, which he called "tubercles." He described the association of the Algae and Bacteria with the root-tissues as a mutualistic symbiosis. Life (1901) made a further study of the tubercle-like roots of *Cycas revoluta,* and came to the conclusion that the dichotomy of the roots is apparent, not real, as a part of the original meristem remains after the meristems of the two branches have been definitely established. This residual meristem, however, does not function further, and soon disappears, so that the older bifurcated roots show what appears to be a true dichotomy.

He isolated on agar cultures, three bacteria from these tubercles. Hyphae of a fungus not identified were observed. A Nostoc-like Alga was also observed in a definite "Algal zone." The tubercular-roots of *Cycas revoluta* do not possess a true root-cap but, instead, "a sheath of several cell layers extends over the tip, and envelops the entire tubercle as an outer cortex." Numerous lenticels were observed on the tubercles, and Life concluded that the tubercles of Cycads have at least two functions, namely aeration and assisting in nitrogen fixation.

Zach (1910), in a later study of the roots, concluded that the fungus present is not a symbiont, but a parasite against which the cell reacts as a phagocyte.

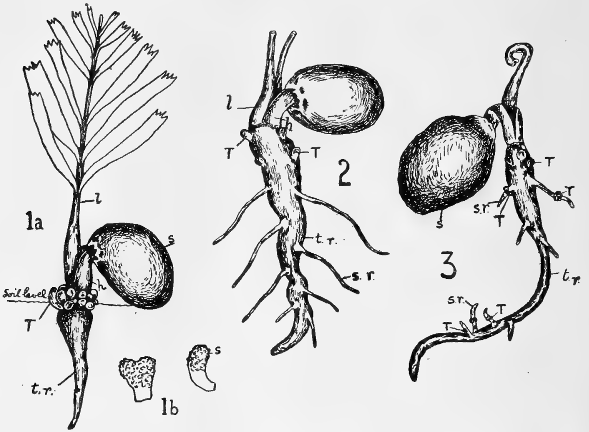
Bottomley (1909) isolated and grew the nitrogen-fixing organisms, *Pseudomonas radicicola* and *Azotobacter* from Cycas tubercles. It therefore appears certain that, in *Cycas* at any rate, the root tubercles, by virtue of the bacterial organisms present in them, are capable of nitrogen fixation.

Observations on Macrozamia spiralis.

The investigations outlined above deal only with the tubercles of *Cycas,* but although tubercles* of a somewhat similar form occur on *Macrozamia spiralis,* I am not aware of this fact having been previously recorded. The

*I have used the term "tubercle" to signify the apogeotropic roots.

tubercles or apogeotropic roots of this genus first came under my notice several years ago when examining seedlings of various stages collected at Woy Woy, N.S.W., in the midst of a dense formation of *Macrozamia* growing on a sandy soil. Since then seedlings raised in pots of sandy soil in the Botanical Garden of the University of Sydney, and even in glass-stoppered jars, have frequently developed similar tubercles.



Text-fig. 1a.—Young seedling of *Macrozamia spiralis* showing seed (s), hypocotyl (h), first leaf (l), tap-root (t.r.), and tubercles (T) just above soil level. Note that these root-tubercles are negatively geotropic. (x 2/3).

Text-fig. 1b.—Single tubercle of *Macrozamia* showing loose papillose surface (s) of the upper part of root. (x 2/3).

Text-fig. 2.—Older seedling of *Macrozamia* showing main tap-root (t.r.), four tubercle roots (T), normal secondary roots (s.r.), bases of two leaves (l), hypocotyl (h) and seed. (x 2/3).

Text-fig. 3.—Seedling of *Macrozamia* showing tubercles (T), developed as the result of inoculating the tap-root (t.r.), and the secondary roots (s.r.) with a pure culture of Macrozamia-bacteria. In each case the root tubercles develop close to the point of inoculation. (x 2/3).

The tubercles are not of universal occurrence on seedlings; in some cases many tubercles are developed, in others none at all, while in the great majority of cases, the tubercles are few in number. In *Macrozamia* the tubercles do not form such large coral-like growths as in *Cycas revoluta*, but each individual tubercle-root is perhaps slightly larger (Text-fig. 1*b*). The tubercles develop almost without exception upon the uppermost secondary roots in nature, and are thus close to the soil-level, or actually project above it, into the air (Text-fig. 1*a*). The tubercles are negatively geotropic.

In the seedlings of *Macrozamia spiralis* there is developed a strong, fleshy, positively geotropic tap-root, into which the starch of the endosperm of the seed is transferred. This root later develops a thin net-like covering of cork, on the surface of which numerous bacteria and other micro-organisms may be found. Secondary roots develop from the main tap-root—those towards the apical region of the root being perfectly normal—but the secondary roots formed near or at the soil-level are frequently tubercle-like in form (Text-fig. 2). It is only very occasionally that the more deeply seated secondary roots become tubercular.

The root tubercles are not developed in seedlings which have been raised on sterilised soil. A number of seeds were carefully washed for two minutes in a sterilising solution of the following composition: mercuric chloride 1 gram, strong hydrochloric acid 3 c.c., water 200 c.c. They were then rinsed for a time in distilled water. Half of the seeds were placed in a pot of sandy soil (derived from the natural habitat of *Macrozamia spiralis*) which had been thoroughly sterilised by alternate heating and cooling. The soil was then watered with distilled water, and the pots placed in the laboratory.

The remainder of the seeds were placed in pots of sandy soil which was unsterilised. The soil was sprinkled with distilled water and pots placed with the others in the laboratory.

None of the seedlings raised in the sterilised sand developed the tubercles, while approximately 70 per cent. of the seedlings in the unsterilised sand formed tubercles.

The result of this experiment and the fact that under natural conditions only a proportion of the seedlings form tubercles seem to furnish quite conclusive evidence that the peculiar tubercles are developed only as the result of bacterial infection. This hypothesis, however, appears to be demonstrated by the following experiments.

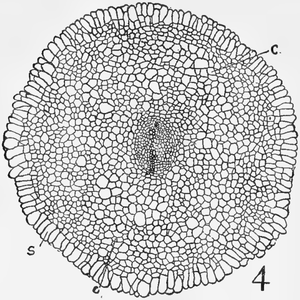
Seedlings growing in sterilised soil were inoculated with Macrozamia bacteria from a pure serum-agar culture, and watered with distilled water.

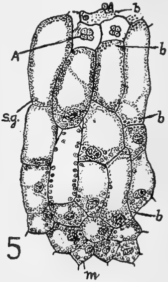
Another series of seeds were thoroughly sterilised, and germinated in a large, sterilised, glass-stoppered jar; the main tap-root was inoculated and the seedlings replaced in the jar which contained a piece of moist cotton wool to maintain a fair humidity. In both experiments, all the seedlings developed tubercles of the usual form in from three to four weeks.

The normal secondary roots of older seedlings were also inoculated, and the seedlings kept in a moist atmosphere in a jar. In about a month from the time of inoculation tubercles developed upon them (Text-fig. 3).

At first the tubercles were plagiogeotropic, but later became negatively geotropic. The roots frequently remain unbranched, but others branch dichotomously.

In a transverse section (Text-fig. 4) of the root-tubercles there is a central diarch stele composed of alternating xylem and phloem groups, surrounded by pericycle and an endodermis whose radial walls are clearly defined by Karsparé strips. Surrounding the stele there is a very extensive cortex, of more or less rounded, thin-walled cells with fairly considerable intercellular spaces and containing protoplasm, a large nucleus, many small rounded starch grains, and in many cases numerous bacteria. There is no definite algal zone as in *Cycas revoluta* roots, although sometimes small unicellular algae occur amongst the superficial cells of the root. Surrounding the cortex there is a very distinct sheath of large, thin-walled, practically papillate, and radially elongated cells, with inter-cellular spaces. The outermost cells of this sheath, especially along that part of the root surface which has developed through soil particles, are





Text-fig. 4.—Transverse section of tubercle showing diarch stele, endodermis, cortex (c), and sheath (s). (x 50).

Text-fig. 5.—A portion of the sheath (s), many of the cells of which have a nucleus, starch grains (s.g.) and bacteria (b). A small group of unicellular algae (A) is seen in the outer sheath-cells. The small cells at the base of the sheath are meristematic (m). (x 265).

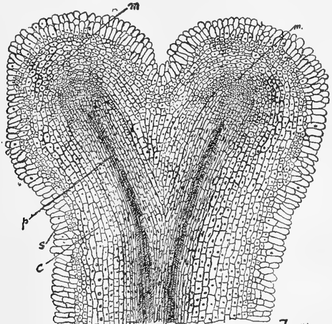
frequently crushed, more or less disorganised and devoid of protoplasmic contents. The inner cells of the sheath contain a peripheral film of cytoplasm, a nucleus and generally several small starch grains. Bacteria frequently occur on the surface of the sheath and inside certain of the sheath-cells (Text-fig. 5, *b*). There is no typical cork formed on the tubercle of *Macrozamia*.

In a longitudinal section (Text-fig. 6) it will be seen that the sheath extends completely round the tip of the root, and forms a definite and persistent root-cap, somewhat different in structure from the cap of a normal root. The papillate sheath-cells at the actual tip of the root are generally very regular in form and arrangement, and have not suffered from pressure. Beneath this sheath, at the apex, there is developed a very massive meristem, the cells of which are small, and contain very granular cytoplasm, a large nucleus, and several starch grains. The calyptrogen and dermatogen are not defined as in the normal root. The periblem and plerome merge into the primordial mass at the apex. The meristematic cells are absolutely free of bacteria, although cortical cells and sheath-cells near by contain these organisms.

The intercellular space-system of these tubercles is extensive and communicates with the atmosphere through the loosely arranged sheath-cells. Lenticels, which Life (1901) has described in *Cycas revoluta,* are not developed on the tubercles of *Macrozamia spiralis.* Nevertheless, gaseous exchange between the atmosphere and the cortical tissues of the tubercles is provided for by the very effective intercellular space system of sheath and cortex. In sections of fresh material mounted in water, a considerable amount of air is present in the spaces.

These tubercles differ from normal secondary roots in certain respects. In the former, the tip is rounded, not conical, while the "root-cap" appears as a persistent, continuous sheath of radially elongated, and somewhat papillate cells. Life observed a similar sheath in *Cycas revoluta* and regarded it as an outer cortex. Morphologically the sheath in *Macrozamia* appears to be analogous to the velamen of the aerial roots of some orchids, and notwithstanding the fact that the calyptrogen and dermatogen cannot be clearly defined as distinctive cell-layers, the evidence supports the view that this sheath is the root-cap which, however, has been considerably transformed and disturbed, like the meristem itself by incursions of bacterial organisms.

The bacteria which occur in the tissues of these tubercle-roots are no doubt soil-forms which enter through some rupture in the main root where a secondary



Text-fig. 6.—A longitudinal section of a dichotomously branched tubercle showing sheath (s), cortex (c), plerome (p), and a mass of meristematic cells (m). (x 40).

Text-fig. 7.—The bacteria of Macrozamia tubercles isolated and grown upon a serum-agar medium. (x 1000).

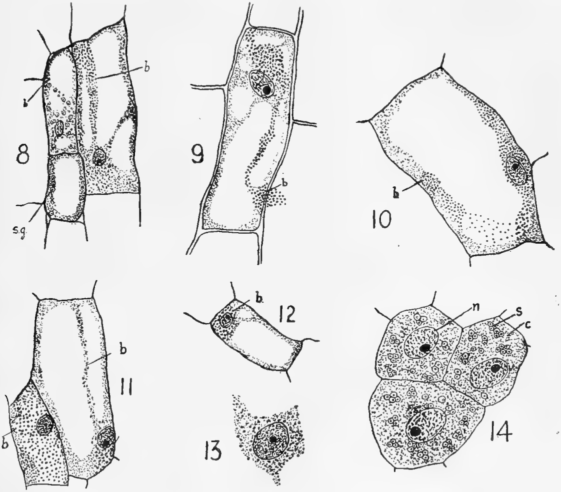
root is growing out, or which gain access to the primary root from the groove in the hypocotyl. Unless infection takes place, the secondary roots show normal development.

In *Macrozamia* deeply seated secondary roots are generally not infected, and develop in the normal way. From this fact, it would appear that the bacteria which cause infection are most abundant in the upper strata of the soil, where they have access to greater supplies of oxygen. If the surface of the main tap-root and of a tubercle-root be gently scraped on to a slide, and the scrapings mounted in water, examination will reveal the presence of numerous bacteria. Many of these bacteria gain access to the tissues of the main root and of the upper secondary roots and develop pathogenically. There seems no doubt that the peculiar form of these tubercles is a pathological effect of bacterial stimulation. The root-tissues are not injured in any way, but there is a greater development of the root-sheath (root-cap) which is permanent, since the tubercles grow into the air, and a more extensive formation of cortical tissue. In both sheath and cortex the cells are considerably enlarged as compared with the corresponding tissues of a normal secondary root, while the intercellular spaces are also more extensive. This structure obviously lends itself to efficient aeration, and suggests the probability that the bacteria are aerobic. This assumption is supported by experimental evidence for, when transferred to a water-drop on a slide, the bacteria generally arrange themselves round the edge of the cover-slip. When placed in a water-drop containing a Spirogyra thread, which is illuminated strongly from the mirror of the microscope through a small diaphragm, they mass in the vicinity of the illuminated spot. It would seem, therefore, that one function of the tubercle is aeration; but the structure is developed for the benefit, principally, of the bacteria in the cortical cells, although no doubt, the tap-root derives some benefit in this respect; that the aeration of the primary tap-root of *Macrozamia* by the tubercles is a subsidiary function; the aeration of the pathogenic bacteria, the primary function, is supported by the fact that many tap-roots do not develop tubercles.

The presence of the bacteria, therefore, produces certain definite effects upon the development of the tubercle, namely, (1) the production of a more extensive sheath and cortex, (2) the enlargement of the sheath and cortical cells, (3) the production of a more extensive system of intercellular spaces for aeration, (4) the disappearance of starch from the infected cells, and (5) the production of a more active meristem which however is free from bacterial infection—Text-fig. 14 shows these meristem cells with starch and no bacteria. The absence of bacteria from actively dividing cells of the tubercles of *Macrozamia* recalls the parallel case of *Dipodium punctatum* roots in which the mycorhizic fungus is not present in the meristematic zone.

Cultures of bacteria were made by placing small fragments of the cortex of a tubercle on sterilised serum-agar, on sterilised turnip jelly, and on a sterilised jelly made from the mashed tap-root of *Macrozamia*, in test tubes. The cultures were developed at ordinary laboratory temperature and at 26° C. in an incubator. In the course of a few days a fairly vigorous growth of bacteria had taken place. The colonies were ovoid to circular, raised, shining, and from 1 mm. to 2 mm. in diameter. From these cultures, others were made with the platinum needle, on similar sterilised media, and in a liquid nutritive medium composed of Cane sugar 1 gram, K. phosphate 1 gram, Am. sulphate 1 gram, $CaCO_3$ .5 gram, Distilled water 1000 c.c.

The bacteria were examined, and two forms were always present, namely a rod-like bacillus form, and a small spherical coccus form (Text-fig. 7). Both forms were motile; this motility was apparent even in the cells of the tubercles. Transverse and longitudinal sections of the tubercles were cut by microtome, and stained with (*a*) carbol-gentian violet, Lugol's iodine and safranin, or (*b*) carbol-fuchsin, or (*c*) in Loffler's stain. The bacteria were clearly differentiated from the cytoplasmic contents and starch grains. Text-figs. 8-12 show different groupings of the bacteria in cells of the cortex of infected roots; sometimes the bacteria are distributed generally throughout the cells or are aggregated at one



Text-figs. 8, 9, 10, 11.—Cells of cortex of tubercle with the bacteria (b) arranged in various ways. Sometimes the bacteria occur throughout the cell, at other times they are arranged in zoogleal-threads which appear to pass from cell to cell. (x 465).

Text-figs. 12, 13.—In these figures a mass of bacteria is shown aggregated around the nucleus of the cell. (x 666).

Text-fig. 14.—A group of meristematic cells containing a large nucleus (n), abundant granular cytoplasm (c), and many small spherical starch-grains. These cells have no bacteria. (x 666).

end or crowded round the nucleus; at other times they form long, irregular zooglea-threads frequently continuous with corresponding threads in adjoining cells. The width of the threads varies, even in adjacent cells. These zooglea-threads are very similar to those present in leguminous nodules and in the Podocarpineae nodules. Text-fig. 13 shows a large number of bacteria round the cell nucleus. This relation of the intruder to the nucleus is very common. A very interesting observation was made in this connection. In cells free of bacteria there is generally abundance of starch-grains, but when bacteria enter and multiply in the cell the starch-content decreases. Text-fig. 10 shows a cell filled with bacteria but devoid of starch. The nucleus and cytoplasm retain their normal structure and appearance, and I found no evidence of nuclear division in the infected cells as has been recorded by Spratt (1912) for the infected cells of the nodule of *Podocarpus*. I have no doubt but that the bacteria give some benefit in return. The individuals of the coccus form differ considerably in size; the smaller form is actively motile and frequently a mass of these may cause the starch-grains to move in the cell. The larger individuals are non-motile and stain more deeply than the smaller. These latter are probably bacteroids which contain proteid and which are digested by the host-cell.

Vines (1888), Frank (1885), McDougall (1899) and others believe that fungi, growing upon or into the cells of a plant, may aid it in nutritive work, especially by converting free nitrogen or the simpler compounds of nitrogen into more complex forms of nutritive value to the plant. Life (1901) also believes that the tubercles of *Cycas revoluta* assist the host in nitrogen fixation. Bottomley (1909) isolated *Pseudomonas radicicola* and *Azotobacter,* which are nitrogen fixing forms, from *Cycas* tubercles. Nobbe and Hiltner (1899) have demonstrated that the nodules of *Podocarpus* are active agents in the fixing of nitrogen of the atmosphere, by cultivating plants with nodules for five years in quartz sand from which nitrogen was absent, and by demonstrating that it was impossible to cultivate *Podocarpus* in the absence of the fungus which caused the nodule formation. Spratt (1912) has since demonstrated that the nodules are formed by bacteria which are apparently identical with the *Pseudomonas radicicola* of the root-nodules of leguminous plants, and of *Cycas,* etc., and that the bacteria utilize the free nitrogen of the atmosphere during the process of metabolism. These results throw light upon those of Hiltner, who cultivated *Podocarpus* in quartz-sand containing no nitrogen.

The disappearance of starch-grains from cells of *Macrozamia* which have been infected by numerous bacteria might suggest that the carbohydrate is utilised by the bacteria. This is supported by the observed fact that deeply-staining bacteroids are formed in which considerable proteid is present. Nitrogen in the free state, at any rate, must enter the cells of the host—a supply of carbohydrate and nitrogen, therefore, is available to the bacteria if they are concerned in nitrogen fixation. If the bacteria were purely parasitic forms, and gave nothing to the host in return for the carbohydrate, one would expect many cells of the host to show signs of disintegration. It is the absence of this condition, combined with the disappearance of starch-grains, and the possibility of free nitrogen entering any cell of the cortex containing bacteria, which suggests to me that the bacteria may be helpful to the plant in the direction of assisting in nitrogen fixation.

With the object of testing this hypothesis, I carried out a series of experiments. The bacteria were first examined in regard to a possible faculty of nitrate formation. A solution containing 1000 c.c. of distilled H_2O, 1 gram of ammonium sulphate, 1 gram of potassium phosphate and 4 grams of basic magnesium carbonate, was used after filtering. Several flasks each containing 100 c.c. of this solution were inoculated from a pure serum-agar culture of the bacteria, and after several days at laboratory temperature the solution was tested for nitrate by means of diphenylamine sulphate—no reaction for nitrate was obtained. The bacteria did not flourish as freely as on the serum-agar medium. I came to the conclusion that the solution was not of a sufficiently nutritive value to the bacteria and subsequently employed the following:—Cane sugar 10 grams, Amm. sulphate 1 gram, Potassium phosphate 1 gram, distilled water 1000 c.c., Calcium carbonate 1 gram. Three flasks, each containing 100 c.c. of this solution which had previously been sterilised in the autoclave and cooled, were inoculated from a pure culture of the bacteria, and kept at laboratory temperature for 14 days. Three other flasks were similarly prepared and incubated at a temperature of 26° C. for 14 days.

Nitrate tests were again applied to a few c.c. of the solution, but there was no evidence of any free nitrate being present in the solution.

The experiments which I have just described were undertaken in order to demonstrate whether or not the bacteria of *Macrozamia*-tubercles are nitrate-forming bacteria; if so, then the cultural solution ought to contain increasing quantities of nitrate. The absence of the blue-colouration on the addition of diphenylamine sulphate demonstrates the absence of nitrate.

But the bacteria may be able to utilize the atmospheric nitrogen, and although nitrogen may be absent from the solution at the beginning, there may be a considerable amount present at the end. The following solution was then prepared:—Cane sugar 10 grams, K. phosphate 1 gram, Mg. sulphate .5 gram, $CaCO_3$ 1 gram, H_2O distilled 1000 c.c.

Three flasks (A), each containing 100 c.c. of solution were inoculated with a pure culture of the bacteria and sterilised. Another three flasks (B1, B2, B3), each containing 100 c.c. of solution, were sterilised, cooled, and inoculated with a pure culture of bacteria. All flasks were incubated at 30° C. for 14 days; the nitrogen content of each was then determined by the Kjeldahl method with the following results:—

In the series A only the slightest trace of nitrogen was found to be present.

In B 1. the nitrogen content was 5.47 mgs.

B 2. „ „ „ „ „ „ 5.30 mgs.

B 3. „ „ „ „ „ „ 5.23 mgs.

As there was only a trace of nitrogen in the flasks A1, A2, and A3, there had obviously been a considerable fixation of nitrogen by the bacteria introduced into the flasks B1, B2, and B3. As there was no combined nitrogen in the culture solution at first, the bacteria must have "fixed" the free nitrogen of the air.

The bacteria of the root tubercles of *Macrozamia spiralis* are therefore nitrogen-fixing forms which live in a symbiotic association with the roots of the host, fix the atmospheric nitrogen, and render it available, in some combined form, for the metabolic processes of the host.

Summary.

"Root-tubercles," somewhat similar to those of *Cycas revoluta,* occur upon many of the seedlings and older plants of *Macrozamia spiralis,* particularly about the soil-level.

The tubercles are seldom present upon the more deeply situated secondary roots, but may be induced to develop by artificial inoculation.

The tubercles are always negatively-geotropic; uninfected secondary roots are plagio-geotropic, but after inoculation become negatively geotropic.

The tubercles occasionally branch dichotomously.

The growth of the root tubercles is due to infection by soil bacteria, of which two forms are generally present in the sheath and cortical cells.

The presence of the bacteria in the cells of the root stimulates the development of the cortex and sheath, so that the tubercles are always more massive than ordinary roots.

Zoogloea-threads of bacteria arise in many cells of the cortex, and the bacteria are frequently crowded in the vicinity of the nucleus. The starch-content decreases in the cells containing bacteria, and is probably used by them in the process of nitrogen fixation.

Occasionally unicellular algae may be present amongst the outer disorganised cells of the sheath, but there is no definite "algal-zone" as in *Cycas revoluta.*

The bacteria are not nitrate-formers but assimilate free nitrogen and render it available in a combined form for the plant.

The structure of the tubercles also indicates that they may function subsidiarily in aeration.

Similar root-tubercles occur in other species of *Macrozamia,* e.g., *M. corallipes.*

I desire to record my sincere thanks to Professor Lawson for his helpful criticism.

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ASTACOCROTON, A NEW TYPE OF ACARID.

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(Plates xxxvi.-xxxvii.)

[Read 30th August, 1922.]

Contents.

1. *Introductory; mode of occurrence, methods, etc.*

The Acarid dealt with in this paper occurs, sometimes abundantly, in the branchial chambers of the common spiny Crayfish (*Astacopsis serratus*) of the rivers of Eastern Australia. I have found it most numerous in the bright crimson variety that frequents the larger tributaries of the Grose and Cox in the Blue Mountains; but it occurs also, though more rarely, in the Crayfishes of small streams not connected with the Hawkesbury River system.*

The adult females, which are devoid of eyes, are firmly attached to the gill-filaments of their hosts by means of the chelicerae and pedipalpi, and can only be detached by the use of a certain amount of force. The males, which are comparatively small, and which are provided with a pair of eyes, are not attached, but swim very actively. Probably they are intermittently parasitic, though I have no actual direct evidence of this. The same holds good of the young females. Though soft and thin-skinned, *Astacocroton* is by no means easily acted on by fixing agents. In cold sublimate-acetic or alcohol it remains

**Astacocroton* does not occur on the common bicarinate Crayfish or "Mirami" *(Parachaeraps bicarinatus)*; and a number of specimens of the Western Australian *Chaeraps tenuimanus*, *C. quinquecarinatus* and *C. preissii* examined by me with the assistance of Mr. F. A. McNeill, Zoologist in charge of Lower Invertebrates at the Australian Museum, proved also to be free from the parasite.

alive for a long time and eventually undergoes more or less shrivelling. The same holds good of other reagents used cold, except Carnoy's solution, the fixing action of which, however, was not satisfactory. Killing with hot water, followed by treatment with various re-agents—Flemming without acetic, Henning, picrosulphuric, Hermann,—did not yield good results. On the whole the best sections so far have been obtained with specimens treated with hot sublimate-acetic. Double embedding (with either toluol-alcohol or alcohol-ether celloidin and paraffin) was found to be of advantage. Staining was most satisfactorily effected by means of haematoxylin (iron-alum method, Heidenhain, Delafield or Ehrlich) followed by erythrosin.

Most of the material available was collected by myself and fixed with hot sublimate-acetic. Though this was for the most part at least ten years old, it was in a good state of preservation. More recently, since I became engaged in this research, I have received highly valued assistance in the form of supplies of live crayfishes from Prof. H. G. Chapman and Mr. F. A. McNeill.

For comparison I have used species of *Tetranychus* and *Trombidium,* and various Hydrachnids, Tyroglyphids and Oribatids.

I am indebted to the University of Sydney for a grant from the McCaughey Research Fund which has defrayed the expenses incurred. My drawings have been re-drawn for the purpose of reproduction by Mr. F. W. Atkins of the Sydney Technical High School.

2. *Diagnosis of* Astacocroton.

Adult female imago permanently parasitic on gills of Crayfish, eyeless, incapable of swimming, devoid of tracheae. Integument of body thin, transparent, devoid of chitinous plates and practically hairless. Body swollen, ovoid, with the legs displaced forwards so as to be all in front of the middle of the trunk. Capitulum not greatly produced, with the mouth at the anterior end of its ventral surface. Chelicerae with the second joint piercing, barbed. Pedipalpi powerful, the last joint provided with hooked spines, the penultimate not produced. Epimera subequal, all distinct, except that the third and fourth are united for a very short distance at their inner ends; on the fused part but opposite the fourth, is the aperture of a gland or group of glands—coxal or integumentary. The legs are devoid of swimming hairs; each is armed terminally with a pair of strongly hooked tridentate claws. The genital aperture is a longitudinal slit close to the posterior extremity of the body. A little distance behind and above it is the excretory aperture. The animal is oviparous; a large number of ripe eggs, each enclosed in a thick shell, collect in the uterus, but their active development does not begin till after they have been discharged.

I propose to name the only species as yet known *A. molle*.

3. *General Features.*

The permanently attached females reach a maximum length of about 2 mm. When detached, full-grown specimens are able to climb about among the branchiae, but, when set free in water, they are unable to swim, though making energetic efforts to do so. Small specimens make more or less rapid progress through the water. The general shape is oval, with a slight ventral flattening. The integument is very thin, colourless and transparent, so that on the ventral side the ova and other internal structures are clearly visible. In some specimens the most conspicuous structures on this surface are a pair of rounded bodies, the "coxal glands" (Pl. xxxvi., fig. 1, *cx.*), situated between the bases of the fourth pair of legs. On the dorsal surface is a very conspicuous median longitudinal white band with irregularly lobed edges, marking the position of the excretory organ. This bifurcates in front and bifurcates also though less distinctly, behind. Towards the posterior end of the ventral surface is a narrow longitudinal slit bounded by a pair of chitinous plates set on edge—the reproductive aperture (Pl. xxxvi., fig. 1, *g.a.*; Pl. xxxvii., fig. 18). On either side of this extends a row of four "genital suckers" (Pl. xxxvii., fig. 18) each about .02 mm. in diameter, the row curved with the concavity inwards and set in a semi-lunar area which is apparently a thickening of the cuticle. A little distance behind the genital slit is the small, sometimes slit-like, sometimes rounded excretory aperture (Pl. xxxvi., fig. 1, *ex.a.*; Pl. xxxvii., fig. 18) with a slight raised rim. In addition to the mouth, to be described with the capitulum, the only other external apertures are those of the ducts of the coxal glands—a pair of minute pores .01 mm. in diameter on the coxae of the fourth pair of legs. There are no stigmata.

4. *Capitulum; appendages.*

In the larger specimens the capitulum (Pl. xxxvi., fig. 1, *cp*; fig. 2), is situated well behind the anterior margin, so as to be completely concealed from view when the animal is looked at from above. Its length is about one-fourteenth to about one-eighth of that of the body. Though it is freely movable, it is not definitely articulated with the body. Distally it is divided by a slight median notch, on either side of which are attached the bases of the pedipalpi. The mouth is situated on the ventral aspect of the distal end of the capitulum. It is a nearly circular aperture, bounded by a thick chitinous ring, continuous in front with the edges of a median slit between the bases of the pedipalpi. The area of the ventral surface of the capitulum behind the mouth is perforated by numerous extremely fine pores which, as sections show, perforate the cuticle.

The chelicerae, instead of lying in a groove on the upper surface as in the *Ixodidae* and *Bdellidae* and a few other *Acarida*, are roofed over by a continuation of the integument of the capitulum, as in *Trombidium* and the Hydrachnids, the entire basal joint being enclosed within the latter and the distal podomere alone being thrust out through the mouth.

Each chelicera (Pl. xxxvi., fig. 2, ch_1, ch_2; fig. 3) is composed, as in the majority of the Acarids, of two joints or podomeres, proximal and distal. The distal podomere is a sharp stylet, strongly curved, with the concavity dorsal and anterior. At a little distance from the point is an oblique flange strengthened by a sharp spine, the end projecting like a tooth; this must play the part of the barb of a hook in hindering withdrawal when a gill filament has been pierced. A second smaller oblique spine appears nearer the apex. Close to the point is a minutely serrated ridge of somewhat variable extent. Along the inner side runs a longitudinal flange extending from the base to near the apex. In the normal relations of the parts, with the two chelicerae in close apposition, their two longitudinal flanges combine to complete a longitudinal canal for the passage of the blood of the crayfish to the mouth of the parasite. The base of the distal joint lies within the mouth and is incapable of protrusion. It is expanded and divided into two condyles for articulation with the proximal joint and for the insertion of the muscles arising within the latter. Sections show that it is hollow, being pierced by a canal which opens into the cavity of the proximal joint by a fine aperture at the base between the two condyles. The canal contains a core of tissue, which, though the structure is not clear in any of my sections, is probably a duct opening near the distal end. The gland of which this would seem to be the duct is a granular mass contained in the cavity of the proximal joint between the muscles. It consists of a number of lobes which converge towards the distal end to form a vesicle which narrows to form the duct. The proximal joint may be described as oval, somewhat compressed laterally, and narrowing distally. Its long axis is not parallel with that of the capitulum, the proximal end being dorsal to the pharynx and the distal near the mouth. At its oral end it lies in the roof of the mouth cavity, and behind that it develops a knob which articulates with the chitinous element which I propose to term the *fulcrum*. The fulcra are of general, if not universal, occurrence in the Acaridae; but they do not appear to have had any name given to them that could be of general application. In tracheate forms such as *Trombidium* and the tracheate Hydrachnids they are hollow, the cavity which each encloses being in continuity with the tracheal system. In this connection they are termed the "drittes kieferpaar" by Haller (1881) "sigmoid chitinous piece" by Michael (1895) "zweite Luftkammer" by Henking (1882). Each not only supports the corresponding chelicera, but gives origin to the muscles by the contraction of which the movements of the latter, as a whole, are effected. The fulcra articulate with the chitinous "bridge." The middle part of the latter lies on the aboral side of the salivary receptacle in which the right and left main salivary ducts unite to open into the mouth. It is produced downwards and outwards in two strong chitinous bars which fuse with the cuticle of the lateral wall of the capitulum at its base. The fulcra in *Astacocroton* are strong, solid, curved rods of dense chitin, which, originating close together where they articulate with the chelicerae and the bridge, diverge as they pass backward and downwards like the limbs of an inverted V. From each arises a set of muscles passing backwards and upwards to be inserted into the proximal end of the basal podomere of the corresponding chelicera. When these muscles contract they must cause the rotation or tilting forwards in the vertical plane of the chelicerae on the fulcra, and this must result in the movement by which the harpoon-like free ends are made to pierce the gill of the crayfish.

In general it may be said that the structure of the capitulum and the chelicerae agrees well with that of these parts in *Trombidium* and the Hydrachnida. The most noteworthy difference seems to lie in the fulcra. In *Trombidium* and the tracheate Hydrachnids, instead of being solid rods, these, as already stated, are hollow and dilated into the form of air-chambers with chitinous walls connected with the tracheal system, while still retaining the same essential relationship with the bridge, the chelicerae and their muscles.

The pedipalpi (Pl. xxxvi., fig. 1, *pd*; figs. 4 and 5) are a little longer than the capitulum, stout, composed of five joints or podomeres, of which the second is the largest. The last, which is much narrower than the rest, is provided terminally with six spines, four of which are hooked; the penultimate bears a spine on the inner side of the distal end. The entire appendage is habitually curved downwards in adaptation to its function of grasping the gill-filaments and suspending the parasite.

The position of the legs (Pl. xxxvi., fig. 1) in the full-grown animal is a very marked feature, the last pair being far in front of the middle of the body—in fact, in large specimens not more than about a fifth of the entire length from the anterior end. This is associated with the great distension of the body with the ingested crayfish blood and the accumulated mass of eggs, but begins at a very early stage. The epimera (coxae) are subequal, the fourth a little longer than the rest, in contact with one another by their edges, but not fused, except the third and fourth, and these only for a short distance at their outer ends. In length the legs increase from before backwards, the fourth being much the longest and about half the length of the body in a large specimen. Each consists, as in other mites, of six podomeres (Pl. xxxvi., fig. 6) in addition to the epimeron. Swimming hairs are not developed on them, there being only a small number of short hairs. At its extremity (Pl. xxxvi., fig. 7) each is provided with a pair of strongly-hooked trifid or tridentate claws without sucking disk, but with a stoutish spine.

5. *Coxal or integumentary glands.*

The two oval bodies referred to above as the coxal glands may not correspond to the organs so named in other Arachnids, and the name is mainly applied to them here on account of the position of the openings of their ducts on the coxae of the last pair of legs. The "glands" in question (Pl. xxxvi., fig. 1, *cx*) are situated close to the ventral surface behind the central nervous system. Each is divided into about half-a-dozen lobes which converge outwards and forwards towards the point from which the duct is given off, and narrow prolongations of some extend into the latter and may reach the aperture. The clear substance of which these lobes are composed is very hard in the preserved specimens and in many cases refused to be cut into sections, the gland breaking into irregular pieces and tearing up adjoining structures. In one series of sections, however, of an immature female without eggs, it is clear enough that each lobe is divided transversely by thin partitions into several (usually four) parts, and that in each of these is a small round body like an indistinct nucleus. On the other hand in some series of sections of full-grown specimens with numerous eggs the organ has not broken and the sections of it appear like sections of an almost homogeneous body, staining strongly and uniformly with eosin or erythrosin, and without histological structure. In the smallest specimens which I have obtained—minute free-swimming stage—the organs in question are very distinctly divided into lobes and have wide ducts, but the specimens, mounted whole unstained, are not in a condition to show minute structure. The conclusion to be derived from the imperfect data appears to be that, while probably functional in the young animal, these glands become inert in the fixed parasite and their histological structure degenerates.

Openings of "integumentary glands" are present on the fourth epimera in *Teutonia, Limnesia* and *Limnesiopsis* (Piersig u. Lohmann, 1901). It seems probable that the glands in question are of the same nature as the bodies above described; but the latter appear to be very different from the dorsal integumentary glands described by Michael (1895) and others in *Thyas* and various other Hydrachnids.

6. *Digestive System.*

A slit between the bases of the pedipalpi expands behind into the rounded aperture of the mouth which is surrounded by a ring-like thickening of the cuticle. The latter is produced inwards to form the investment of the buccal cavity. The latter gives off the pharynx almost immediately within the mouth-opening (Pl. xxxvi., fig. 8), and is continued below the basal joints of the two chelicerae into a dorso-ventrally compressed space which expands laterally and receives at its outer angles the main salivary ducts. This space, which may be termed the *salivary receptacle* (*s.r.*), is separated from the buccal cavity proper by a fold of the thin membrane forming the floor of both, a fold which lies on a cushion-like elevation and may act as a valve.

The pharynx (Pl. xxxvi., figs. 8-10, *ph*; Pl. xxxvii., figs. 11-12) has the general structure usual in the *Acarida,* corresponding closely in most respects with that of *Trombidium* as described by Henking and that of *Thyas* as described by Michael. An important difference, however, is that the swallowing muscles ("Schluckmuskeln" of Henking, "transverse muscles" of Michael) which are so conspicuous in transverse sections of this region in *Trombidium* and occur also in the Hydrachnids, or at least in some of them, are here entirely absent—the sucking muscles being opposed merely by the elasticity of the wall of the pharynx. The chief agents in the sucking action are the "dilatores pharyngis" muscles of Michael (1895, p. 182). To the result of the contraction of these muscles in enlarging the lumen of the pharynx, a contribution is made by short muscular bundles arising from the inner surface of the ventral cuticle in the middle line and inserted into the ventral half-tube of the pharynx, mainly into a keel-like process which projects downwards from the latter; this muscle which may be termed *depressor pharyngis,* is figured by Michael in *Thyas* (1895, fig. 23), but is not lettered and is not mentioned in the text.

The "Giftdrüsen" which are also very conspicuous in transverse sections of the capitulum of *Trombidium* and are described and figured in that genus by Henking (1882) are entirely absent in *Astacocroton.* So also is the azygous gland referred to by Michael (1895, p. 192) as lying (in *Thyas*) between the two sets of muscles which tilt up the chelicerae.

There is, however, in this region, a gland (?) not represented in *Trombidium* and not recorded, so far as I can ascertain, as occurring in any other Acarid. This, which I propose to name pharyngeal gland, is rather (if it be indeed glandular) of the nature of a group of large unicellular than of a pair of compound glands. These (Pl. xxxvii., fig. 12, *g*) are situated between and around the dilator muscles of the pharynx. Each is a somewhat pyramidal cell, 0.1 mm. in length, with a rounded base directed upwards, and the attenuated apex becoming lost among the fibres of the dilator muscles near the dorsal wall of the pharynx. Each cell has a nucleus about .01 mm. in diameter, and vacuolated cytoplasm which is not readily affected by stains.

The oesophagus is extremely narrow, with an excessively minute lumen. As usual it perforates the central nerve-mass to open into the mesenteron. The latter consists of an anterior median sac extending across the whole breadth of the body immediately behind the dorsal salivary gland, and a pair of caeca which extend back to the posterior end of the body. As in the *Prostigmata* in general, there is no hind-gut or anus. The two caeca (Pl. xxxvii., figs. 14-16, *ent*) are separated from one another by the median excretory organ (*ex*) and occupy with it all the dorsal part of the cavity of the body—the ventral part being taken up by the ovary and the uterus. The median sac and the caeca are of essentially the same structure. A basement membrane supports an epithelium of an extremely irregular character. The contents are invariably the blood of the crayfish, disseminated through which are usually to be seen numbers of the characteristic blood-corpuscles.

The epithelium resembles the corresponding layer in the Acarida in general as described by Michael (1895, 1894-97), Thor (1904) and others. Some of the cells are relatively small, others are produced into the lumen and dilated distally, the proximal part usually becoming constricted. The protoplasm of the large cells and, to some extent, of the small also, is loaded with a variety of metaplasmic bodies, in the form of granules, spherules and irregular concretions, which vary very greatly in character and relative abundance in different individuals.

As appears to be very generally the case in the Acarida (Michael, 1895, 1894-97; Thor, 1904), as well as in some other Arachnids (Bernard, 1894), the cells or portions of them, often become free in the lumen. As the contained blood remains uncoagulated they are able to float freely, but in a few of my series, the blood has for some reason undergone coagulation while the animal was still alive, and in these cases the passage of the wandering cells from one side to the other is plainly indicated by clean-cut cylindrical burrows through the coagulum (Pl. xxxvii., fig. 14). The definitiveness of these and their straight, or nearly straight, course, seem to indicate a distinct attraction or repulsion—not due to gravity, since the direction of the canals is not the same on opposite sides. In a specimen crushed while alive, moving enteric cells can sometimes be distinguished. These assume the elongated narrow shape which they most habitually adopt in traversing the enteric lumen.

The crayfish blood-corpuscles are ingested by the cells of the enteric epithelium. This is quite clear in only one of my series of sections—one in which the corpuscles are very strongly stained and the blood plasma and endoderm cells not too strongly. It is certain of the latter projecting far into the lumen or altogether detached that mainly discharge this function. In successive sections of one of these cells I have counted as many as fifty of the corpuscles, some adhering to the surface, others half embedded, others more or less deeply sunk in the cell-protoplasm.

There are no intrinsic muscles in the wall either of the mesenteron or of the excretory organ, and yet in the living animal, contractions occur in waves at irregular intervals in the walls of both mesenteron and excretory organ. These contractions must be due to a pair of strong muscular bands which extend obliquely throughout the length of the body from the dorsal body-wall above the anterior extremity of the excretory organ backwards and downwards, one on either side of the excretory organ, between it and the corresponding mesenteric caecum, to the neighbourhood of the excretory aperture.

7. *Salivary and anti-coagulin Glands.*

There are in *Astacocroton* three pairs of glands representing the "salivary" series. If we adopt Thor's (1904, p. 105) nomenclature, these would correspond to his *tubular, reniform* and *dorsal*—the last being perhaps the equivalents of both anterior and posterior dorsal pairs, or perhaps of only one of them. The anterior and posterior oesophageal pairs and the unpaired tracheal are not represented.

By far the largest of these are the last—the *dorsal.* These are about .3 mm. in diameter, situated dorsally at the extreme anterior end of the body, just behind the bases of the chelicerae, dorsal to the oesophagus and nerve-centre, fitting close down over these structures and in close contact with one another in the middle line. Each consists (Pl. xxxvii., fig. 13) of a group of large cells, about .2 mm. in length, of approximately pyramidal shape, arranged around a central cavity of variable extent—the beginning of the duct (d)—which is bounded by their apices and is lined by a thin cuticle. Towards the broader end each cell is composed of an almost homogeneous substance which is not very strongly affected by staining agents; but, invading this near the apex, and sometimes spreading throughout the greater part of the cell, is the accumulating secretion, which in lightly stained sections appears clear and yellowish, but in such as have been strongly eosinated shows as masses of rounded granules. Each cell has a large nucleus, .03 mm. in diameter, with a spheroidal nucleolus, .01 mm. in diameter, and an achromatic network having a prevailingly radial arrangement. The narrow apical part of each cell is virtually its duct and pierces the cuticle of the beginning of the main duct to open into its lumen. In large adult animals the structure becomes complicated by the main duct receiving a tributary duct, which arises from a small cavity of the nature of a secondary lumen in the interior of the more ventral part of the gland.

The duct, a narrow tube with a cuticular lining, runs straight forwards to join those of the two glands yet to be described.

The *reniform* glands (Pl. xxxvi., fig. 10 and Pl. xxxvii., fig. 13, S_2) are much smaller than the dorsal—only about .07 mm. in diameter—and lie opposite the middle of the dorsal glands and external to the latter. The main part of each is a rounded body containing a number of nuclei which, though large (.01 mm. in diameter) compared with those of most of the other tissue-elements, are small in comparison with those of the cells of the dorsal glands. These nuclei are quite irregularly arranged and the cells which they represent are not always clearly distinguishable. In the substance of the gland are small vacuoles and canals and a narrow central lumen, not distinguishable in all cases, from which the duct arises. The latter runs forwards to join the other salivary ducts.

The third pair of glands in *Astacocroton* belonging to the "salivary" group—the *anti-coagulin* glands—undoubtedly correspond morphologically to the "tubular salivary glands" of Michael, the "glandes tubulaires" of Thor, the "schlauchförmige Drüsen" of Schaub (1888). But in *Astacocroton* these glands present features of significance which, so far as I can ascertain, have not been observed in any other Acarid. Each gland (Pl. xxxvi., fig. 10, *co*) begins in front close to the corresponding dorsal and reniform glands, external to the former and separated from it by the muscles running from the dorsal body-wall to the base of the rostrum, somewhat ventral to and behind the latter. The anti-coagulin gland begins in front in an elongated vesicle or reservoir with, in some cases, a considerable lumen and comparatively thin walls. This gives off, in front, a duct which runs inwards and forwards to join those of the reniform glands. Posteriorly it is produced into a tube which is thrown into several folds, and undergoes several dilatations. The chief of these dilatations has a funnel-like appearance in transverse sections. What represents the mouth of the funnel, which faces inwards, is closed by a thin wall of small cells. The remaining walls of the "funnel" are relatively thick and composed, like the rest of the organ, of cells without definite boundaries, recognisable only by their nuclei which are distinctly smaller than those of the reniform glands. The reservoir passes into a wide tube which is twisted on itself and this divides behind into two narrow tubes (about .03 mm. in diameter) which run backwards in the wall of the mesenteron (Pl. xxxvii., fig. 15, *a.c.g.*) sometimes close together, sometimes wider apart. Finally, far back in the wall of the mesenteric diverticulum, the two tubes unite and terminate; in other words, the two tubes are in reality a loop. In some series there is a short anastomosis about the middle.

The meaning of the special form of the tubular glands and the peculiar position of their loops might be conjectured; but to my mind at least it is rendered perfectly clear by the evidence of some of my series of sections. In these, not only is the mesenteric epithelium altered and partly dissolved away along the track of the loop, but a definite effect has evidently been in the act of being produced on the blood in the mesenteric lumen, an effect which is strictly limited to this track and extends throughout its length. The nature of this effect is difficult to describe: it is as if a cloud of clear unstainable liquid were passing out into the faintly stainable granular plasma of the blood-food along the course of the loop. The conclusion seems unavoidable that, though the tubular glands have their own ducts which carry their secretion into the mouth through the common salivary duct, a part of the secretion diffuses from the looped tube into the lumen of the mesenteron.

That an anti-coagulin is produced in the digestive system of *Astacocroton* has not been proved. In the ticks *Ixodes* and *Argas*, Sabbatani, in the case of the former, and Nuttall and Strickland (1908) in the case of the latter, demonstrated its presence experimentally. But since the question presented itself I have not been able to muster sufficient fresh material to render such experiment practicable. However, the fact that the blood-food does remain uncoagulated in all but a few exceptional cases seems to prove that an anti-coagulin is produced. And the very peculiar relationship found to exist between the loop of the tubular gland and the mesenteric epithelium seems to point to that gland as the most probable source of the ferment.

8. *The integument; the so-called fat-body.*

The cuticle of the general surface is very thin—about .00143 mm.—It consists of two layers—the outer homogeneous, the inner with an obscure structure of vertical pillars, with an undulated inner surface. That of the capitulum is nearly twice as thick. The underlying layer—epidermis—is thinner than the cuticle, and in the adult animal no longer exhibits a cellular structure. Below the epidermis, in the body-cavity are a good many leucocytes, about .01 mm. in diameter when rounded off, filled with small granules, which have a strong affinity for eosin or erythrosin.

Within, on the dorsal side, is a layer (Pl. xxxvii., figs. 15 and 16, *f*) not quite continuous, of sharply defined cells of irregular shape and size, averaging about 0.02 mm. in diameter with nuclei of about 0.01 mm. and nucleoli of about 0.005 mm. or rather less.

These are the cells figured and described in *Trombidium* by Henking (1882, Plate xxxiv., fig. 10) as "Fettkörperzellen." They lie in close contact with the dorsal side of the mesenteron and excretory organ, and in front of these over the dorsal glands. Thor (1904, p. 37) regarded them erroneously as young ova.

9. *The Excretory Organ.*

This is a median sac (Pl. xxxvii., figs. 14-16, *ex*) extending throughout the length of the body towards the dorsal side, and opening on the exterior by the small excretory aperture (Pl. xxxvi., fig. 1 and Pl. xxxvii., fig. 18), situated a little distance behind the posterior end of the genital slit. In front it divides into two branches which curve outwards and forwards each running in an almost transverse direction in a fold of the wall of the mesenteron to terminate blindly over the coxal glands. Behind, before narrowing to open on the exterior, it gives off a pair of short lobed caeca. Its general appearance in the living animal has already been referred to. In sections the main part of the organ is seen to be a laterally compressed tube with a narrow vertical lumen expanding somewhat dorsally where it lies immediately below the dorsal body-wall. It is intercepted between the two enteric caeca, with the inner walls of which it is intimately connected, and abuts below on the wall of the uterus.

The wall of the organ consists of two layers only—an internal epithelium and an external supporting layer or basement-membrane. The epithelium is a single layer of cells flattened for the most part and not sharply marked off from one another. The nuclei are characterised by the possession of several rounded nucleoli. The basement-membrane has no recognisable structure. It and the basement-membrane of the mesenteron are in intimate apposition, but are not fused, a definite cleft being distinguishable between them in some places, and the dorso-ventral muscles already referred to in connection with the mesenteron intervening in others.

10. *Reproductive system.*

The female genital aperture has, as already stated, a form which is very usual in the Acarids, viz., that of a longitudinal slit bounded by a pair of vertically-placed chitinous plates. The passage (vagina) into which it leads is surrounded by a thick mass of muscular fibres, and the cavity is almost obliterated in most sectioned specimens by the close apposition of the lateral walls. In front the cavity opens out and then bifurcates, each of the two lateral vaginae thus formed opening into the corresponding division of the uterus.

In young specimens in which there are no fully formed ova and in which the uterus is empty, the latter is divided, except in front, into right and left cavities by a median vertical partition. In mature specimens with the uterus packed with eggs, this partition only remains complete in the posterior region; further forward it breaks down, only a remnant at most of its dorsal part persisting. Further forward still it completely disappears and the uterus presents an undivided cavity.

The wall of the uterus is composed of a single layer of cells supported upon a basement membrane. In the mid-ventral region the latter alone persists. In the lateral regions the cells become vertically elongated. It must be to the activity of these cells that the formation of the thick and complicated egg-shells is due, since there are no other elements that could be concerned in this process.

The ovary (Pl. xxxvii., figs. 15 and 16, *ov;* fig. 17) lies mainly on the ventral side of the uterus with the ventral wall of which, here for the most part composed merely of basement membrane, it is intimately united. But in front it extends round it to the dorsal side and is prolonged a little distance in front of it in the region just behind and between the coxal glands. The ova, developed in the substance of the ovary in the manner subsequently described, then projecting outwards in the stalked stage, later become free in the surrounding cavity (which is simply the body-cavity) and there grow to their full size. Communication between the body-cavity and the interior of the uterus is effected by a pair of apertures situated far forward just behind the coxal glands. The free (outer) surface of the ovary is covered with a very thin layer (not definitely represented in Pl. xxxvii., fig. 17) which is prolonged over each of the developing ova—Henking's *tunica propria ovarii.*

Although it is impossible to follow the details of the oogenesis in the material at present available, there are a few important points to be noted. The ova appear in the substance of the ovary—a layer about .05 to .07 mm. in thickness. The cells, as they near the outer surface, become separated into two sets—(1) those destined to become ova and (2) those destined to become stalk-cells. The former become larger and come to project on the free surface. The latter remain small with denser protoplasm and very small nuclei, and form groups of about five or six beneath the growing ova. Each group is developed into a stalk with about a dozen nuclei, embedded at its base in the substance of the ovary, but quite sharply cut off from the latter, and bearing a young ovum at its free end. Such a stalk probably plays the part of a nutrient organ, replacing the cells of the nutrient chambers of the ovaries of certain Insects. But before the ova have increased greatly in size, and long before the yolk has begun to be formed, the ovum has developed over its entire surface a definite though thin membrane with the appearance of chitin, which cuts off the stalk and must interfere to some extent with free absorption. The original investment meanwhile disappears. The younger stalked ova (Pl. xxxvii., fig. 17, 1-4) are quite devoid of yolk, but each contains in its cytoplasm a mass of substance having staining reactions very similar to those of chromatin. This, corresponding to a "yolk-nucleus," at first surrounds, or partly surrounds, the nucleus; then becomes aggregated on one side assuming a variety of forms usually analysable into twisted anastomosing threads. Later it becomes broken up into small masses and dispersed through the cytoplasm, and long before the detachment of the ovum from its stalk, yolk-spherules make their appearance. At first they are only developed in the outer zones, leaving a large, sharply defined, yolkless central area (Pl. xxxvii., fig. 17, 5); but later they extend uniformly throughout the protoplasm and increase greatly in size from .002 mm., when first clearly distinguishable, to .015 mm. in the ripe egg.

How and at what stage fertilization takes place has not been ascertained, nor has any trace been seen of maturation phases. When the ovum enters the uterus it at once becomes enclosed in a thick shell secreted by the elongated epithelial cells of the lateral parts of the uterus. The completed egg is .23 mm. in diameter. The egg shell is about .015 mm. in thickness and consists of three layers, an outer very thin, a middle, the thickest, made up of radially elongated rod-like elements, and an inner which is the original chitinous investment of the ovum. About fifty of these ripe eggs accumulate in the uterus of a mature female. Their further history has not yet been followed.

The relations between the ova, the body-cavity and the uterus in *Astacocroton* seem, if we have regard to the statements in general works such as Warburton's "Arachnids" of the "Cambridge Natural History," or Marie Daiber's "Arachnoidea" of Lang's "Lehrbuch," to be quite without parallel in the Arachnida; but if we look more closely into the descriptions and figures of certain of the original papers we are forced to the conclusion that the relations in question must in certain other groups of the *Acarida* be essentially the same as in *Astacocroton*.

Thus in his account of *Bdella* Michael (1894-97, p. 516) states "The ova are formed and more or less matured in short pedunculated cysts, each ovum apparently forming its own oocyst by pushing out the exterior tunic of the ovary, thus forming a sac in which the ovum lies. Exactly how the ovum gets from the oocyst into the oviduct is not by any means clear to me in *Bdella*, or, indeed in many of the other Acarina, although it is evident in the Oribatidae and most Gamasidae."

His figures 24 and 25 show clearly enough that before the ova represented can reach the interior of the oviduct they must first become detached from their peduncles and enter by apertures in the wall of the oviduct or uterus. Precisely the same holds good of Henking's (1882) Figs. 14-16, representing the female reproductive apparatus of *Trombidium*.

Under the heading "Glands of unknown function" Michael (1895) in his account of *Thyas petrophilus* describes as follows a pair of glands which occur in both sexes:—

"Lying immediately below the lateral portions of the hollow square of the ventriculus immediately above the genital organs in both sexes, and about the middle longitudinally of the latter organs, exist a pair of almost globular or slightly elliptical, organs of about .04 mm. diameter in the male and about .05 to .1 mm. in the female. These organs (fig. 19, *gu*) have every appearance of being glands; they are composed of distinctly nucleated closely-packed elongated cells of about .01 mm. diameter and in section exhibit similar cellulation all through; they are quite solid without lumen, but I have not been able to trace any duct from them. I thought at one time that they probably discharged into the posterior part of the tubular salivary glands, but after careful investigation I am not, up to the present, able to state that this is the case, although the two organs are in tolerably close juxtaposition; and the function of the glands therefore remains uncertain to me" (1895, p. 197).

A pair of organs which are almost certainly homologous with those described occur in the female *Astacocroton.* They are a pair of rounded organs nearly .2 mm. in diameter, ventro-laterally situated between the mesenteric diverticulum and the uterus, embedded in the posterior wall of the latter. Each is a solid mass of polyhedral cells averaging about .02 mm. in diameter, without lumen and without duct. There is certainly no connection with the tubular salivary gland, the bend of the loop of which is definitely anterior. There is a very close association between the cells of this gland and those of the uterine epithelium, but if the former organ occurs, as Michael states it does in *Thyas,* in both sexes, its function is not easy to determine. In the only male *Astacocroton* (immature) of which I have sections it was not seen.

11. *Male.*

I am not in a position to give a full account of the male since I have only a single specimen, and that is in an immature condition. I have never found a male attached to the gills—the few I have seen being free in the gill-cavity. Their apparent scarcity may be partly due to their freedom. The specimen referred to was very small, not more than a millimetre in length. The appendages are not distinguishable from those of the female. The presence of a pair of eyes may be peculiar to the male; but early stages of the female may possess them. The chief—if not the only—external difference distinguishing the male is in the reproductive aperture, which is a comparatively short slit situated relatively far forward, about the middle of the ventral surface.

Sections of this specimen show that the reproductive apparatus is still in a very rudimentary condition. The testes are a pair of sacs with distinct empty lumina. These open in front into a narrow median passage (vas deferens) leading to the genital aperture. Behind they unite together in the middle line, their cavities communicating. The two testes and their connections thus form a kind of ring. The walls of the testes are composed of a mass of minute cells of uniform character. Accessory glands are recognisable as a group of cells about the median vas deferens and its external aperture. In the mature condition it is obvious that the lumina of the testes will act as vesiculae seminales, and their continuation to the median vas deferens as the lateral vasa deferentia.

12. *Conclusion.*

It appears to be almost certain that the nearest relatives of *Astacocroton* are to be looked for among the Hydrachnida; no mite not adapted to aquatic life could conceivably have given origin to a permanent external parasite of an aquatic animal. The marine derivation of such a hypothetical non-parasitic or partly parasitic ancestor is not necessarily excluded. Living alongside *Astacocroton* in the gill-cavity of the crayfish is *Stratiodrilus,* whose only known relative

—and that quite a near one—lives on European lobsters (*Nephrops* and *Homarus*). But structurally the marine Hydrachnid genera—*Pontarachna* and *Nautarachna*—seem less remote than the rest of the marine Acarids—the Halacaridae.

Such cases of parasitism as are known in the Hydrachnids have little analogy with the case of *Astacocroton*. Many of them are cases in which the parasitism is confined to the larval stage. In the case of various species of *Atax* and of *Naiadicola ingens*, in which the young become parasitic on the gills of fresh-water mussels, the parasitism may be continued to the adult condition. But there is nothing to connect any of these structurally with *Astacocroton*; if that genus is to be set down as a parasitic Hydrachnid, it seems to have no close relationship with any Hydrachnid hitherto known.

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Lettering.

a.c.g. (in fig. 15) supposed anti-coagulin glands; *b.c.* buccal cavity; *br.* bridge; ch_1, ch_2, basal and terminal joints of chelicerae; *ch.m.* muscles running from fulcra to chelicerae; *ch.m.* muscles in basal joint of chelicerae; *co* (in fig. 7) supposed anti-coagulin gland; *d.* duct of dorsal salivary gland; *d.m.* depressor muscle of pharynx; *ent.* enteron; *ex.* excretory organ; *ex. a.* excretory aperture; *cx.* coxal gland; *f.* "fat-body"; *fu.* fulcrum; *g.* pharyngeal gland; *l.n.* lateral nerve (in capitulum); *m.n.* median nerve (in capitulum); *mus.* dorso-ventral muscle eventually inserted into base of capitulum; *ov.* ovary; *pd.* pedipalpi; *pd.m.* muscles to base of pedipalpi; *ph.* pharynx; *pi.* undetermined pigmented body; *r.m.* retractor muscle of chelicera; s_2 reniform salivary gland; *s.r.* salivary receptacle; *u.* uterus.

EXPLANATION OF PLATES XXXVI.-XXXVII.

Plate xxxvi.

Fig. 1. Female; general ventral view ($\times$ 30).

Fig. 2. Ventral view of capitulum and chelicerae ($\times$ 225) with outlines of basal parts of chelicerae, bridge and pharynx seen through the integument; pedipalpi not shown.

Fig. 3. Second podomeres of chelicerae as seen *in situ* slightly separated by pressure and turned in slightly different directions ($\times$ 520).

Figs. 4 and 5. Views of extremity of pedipalpi ($\times$ 525).

Fig. 6. Fourth leg.

Fig. 7. Extremity of leg ($\times$ 525).

Fig. 8. Approximately sagittal section of capitulum ($\times$ 225).

Fig. 9. Transverse section of the capitulum passing through the bridge and the salivary receptacle ($\times$ 225).

Fig. 10. Semi-diagrammatic outline of the nerve-mass, the anti-coagulin gland of the left side, and adjoining parts. The dorsal salivary gland and the main duct are indicated by the broken lines, the main salivary duct by the dotted lines.

Plate xxxvii.

Fig. 11. Transverse sections of capitulum behind the middle part of the bridge ($\times$ 225).

Fig. 12. Similar section a little further back.

Fig. 13. Section of dorsal salivary gland from a transverse series.

Fig. 14. Transverse section of the right enteric caecum and the adjacent median excretory organ. The shaded body in the interior of the former represents the mass of crayfish blood with the channels excavated in it. The details of the boundaries of the cells in this and the two following figures are not given.

Fig. 15. Transverse section of young animal without any full-grown ova and the uterus empty. The blood filling the enteric caeca is not represented: the integument is indicated by a single line. The uterine partition has disappeared in the region represented.

Fig. 16. Similar sections of a mature specimen with the uterus distended with ripe eggs, one only of which is represented ($\times$ 40).

Fig. 17. Portion of a section through the ovary, showing various stages in the development of the stalked ova, the "yolk-nucleus," and its replacement in the largest ovum by the yolk spherules ($\times$ 525).

Fig. 18. Genital aperture, genital suckers and excretory aperture ($\times$ 120).

DESCRIPTION OF A NEW PHASMA BELONGING TO THE GENUS *EXTATOSOMA*.

By Walter W. Froggatt, Government Entomologist.

(Plate xxxviii.)

[Read 30th August, 1922.]

Among the members of the family *Phasmidae* there are many large and curious forms which, both in structure and colouration, are striking examples of protective mimicry.

Those belonging to the genus *Extatosoma* have reached the limit. The females with rudimentary wings are swollen unwieldy creatures. They have the oval head spiny, and the body spined and flanged, the legs are produced into flattened processes, deeply arcuate like the leaves of the English Holly and like some of our brush scrub shrubs. Even the colouration is exaggerated, for besides their uniform deep green colour, the body and legs are often mottled and spotted with greyish-white blotches like the grey lichens so common on the leaves and stems of many coastal shrubs.

Two species have been previously described: the type species *Extatosoma tiaratum* W. S. Macleay, and *E. bufonium* Westwood. Gray, however, going through Hope's collection of Australian insects, found the male and, figuring both sexes, called the male of Macleay's species *Extatosoma hopei*.

Westwood's species, from the description and figure, is apparently an immature female, with the legs very much dilated, and the flanges on the abdominal segments very well developed.

In my "Australian Insects" it is stated that *Extatosoma tiaratum* ranges from Tasmania to New Guinea, but recent investigations prove that the most southern locality where specimens have been obtained is Kiama, N.S. Wales. In answer to my enquiries, Mr. J. A. Kershaw (Curator of the National Museum, Melbourne) informs me that he has no record of its occurrence in Victoria.

While the female is not uncommon in the Gosford and Newcastle scrub country, the male is very rare; probably it is so seldom seen because it has large well developed wings and frequents the tops of the trees. The only two male specimens I have seen are one in our New South Wales Departmental collections, collected over 25 years ago, and a second in the Macleay collection, also a very old specimen.

Though the females are usually deep green, I have had two specimens of them which are of a bright yellow tint, a remarkable colour variation.

EXTATOSOMA ELONGATUM, n.sp. (Plate xxxviii.)

♀. Length from front of head to tip of body 5 inches; ♂ unknown. Colour deep green, lightest on the wing pads; abdomen and legs mottled with dull white and greyish spots. Fine spines on head, thorax, and abdomen reddish-brown. It differs from *Extatosoma tiaratum* in being much more slender in form, and in having the more slender legs with very narrow arcuate flanges or ridges on the femora and tibia, with small lateral flanges on the sides of the first four abdominal segments, and those on the following very much reduced in size; the whole surface is covered with stout spines, thickest on the under surface. The sides and crown of the head thickly covered with sharp pointed spines, with two double spines on the summit. The prothorax covered with similar spines with two double-spined ones on the hind margin; the mesothorax bearing spines on the sides, with three pairs on the dorsal surface, the first pair conical, blunt at apex, with a group of two thickened spines and two single ones in front of the base of the insertion of the tegmina, the metathorax with four parallel rows of smaller spines on the dorsal surface. The legs with the dorsal and lateral edges toothed with short mottled thorn-like spines, the coxae usually bearing shorter stout conical spines, with an odd double spine here and there.

The first three abdominal segments rounded, with a pair of double finger-like spines in the centre of the back and simple spines on either side; below there, standing out is a horny, arcuate, spined, flattened flange. The fifth and sixth segments have a pair of serrate, parallel, erect flanges in the centre of the back and two stout spines; on either side is a large flattened serrate flange in a line with those of the first three segments, about a third larger, and spined in the same manner. The 7th abdominal segment is small, with similar but smaller spines, and the side flanges are turned downwards. The 8th and 9th are small, projecting above the genitalia with similar small spines, and the hind margin of the anal one is fringed with spines. The ventral surface and sides of the abdominal segments are lightly covered with slender reddish-brown spines.

Hab.—Gosford, N.S.W. Found crawling over a brush tree; afterwards kept in a breeding cage for a week when she laid over 100 eggs. There is another ♀ specimen in the Macleay Museum Collections from Camden, N.S. Wales.

EXPLANATION OF PLATE XXXVIII.

Extatosoma elongatum, n.sp. ♀. (x $\frac{3}{4}$).

A NEW SPECIES OF *MORDELLISTENA* (COLEOPTERA, FAM. MORDELLIDAE) PARASITIC ON TERMITES.

By Gerald F. Hill, Townsville, N.Q.

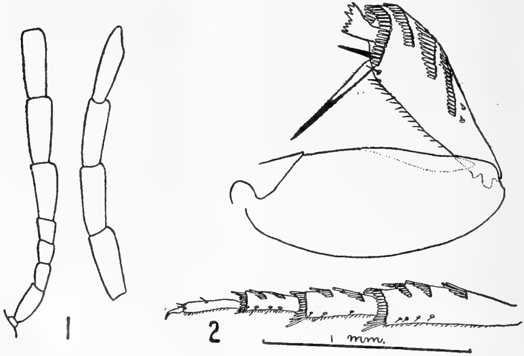
(Two Text-figures.)

[Read 30th August, 1922.]

Mordellistena erythroderes, n.sp. (Text-figs. 1 and 2.)

Black, prothorax, part of pygidium, inner half of hind coxae and spurs to hind tibiae reddish-flavous. Densely clothed with short pubescence, black on the black parts, golden on the red, but silvery on parts of th.. under surface and legs.

Moderately long and thin. Antennae (Text-fig. 1) rather long, extending almost to base of second segment of abdomen. Scutellum small. Pygidium acute but rather short for the genus. Hind-tibiae with longer spur more than 3 times



Text-figs. 1-2. *Mordellistena erythroderes*, n.sp.
1. Antenna. 2. Hind-leg.

the length of the shorter, with three long oblique rows of bluntly-tipped, flattened setae; basal joint of hind tarsi also has three oblique rows of similar setae, second and third with two each (Text-fig. 2). Length 5—5.5 mm.

A rather large species readily distinguished from all other Australian species of the genus by its large size and bright red prothorax; at first glance the specimens look like elongate ones of *Mordella ruficollis* without the elytral markings, but the hind-tibiae and tarsi have the characteristic features of *Mordellistena.*

Type and two co-types in South Australian Museum.

Locality.—North Queensland: Palm Island.

Biology.

The above beetles were bred from a piece of rotten log infested with a recently described species of Termite, *Calotermes* (*Glyptotermes*) *nigrolabrum* Hill (These Proceedings, xlvi., p. 437), which was gathered in a scrub-covered ravine on the southern end of the largest of this group of islands (22/6/21). Larvae and pupae were noticed amongst the termites in the tunnels through the rotten, spongy wood. Specimens of these and other termitophilous insects were secured in the field and a large piece of the log, containing probably several hundred termites, was brought back and placed in a jar for further observation. Beyond keeping the wood moist, no further attention was paid to it until about the 15th July, when the appearance of the alate forms of the termite was expected. On the latter date some of the wood was cut open, exposing only a small colony of termites and one beetle pupa, all of which were returned to the jar with as little disturbance as possible. The first beetle emerged on the 20th August and the others on or about 27th August. Unfortunately it was not discovered until too late that the tube containing larval and pupal stages had been lost. As the termite and its enemy are probably both fairly common in certain localities on the island it is hoped to secure further material for description at an early date.

I am greatly indebted to Mr. A. M. Lea for the examination of, and expressions of opinion upon, this interesting insect.

As a beneficial insect, the species described above is hardly likely to prove of any practical value unless it could be established in the colonies of some of the more destructive species of Termites. Its present only known host is not now, nor is it likely to become in the future, of any economic importance; moreover, the habits of this and allied species of Termites are so entirely different from those of, say, *Mastotermes darwiniensis, Rhinotermes* spp., *Coptotermes* spp. and other injurious species, that it seems improbable that a parasite of the former could ever become a factor in controlling the latter.

REVISION OF AUSTRALIAN *LEPIDOPTERA*.

Saturniadae, Bombycidae, Eupterotidae, Notodontidae.

By A. Jefferis Turner, M.D., F.E.S.

[Read 30th August, 1922.]

In this instalment a few additions are made to the families previously dealt with, and four families, three of which have very few Australian representatives, are subjected to revision. So far we have been dealing with families which I ascribe to the group Noctuoidea, though the Anthelidae are an aberrant family in the group, but we now proceed to widely divergent groups. The Saturniadae (in which I include the Ceratocampidae) are derived by specialisation, especially by the loss of two veins in the forewing, from the same stem as the Bombycidae, and for them we may form the group Bombycoidea. To this also we refer the Neotropical Sematuridae, very similar to the Saturniadae in the neuration of the forewings, but peculiar in the neuration and tailing of the hindwings, and with strong tongue, long palpi, filiform antennae, and short, doubtfully functional frenulum. I think the Lemoniadae and Brahmaeidae, which should perhaps be merged into one family, are also Bombycoidea. The essential character of the group is, I think, the small cell, invariable absence of an areole, and long-stalking of vein 10. I conceive that the absence of an areole is indicated in the pupal tracheation by the distal position of the fork 9, 10, and that this will distinguish the group from the Notodontoidea; but this remains to be proved.

The Eupterotidae should also, I think, be referred to the Bombycoidea. From what material I have been able to examine, this conclusion appears natural and, though the forewing neuration of *Gangarides*, as described by Hampson (Moths Ind., i., p. 42), is anomalous, it is evident that the structure he describes cannot be a true areole.

The Notodontoidea have the areole present in all primitive genera, and vein 5 of the forewing from the middle or above the middle of the cell, that is to say, the second branch of the *media* either retains its original position, or is annexed by the *radius*, never by the *cubitus*. In the latter respect it agrees with the Bombycoidea. It consists of the geometriform families, which constitute a separate tribe, the Geometrites, the Notodontidae, Cymatophoridae, probably the Sphingidae, and possibly other families.

Fam. LIPARIDAE.

Gen. ACYPHAS.

Veins 3 and 4 of hindwings may be separate, connate, or stalked.

EUPROCTIS STENOMORPHA.

The description of ♂ should be amended as follows,—an orange streak on dorsum from base to one-third; an inwardly oblique orange-ochreous fascia beyond middle not quite reaching costa, dilated beneath costa, interrupted in middle, dilated into a smaller spot on dorsum; an indistinct suffused subterminal line on lower two-thirds. A ♀ from Coll. Lyell differs as follows.—40 mm. Forewings pale ochreous-fuscous; dorsal edge with very long hairs; no basal dorsal streak; fascia reduced to a round whitish-ochreous spot beneath costa and a much smaller spot on mid-dorsum. Hindwings pale-fuscous; base and cilia pale-ochreous.

ENOME PELOSPILA.

Lymantria lutescens, Auriv., Arkiv f. Zool., Stockholm, xiii., 1920, p. 26, T.i., f. 3, N.W. Aust.: Broome.

The excellent figures given of this and the following species are easily recognised.

LYMANTRIA NEPHROGRAPHA.

Lymantria mjõbergi, Auriv., Arkiv f. Zool., xiii., 1920, p. 26, T.i., f.l.

Fam. ANTHELIDAE.

Gen. CHENUALA.

Chenuala, Swin., Cat. Oxf. Mus., i., 1892, p. 212.

Closely allied to *Anthela* from which it differs only in the ♂ frenulum being weakly developed, with the retinaculum very near the base of the forewing, and in the elongation of the tornal area of the hindwing.

CHENUALA HELIASPIS.

Ocneria heliaspis, Meyr., Trans. Roy. Soc. S. Aust., 1891, p. 192.—*Chenuala rufa*, Swin., Cat. Oxf. Mus., i., 1892, p. 212.

♂. 52-58 mm. Head and palpi brownish or grey. Antennae fuscous-grey; pectinations in ♂ 10, fuscous. Thorax and abdomen brownish or reddish-brown. Legs brownish or grey. Forewings triangular, costa straight to two-thirds, thence gently arched, apex round-pointed, termen longer than dorsum, strongly sinuate, oblique; reddish-ochreous-brown; markings fuscous; four dentate or crenulate transverse lines more or less distinct; first outwardly-curved from one-fourth costa to one-third dorsum; second shortly beyond and parallel to first; third nearly straight from two-thirds costa to two-thirds dorsum; fourth similar, subterminal; a dark-fuscous discal dot beneath midcosta; cilia brownish or fuscous. Hindwings with dorsum elongate, tornus prominent, rounded, apex obtusely rounded, termen nearly straight; orange-red; a fuscous discal dot at one-fourth; a dentate subterminal fuscous line from dorsum, lost in disc; traces of a similar line preceding this; a grey tornal blotch; cilia ochreous. Underside pale orange-red; markings similar, but forewings with an additional discal dot at one-fourth.

♀. 62-76 mm. Head, thorax, abdomen, and wings whitish-grey. Forewings with termen not sinuate; hindwings with tornus less prominent; markings as in ♂. but less defined.

N.S.W.: Newcastle. Vict.: Melbourne, Mansfield, Narrewarren.

Anthela xantharcha.

Darala xantharcha, Meyr., Trans. Roy. Soc. S. Aust., 1891, p. 191.

From a number of pupae sent me by Mr. W. B. Barnard, I have bred out a series of examples which have convinced me that this is a distinct species, and not a local race of *A. magnifica.* It is smaller (♂. 65-68 mm. ♀. 75-90 mm.); the abdomen is reddish-orange on dorsum in both sexes; the post-median line on forewings usually touches the second discal spot; the subterminal lines on both wings have the dentations very deep; the hindwings of ♂ are mostly whitish-yellow.

Qland: Jandowae (a series emerged from the pupae in March and April), Cunnamulla; Vict.: Lake Hattah; S. Aust.: Koolunga; W. Aust.: Beverley.

Anthela magnifica.

Darala magnifica, Luc., Proc. Linn. Soc. N.S.W., 1891, p. 286.—*Anthela tritonea,* Swin., Trans. Ent. Soc., 1903, p. 448.

My description of this species included the preceding, and should be amended as follows:—♂. 86-100 mm. ♀. 92-108 mm. Abdomen in ♂ whitish towards apex on dorsum, never reddish-orange. Forewings of ♀ acute; post-median line well posterior to second median spot; subterminal line moderately dentate. Hindwings of ♂ yellowish near base only; subterminal line in both sexes only slightly dentate.

Qland.: Duaringa; W. Aust.: Beverley, Northam; N.W. Aust.: Derby.

This species has not yet been recorded from the interior, but doubtless will be.

Anthela tetraphrica.

Anthela tetraphrica, Turn., Proc. Linn. Soc. N.S.W., xlvi., 1921, p. 181.

♂. 50 mm. Head dark-fuscous; face pale-ochreous. Palpi dark-fuscous; antennae reddish-brown, pectinations fuscous. Thorax dark-fuscous; tegulae pale-ochreous. Abdomen dark-fuscous, bases of apical segments narrowly whitish. Legs fuscous. Forewings triangular, costa straight, slightly arched towards apex, apex subrectangular, termen bowed, oblique; whitish, densely irrorated with fuscous, median area brownish-tinged; a slightly dentate, outwardly curved line from one-sixth costa to one-fourth dorsum; a similar line from one-third costa, joining preceding on dorsum; between these a small circular, brownish, subcostal spot, outlined with dark-fuscous; a similar spot beneath mid-costa; a dark-fuscous, nearly straight line from two-thirds costa to three-fourths dorsum, followed by a brownish line, and this by a very broad dark-fuscous line, which is edged posteriorly by whitish; cilia whitish mixed with fuscous. Hindwings with termen rounded; whitish unevenly irrorated with fuscous; a fuscous discal spot at one-third; median and post-median transverse fuscous lines, the latter very distinct, and followed by two suffused whitish lines. Underside grey; a fuscous post-median line on both wings; two discal spots on forewing, one on hindwing, the last with whitish centre.

More brightly coloured and with darker markings than the ♀ type. One ♂ collected on the Barclay Expedition to Central Australia by Mr. G. F. Hill at Bullocky Flat, near the border line in March; now in National Museum, Melbourne.

ANTHELA CALLILEUCA, n.sp.

καλλιλευκος, beautifully white.

♂. 40 mm. ♀. 54 mm. Head fuscous; face and palpi ochreous-brown. Antennae rosy, towards apex grey, pectinations fuscous. Thorax white. Abdomen dark-ochreous, tuft, sides, and underside pale-yellow. Legs rosy. Forewings triangular, costa in ♂ straight, in ♀ gently arched, apex pointed, termen slightly bowed, slightly oblique; white; moderate, circular, discal spots beneath costa at one-fourth and middle, ochreous edged with blackish; a short, inwardly-oblique, fuscous, subapical streak from costa; cilia white. Hindwings with termen gently rounded; white; sometimes a fuscous subapical costal spot; cilia white, in ♂ pale-yellow on dorsum. Underside similar, but discal spots on forewing fuscous and small; two fuscous discal dots on hindwing, and sometimes a suffused straight fuscous line from costa just before apex to tornus.

Qland.: Emerald, in January and February; two specimens received from Mr. W. B. Barnard. Clermont, in January; one specimen received from Mr. E. J. Dumigan.

ANTHELA XANTHOCERA, n.sp.

ξανθοκερος, yellow-horned.

♂. 50 mm. ♀. 66 mm. Head whitish or pale purple-grey; face with a transverse fuscous line on upper margin. Palpi fuscous, whitish beneath. Antennae yellow or orange; pectinations in ♂ 6, in ♀ 2. Thorax and abdomen whitish, more or less tinged with purple-grey. Legs grey-whitish; apices of middle and posterior femora with a white spot, edged with blackish, on inner side. Forewings triangular, in ♀ more elongate, costa very slightly arched, apex pointed, in ♀ acute and produced, termen rounded, oblique, in ♀ strongly sinuate; pale purple-grey; two white discal dots edged with fuscous; cilia yellow, in ♀ fuscous. Hindwings broader in ♀, termen rounded; colour and cilia as forewings; a subterminal series of dots, or a dentate subterminal line, fuscous. Underside grey with two fuscous discal dots on forewing; hindwing with a very short transverse fuscous mark on dorsum before tornus.

Allied to *A. acuta* Wlk., but entirely devoid of markings except discal dots on forewings.

Qland.: Jandowae, in March; two specimens from larvae found by Mrs. Hobler.

ANTHELA BARNARDI, n.sp.

♀. 42-50 mm. Head, palpi, antennae, thorax, abdomen, and legs pale-brown. Forewings triangular, costa straight, apex acute, termen strongly sinuate, slightly oblique; pale-brown; markings dark-brown; an outwardly curved line from one-sixth costa to one-sixth dorsum; a less curved line from one-third costa to one-third dorsum; a small transverse discal mark beneath mid-costa; a broad sinuate line from two-thirds costa to mid-dorsum, anteriorly sharply defined, posteriorly suffused and merging into a moderately broad, brown transverse fascia, which is limited by a slender darker line from three-fourths costa to three-fourths dorsum; a narrow terminal fascia, less distinct toward tornus, its anterior edge slightly crenulate; cilia pale-brown. Hindwings with termen rounded; colour and markings as forewings except that there is only one ante-median line, and no terminal fascia. Underside similar, but with no ante-median lines, and with two discal dots on each wing.

A fine and distinct species, which I have much pleasure in dedicating to Mr. W. B. Barnard, from whom I first received it. A second ♀ example received from Mr. E. J. Dumigan is smaller; median and terminal fasciae paler, the former edged posteriorly and the latter anteriorly by whitish lines; antemedian lines broadly suffused and partly confluent.

Qland: Duaringa, Blackbutt; two specimens.

Fam. SATURNIADAE.

Tongue absent. Labial palpi short or obsolete. Antennae very short (one-fourth or less); bipectinate to apex in both sexes with two pairs of pectinations in each segment; in ♂ very broadly pectinate in middle, the pectinations diminishing towards base and apex; in both sexes the pectinations run dorsally and ventrally nearly on the same plane. Tibiae without spurs, or with short, stout, terminal spurs on middle and posterior tibiae, but without median spurs. Frenulum and retinaculum absent; hindwings with a basal costal expansion. Forewings with anal vein shortly furcate at base; 1 absent, 5 from upper angle of cell, 6 from before angle, 8, 9, 10 coincident, 7, 9, 11 stalked, or 7, 9 stalked and 11 arising separately from cell; no areole. Hindwings with one anal vein, 1 absent, 5 from upper angle of cell, 6 from costal edge of cell before angle, 7 from far before angle, 11 absent, 12 diverging widely from cell from base.

Hampson (Moths Ind., i., p. 12) makes the two absent veins in the forewing 10 and 11; Meyrick (Brit. Ent., p. 313) makes them 7 and 11. I find that 11 is not absent, for in *Coscinocera, Attacus,* and several American and African genera it arises separately from the cell; and though it is possible that this vein may be 10 and 11 conjoined, it seems improbable. Similarly, though 7 and 8 may have fused together, I think the fusion is of 8, 9, and 10, any two of which may be regarded as absent. In *Attacus,* vein 10 is sometimes indicated, separating just before the apex as figured by Hampson (Moths Ind., i., p. 15); in this figure, vein 11, which is strongly developed, has been unaccountably omitted. Hampson incorrectly states that the tibial spurs are always absent. The antennal pectinations usually arise from the bases and apices of the segments and are in two rows; but in *Coscinocera* and *Attacus* they are arranged in four rows.

Some American genera have been regarded as forming a distinct family, the *Ceratocampidae* (or *Syssphingidae*). For this I can see no justification. I have examined examples of the genera *Citheronia* and *Eacles* and they differ in no way from the definition of the family, except that a very weakly developed tongue can be detected. In the tibial spurs there is no difference. Even if some genera have a strong tongue, it would only entail a slight broadening of the family definition.

1. Forewings with 7, 9, 11 stalked	1.	*Antheraea.*
Forewings with 11 arising separately from cell		2.
2. Hindwings produced into a long tornal process containing the anal vein and veins 2 and 3	2.	*Coscinocera.*
Hindwings with tornus not produced	3.	*Attacus.*

Gen. 1. ANTHERAEA.

Antheraea, Hb., Verz., p. 152; Hmps., Moth Ind., i., p. 18.

Palpi short. Middle and posterior tibiae with very short, stout, terminal spurs only. Tarsi hairy. Forewings with 2 from shortly beyond middle, 3 from shortly before angle, 4 from angle, 5 from upper angle, 6 from shortly before angle, 7, 9, 11 stalked, 11 separating near apex. Hindwings with 2 from three-fourths, 3 from before angle, 5 from upper angle, 6 from shortly before angle, 7 from four-fifths.

Type, *A. paphia* Lin. from India. The genus *Saturnia* Lin. is closely allied, apparently differing only in the naked tarsi.

1.	Ocelli of both wings small and mostly hyaline	*janetta.*
	Ocelli of both wings moderate, hyaline centre dot-like or vestigial	2.
2.	Forewings without rosy patch at apex	*astrophela.*
	Forewings with rosy patch at apex	3.
3.	Forewings without ante-median line	4.
	Forewings with ante-median line indicated	5.
4.	Anterior edge of thorax broadly fuscous	*loranthi.*
	Anterior edge of thorax not fuscous	*engaea.*
5.	Forewings with a triangular, whitish, subcostal mark before middle	*eucalypti.*
	Forewings without whitish triangle	*helena.*

1. Antheraea janetta.

Saturnia janetta, White, Ann. Mag. Nat. Hist., xii., 1843, p. 344.—*S. melvilla,* Westw., Proc. Zool. Soc., 1853, p. 166.—*Antheraea purpurascens,* Wlk., Cat. Brit. Mus., xxviii., p. 528.—*A. insignis,* Wlk., *ib.*, p. 529.—*A. disjuncta,* Wlk., *ib.*, p. 529.

♂. 100-120 mm. Head and palpi yellow, brown, or grey-brown. Antennae ochreous. Thorax yellow, brown, or grey; a broad transverse anterior whitish line mixed with brownish. Abdomen and legs yellow, brown, or grey. Forewings broadly triangular, slightly falcate, costa straight to two-thirds, thence very strongly arched, apex rounded, produced, termen strongly sinuate, slightly oblique; usually bright-yellow, more or less suffused in centre of disc with brown, sometimes wholly brown or dark-grey; basal half of costa broadly suffused with whitish; three dark-grey or brown transverse lines more or less distinct; first from one-third costa, at first transverse, then abruptly bent inwards so as to approach costa at one-sixth, forming a rounded angle, from which it proceeds outwards, and after several dentations reaches dorsum at one-fourth; second from five-sixths costa to three-fifths dorsum, crenate; third from near apex to three-fourths dorsum, slightly wavy; a small, circular, hyaline, discal ocellus, margined with whitish, at two-thirds; sometimes a dark line on or near termen; cilia concolorous. Hindwings with termen rounded; colour as forewings; first line at one-third; wavy; a median discal spot; second line at two-thirds, crenate; third line represented by a series of spots.

♀. 120-160 mm. Forewing not falcate, termen nearly straight; colour and markings similar.

N. Aust.: Darwin, Melville Is.; N. Qland: Thursday Is., Cape York, Bloomfield River, Dunk Is., Herberton, Ingham, Townsville; Qland: Rockhampton, Brisbane, Coolangatta, Toowoomba; N.S.W.: Lismore.

2. Antheraea astrophela.

Antheraea astrophela, Wlk., Cat. Brit. Mus., v., p. 1255.—*A. simplex,* Wlk., *ib.*, p. 1256.—*Opodiphthera varicolor,* Wlgrn., Wien Ent. Mon., iv., 1860, p. 167.

♂. 90-105 mm. ♀. 100-115 mm. Head yellow, orange, brown, or reddish.

Palpi fuscous. Antennae ochreous-brown. Thorax yellow, orange, brown, or reddish; anteriorly with a broad, sharply defined, transverse band, fuscous mixed with whitish. Abdomen and legs yellow, orange, brown, or reddish. Forewings triangular, costa straight to two-thirds, thence moderately arched, apex rounded-rectangular, termen nearly straight or slightly sinuate, oblique; yellow, orange, brown or reddish; a moderate, circular ocellus about middle, orange, edged anteriorly first with whitish, then with brown, edged posteriorly with fuscous, with a central, fine, hyaline or thinly-scaled, transverse streak; a broad costal streak from base to about five-sixths, fuscous mixed with whitish; a fuscous line from one-fifth costa, at first transverse, then sharply bent inwards and inwardly-curved to one-fourth dorsum; an oblique fuscous line from costa before apex to mid-dorsum, nearly straight, edged posteriorly with whitish irroration; cilia concolorous. Hindwings with termen rounded; colour and ocellus as forewings; a transverse line at three-fourths parallel to termen.

The ♂ varies in colour; it is most commonly yellow, but may be orange, brown, or reddish; the ♀ is uniformly brown.

Qland: Mt. Tambourine, Rosewood, Kingaroy, Killarney; N.S.W.: Tweed River.

3. Antheraea loranthi.

Antheraea loranthi, Luc., Proc. Linn. Soc. N.S.W., 1891, p. 292.

♂. 120-145 mm. ♀. 150-155 mm. Head and palpi reddish or orange-reddish. Antennae brownish. Thorax reddish or orange-reddish; anterior edge broadly fuscous. Abdomen and legs reddish or orange-reddish. Forewings triangular, costa straight to two-thirds, thence strongly arched, apex rounded, termen more or less sinuate, oblique; reddish or orange-reddish; a moderate or rather large, circular, discal ocellus slightly beyond middle; dark-red, edged anteriorly broadly with whitish, and then again with dark-red, edged posteriorly narrowly with whitish and then with blackish, a fine, transverse, central streak hyaline or thinly-scaled; a broad, fuscous, costal streak from base to about five-sixths; a blackish subcostal spot surrounded by whitish suffusion before apex, from which proceeds a broadly suffused fuscous line to two-thirds dorsum; a suffused rosy patch at apex; cilia concolorous. Hindwings with termen rounded; colour and ocellus as forewings; a faintly-marked fuscous line at three-fourths parallel to termen.

N. Qland: Herberton, Townsville; Qland: Duaringa, Gayndah, Brisbane.

The larvae feed gregariously on *Loranthus,* usually high on *Eucalyptus* trees, and pupate in a mass on the butt of the *Loranthus.*

4. Antheraea engaea, n.sp.

ἔγγαιος, inland.

♂. 90 mm. ♀. 95-110 mm. Differs from *A. loranthi* as follows:—Size much smaller; colour pale ochreous-yellow; wings rather thinly scaled; thorax not fuscous anteriorly; a broadly suffused fuscous band from beneath costa near apex to termen, on which it is expanded to reach middle or before middle; a broadly suffused post-median band on hindwing immediately beyond ocellus.

This may be no more than an inland race of the preceding modified by arid conditions; but I propose to regard it as distinct until intermediate forms have been proved to occur. I am informed that this species also feeds on *Loranthus,* but pupates singly, not in a mass.

Qland: Jandowae, in March; two specimens bred by Mrs. Hobler. Charleville, in September and December; two specimens.

5. Antheraea eucalypti.

Antheraea eucalypti, Scott, Aust. Lep., i., 1864, Pl. i.

♂. 110-120 mm. ♀. 120-140 mm. Head and palpi reddish or brown. Antennae brownish. Thorax reddish or greyish-brown; anterior third whitish mixed, or posteriorly edged, with fuscous. Abdomen reddish or greyish-brown. Legs reddish or brown. Forewings triangular, in ♂ strongly falcate, costa straight to four-fifths, thence strongly arched, apex rounded, termen very strongly sinuate in ♂, nearly straight in ♀; reddish, brown, or greyish; a moderate circular ocellus slightly beyond middle, reddish, edged anteriorly first with whitish, then with dark-reddish, posteriorly first with pale-yellow, then with dark-reddish or fuscous, a central hyaline dot; a broad costal streak to about five-sixths, whitish mixed with fuscous; a fine, transverse, reddish line from near base of dorsum, not reaching costa, edged anteriorly with whitish, in ♀ nearly obsolete; a small, white, subcostal triangle at one-fourth edged posteriorly with dark-reddish; a suffused rosy apical patch, preceded by a blackish subcostal spot in a patch of whitish suffusion; a faint dark-reddish or fuscous line from three-fifths dorsum obliquely outwards, passing closely posterior to ocellus, but not reaching costa; terminal edge and cilia ochreous-grey, sometimes edged with orange. Hindwings with termen rounded; colour as forewings; ocellus as forewings but orange and larger, broadly margined with blackish, anteriorly with a narrow whitish lunule within the margin; a reddish or fuscous obliquely transverse line at one-fourth; a similar subterminal line from costa, curved at first parallel to termen, then straight to three-fourths dorsum; cilia as forewings, but with a broad submarginal orange line.

N. Qland: Herberton; Qland: Brisbane, Toowoomba; N.S.W.: Sydney; Vict.: Melbourne, Gisborne; Tas.—

6. Antheraea helena.

Saturnia helena, White, Ann. Mag. Nat. Hist., xii., 1843, p. 344.—*Antheraea intermedia,* Luc., Proc. Linn. Soc. N.S.W., 1889, p. 1091.

♂. 130-160 mm. ♀. 170 mm. Head and palpi reddish-brown. Antennae brownish. Thorax ochreous-brown; anterior third grey-whitish. Abdomen ochreous-brown. Legs brown. Forewings triangular, in ♂ slightly falcate, costa straight to two-thirds, thence arched, apex rounded, termen in ♂ sinuate, in ♀ nearly straight, oblique; ochreous-brown; costa broadly suffused with grey-whitish to two-thirds; a moderate ocellus beyond middle, reddish, edged anteriorly with whitish, posteriorly with yellow, the whole margined with dark-red or fuscous, a central hyaline dot; ante-median line often indistinct, reddish, from one-fourth costa, sharply bent inwards in disc, and again transverse to dorsum; an oblique line from two-thirds dorsum proceeding well posterior to ocellus, not reaching costa, reddish edged posteriorly with ochreous-whitish; a small, suffused, rosy apical patch, preceded by a blackish subcostal spot surrounded by whitish suffusion; terminal edge and cilia pale-yellowish. Hindwings with termen very slightly rounded; colour as forewings; ocellus larger than in forewings, orange, broadly margined with blackish, with a slender, whitish, anterior lunule inside margin; ante-median line near base, oblique; post-median at five-sixths, nearly parallel to termen.

Qland: Brisbane; N.S.W.: Newcastle, Sydney; Vict.: Melbourne, Dronin, Gisborne; Tas.: ————; W. Aust.: Perth.

Gen. 2. COSCINOCERA.

Coscinocera, Butl., Proc. Zool. Soc., 1879, p. 163.

Frons convex, hairy. Palpi minute. Tibiae without spurs; tarsi hairy, dilated at apex. Forewings with a discal hyaline patch; disco-cellulars absent, leaving cell open; 7 and 9 stalked, 11 arising separately. Hindwings with discal hyaline patch; disco-cellulars absent; tornal area produced forming in ♀ a short, broad, quadrate process, in ♂ a long narrow process dilated at apex, in length equal to rest of wing; in both sexes this process contains the anal vein, and veins 2 and 3.

Differs from *Attacus* only in the conformation of the hindwings.

7. COSCINOCERA HERCULES.

Attacus hercules, Miskin, Trans. Ent. Soc., 1876, p. 7.—*Coscinocera omphale,* Butl., Proc. Zool. Soc., 1879, p. 164.

♂. 105 mm. Head brown, with white spots in front of antennae. Thorax brown; on posterior margin mostly white. Abdomen brown with white transverse lines at base and before apex, and longitudinal lateral white lines. Legs brown; coxae and femora partly white. Forewings triangular, costa straight to two-thirds, thence strongly arched, apex rounded, slightly produced, termen strongly sinuate, oblique, wavy; brown, towards base and costa irrorated with white; an outwardly oblique white line from dorsum near base to middle of disc; a triangular discal hyaline patch, its basal side convex, its apical acutely pointed, surrounded by ochreous-brown, which is edged with blackish, and preceded at some distance by a white lunule; a line from two-thirds costa to three-fourths dorsum, slightly bent inwards on costa, slightly incurved in disc, whitish, sometimes interrupted, anteriorly edged with fuscous; a band of white irroration succeeds this; a large subapical blotch partly rosy, partly white, and on costa partly fuscous; cilia brown. Hindwings with termen straight, strongly oblique, wavy, tornus immensely produced in a long, rather slender, apically dilated process, colour as forewings; a wavy transverse line at one-fourth, white edged posteriorly with fuscous; discal hyaline patch as forewings, but sub-triangular with rounded angles; post-median line and band of irroration as forewings, but prolonged into tornal process; a coarsely dentate, white, submarginal line in dilated apex of process.

♀. 130 mm. (Some examples are larger). Like ♂ but rather paler; tornal process of hindwing very broad, short, quadrate.

N. Qland: Cairns, Dunk Island. Also from New Guinea and New Ireland.

Gen. 3. ATTACUS.

Attacus, Lin., Syst. Ent., i., pt. 2, p. 808.

Frons convex, hairy. Palpi minute. Tibiae without spurs. Tarsi hairy, dilated at apex. Forewings with a discal hyaline patch; disco-cellulars absent, leaving cell open; 7 and 9 stalked, 11 arising separately. Hindwings with a discal hyaline patch; disco-cellulars absent leaving cell open.

Type, *A. atlas* Lin. from India.

8. ATTACUS DOHERTYI.

Attacus dohertyi, Roths., Nov., Zool., 1895, p. 36.—*A. dohertyi wardi,* Roths., Nov. Zool., 1910, p. 507.

♂. 90-95 mm. ♀. 105 mm. Head and thorax brown. Abdomen brown on dorsum; basal and three apical segments whitish-grey. Legs brown. Forewings triangular, costa straight to middle, thence strongly arched, apex rounded, strongly produced and falcate in ♂, less so in ♀, termen sinuate; brown; basal area and a broad costal strip nearly to apex irrorated with white; a white line, edged anteriorly with reddish purple, from beneath one-fourth costa to near base of dorsum, angled outwardly in disc; a large, central, hyaline, discal patch approximating to semicircular, with convex edge towards costa, outlined with ochreous and then partly with blackish; a sinuate white line, constricted on veins, edged posteriorly with reddish-purple, and followed by a narrow band of white irroration from beneath three-fifths costa to dorsum near tornus; an ochreous subterminal shade broader beneath costa; a narrow, white, subcostal suffusion towards apex limited by a black, subapical, white-edged spot; an ochreous-grey terminal band, containing a fine, irregularly crenate, submarginal line, towards apex reddish-purple and edged with white posteriorly, towards tornus fuscous; cilia ochreous-grey. Hindwings elongate on dorsal half, termen straight, tornus broadly rounded; as forewings, but discal patch subtriangular; disc suffused with reddish-purple; submarginal line reddish-purple, preceded by a series of reddish-purple spots, some of them confluent.

N. Aust.: Port Darwin from December to March (F. P. Dodd). Also from Timor and Flores.

Index to *Saturniadae*.

Genera.

Species.

Synonyms in *italics*.

Fam. BOMBYCIDAE.

Tongue absent. Palpi short or obsolete. Antennae short (less than one-half), bipectinated to apex in both sexes. Tibiae with short terminal spurs concealed by hairs. Frenulum and retinaculum usually weakly developed or absent; hindwings with a basal costal expansion. Forewings with basal fork of anal vein obsolete or nearly so; 1 (1c) present or absent, 5 from middle or above middle of cell, sometimes from upper angle, 7, 8, 9, 10 stalked or 10 absent; cell usually small; areole absent. Hindwings with two anal veins; 1 present or absent, 5 from middle or above middle of cell, or stalked with 6, 12 fused with cell at base, or connected with it near base, thence diverging.

This family, although of small extent, presents considerable variation in structure, some genera having retained primitive characters which are absent in the majority. For instance, *Bombyx mori* has a rudimentary non-functional frenulum in the ♂. Some neotropical genera have a frenulum in both sexes, in the ♂ it is strong and articulates with a well developed retinaculum. In *Bombyx* *mori* vein 11 of hindwings is present, running into 12, and vein 1 of the forewings is distinctly developed in its distal half. In the Indian *Ocinara* and the Australian *Gastridiota* vein 1 is present in both wings.

1. Both wings with vein 1 absent		2.
Both wings with vein 1 present	3.	*Gastridiota.*
2. Both wings with 3 and 4 stalked	1.	*Panacela.*
Both wings with 3 and 4 separate	2.	*Mallodeta.*

Gen. 1. PANACELA.

Panacela, Wlk., Cat. Brit. Mus., v., p. 1156.

Palpi very short and concealed by hairs. Forewings with 1 absent, 3 and 4 stalked, 5 from upper angle of cell, connate or short-stalked with 6, 6, 7, 8, 9 stalked, 10 absent; cell short (about one-fourth). Hindwings with 1 absent, 3 and 4 long-stalked, 5, 6, 7 stalked, 12 fused with upper margin of cell near base, thence diverging; cell short (about one-fourth).

Well characterised by the long-stalking of veins 3 and 4 of both wings. I do not know of any extra-Australian species.

Type, *P. lewinae* Lew.

1. PANACELA LEWINAE.

Clisiocampa lewinae, Lew., Prodr. Ent., 7, 1807, Pl. 6.—*Panacela transiens,* Wlk., Cat. Brit. Mus., v., p. 1156.—*Thaumatopoea lewinii,* H.-Sch., Ausser. Schmet., 1853, f. 510.—*Oreta sobria,* Wlk., *ib.,* v., p. 1168.—*Eriogaster simplex,* Wlk., *ib.,* vi., p. 1473.—*Naprepa pilosa,* Wlk., *ib.,* xxxii., p. 489.—*N. hirta,* Wlk., *ib.,* xxxii., p. 490.—*Trilocha rufescens,* Wlk., *ib.,* xxxii., p. 546.—*Semuta prisca,* Wlk., *ib.,* xxxii., p. 547.

♂. 28-32 mm. Head, antennae, thorax, abdomen, and legs reddish-grey. Forewings triangular, costa straight to three-fourths, thence strongly arched, apex pointed, produced, termen sinuate; reddish-grey; two oblique dark-reddish lines, from one-third and two-thirds costa to one-third and two-thirds dorsum, sometimes replaced by a broad, dark-red, oblique band; a faint, crenulate, subterminal line, fuscous or dark-reddish, sometimes reduced to dots on veins; cilia dark-reddish, becoming reddish-grey towards tornus. Hindwings with termen obtusely bent and prominent in middle; colour as forewings, but lines very indistinct or obsolete; cilia reddish, on dorsum fuscous or dark-reddish with two whitish bars.

♀. 34-42 mm. Forewings with apex not pointed, not produced, termen scarcely sinuate; pale-fuscous, thinly scaled; lines slightly darker, suffused. Hindwings shaped as in ♂; colour as forewings; lines obsolete or very obscurely indicated; dorsal cilia with two obscure whitish bars.

The sexes differ much, but, except for the occurrence of banded forewings in the ♂, there is little variation. The larvae are gregarious and inhabit bag-shaped shelters on *Exocarpus, Tristania* and doubtless other trees.

Qland: Brisbane; N.S.W.: Lismore, Glen Innes, Armidale, Sydney, Bateman's Bay, Gilgai.

2. PANACELA SYNTROPHA, n.sp.

σύντροφος, of the same breed.

♂. 26-28 mm. Head, antennae, thorax, abdomen, and legs reddish-grey. Forewings triangular, costa straight nearly to apex, apex pointed, not produced, termen nearly straight, oblique; reddish-grey; an outwardly curved fuscous line from before mid-costa to before mid-dorsum; post-median and subterminal lines of minute fuscous dots on veins; cilia reddish-grey. Hindwings with termen rounded; reddish-grey; cilia reddish-grey.

♀. 40 mm. Fuscous-grey. Forewings broadly triangular; thinly scaled; lines fuscous, distinct. Hindwings similar but lines fainter.

Differs from *P. lewinae* in shape of forewings, which are not falcate in ♂, and proportionately broader in ♀. The dorsal marginal fuscous and white spots, conspicuous in the ♂ of *lewinae*, are here absent.

N. Qland: Kuranda, near Cairns, in September and December; 3 ♂, 1 ♀ specimens received from Mr. F. P. Dodd.

Gen. 2. Mallodeta, n.g.

μαλλόδετος, woolly.

Palpi obsolete. Forewings with 3 and 4 approximated at origin from lower angle of cell, 5 connate or short-stalked from upper angle, 6, 7, 8, 9 stalked, 10 absent. Hindwings with 3 and 4 separate from lower angle of cell, 5 connate or short-stalked from upper angle, 6, 7 stalked, 12 fused with cell towards base.

3. Mallodeta nyctopa, n.sp.

νυκτωπός, dusky.

♂. 34 mm. Head, thorax, abdomen, and legs fuscous-brown. Antennae pale-ochreous; pectinations 8. Forewings triangular, costa straight to three-fourths, thence strongly arched, apex pointed, slightly produced and falcate, termen strongly sinuate, scarcely oblique; fuscous-brown; a dark-fuscous line from mid-costa to mid-dorsum, nearly straight; a second parallel line from three-fourths costa to three-fourths dorsum; a slender, faintly marked, subterminal line; cilia fuscous-brown. Hindwings with termen rounded; colour, lines, and cilia as forewings, but first line before middle, second at two-thirds; some whitish hairs on dorsum above tornus. Underside similar but paler.

♀. 40-44 mm. Antennal pectinations scarcely exceeding 1. Head, thorax, abdomen, and legs dark-fuscous. Forewings with apex less produced, termen more oblique; dark-fuscous, with scarcely any brownish tinge; rather thinly scaled; lines indistinct. Hindwings similar.

Qland: National Park (3,000 ft.) early in March; one ♂ and 5 ♀ taken at light. On the preceding January 2nd, I took a hairy larva, which pupated, and emerged as a damaged ♀ the same month, the emergence having been probably hastened by the greater heat at the lower elevation of Brisbane.

Gen. 3. Gastridiota, n.g.

γαστρίδιοτος, with small abdomen.

Palpi very short but discernible. Forewings with 1 present, 2 from two-thirds, 3 and 4 approximated at origin or connate from lower angle of cell, 5 from half-way between middle and upper angle, 6 connate or short-stalked from upper angle, 7, 8, 9, 10 stalked, 11 connate or short-stalked. Hindwings with 1 present, 3 and 4 connate or short-stalked from lower angle of cell, 5 from above middle, 6 and 7 short-stalked, 12 approximated and connected with cell near base.

I cannot refer this to *Andraca* Wlk., which it otherwise resembles, because Hampson states (Moths Ind., i., p. 40) that in that genus 1c is absent in both wings.

4. Gastridiota adoxima.

Andraca adoxima, Turn., Trans. Roy. Soc. S. Aust., 1902, p. 184.

♂. 40-42 mm. Head pale-ochreous. Antennae very short (one-sixth), pectinations 12; fuscous. Thorax, abdomen and legs reddish-ochreous or ochreous-grey; anterior margin of thorax sometimes paler. Forewings triangular, rather elongate, costa straight to three-fourths, thence slightly arched, apex round-pointed, termen longer than dorsum, bowed, oblique; reddish-ochreous or ochreous-grey; sometimes a pale-centred, fuscous, discal spot beneath costa slightly before middle; sometimes a suffused fuscous blotch on base of dorsum; sometimes a strongly rounded fuscous line from one-fifth costa to mid-dorsum; a reddish or fuscous line from two-thirds costa, strongly rounded beneath costa, then nearly parallel to termen to four-fifths dorsum; cilia brownish-fuscous. Hindwings with termen obtusely bent in middle; reddish or brownish; apical half of termen broadly pale-ochreous-grey; cilia pale-ochreous-grey, towards tornus reddish or brownish.

The two examples I have before me differ considerably in coloration and distinctness of marking.

Qland: Blackall Range, near Nambour (in Coll. Lyell), Brisbane.

Unrecognised Species.

All species described by Meyrick, Lucas, and Lower under the generic name *Bombyx* are incorrectly so referred, and belong to the *Lasiocampidae*. They will be dealt with under that family.

Index to *Bombycidae*.

Genera.

Species.

Synonyms in *italics*.

Fam. EUPTEROTIDAE.

Tongue absent. Labial palpi short or moderate. Antennae bipectinated to apex in both sexes. Tibial spurs short. Frenulum present or absent. Forewings with cell small, 1 absent, 5 from middle, above middle, or from upper angle of cell, 7, 8, 9 stalked, 10 short or absent. Hindwings with cell short, 1 absent, 5 from middle, above middle, or from upper angle of cell, 12 diverging widely from cell at or near base.

The conception of this family has been obscured by the inclusion with it of the *Cnethocampa* group. By their removal, it is left with only two Australian genera represented by three species. Hampson records some forty species in his Moths of India. In his key to the families of the Lepidoptera (Nov. Zool., 1918, p. 388) the *Eupterotidae* are differentiated from the *Notodontidae* by the absence of vein 9. This seems to me an unsatisfactory character, and is not strictly correct, as vein 10 separates from 9 in the genus *Cotana*. The best distinction lies in the structure of vein 12 of the hindwings; and, as already explained, I do not consider the two families to be of allied origin.

1. Forewings with 11 connected by a bar with 9, 10 towards apex 1. *Cotana.*
   Forewings with 11 free .. .. 2. *Eupterote.*

Gen. 1. Cotana.

Cotana, Wlk., Cat. Brit. Mus., xxxii., p. 548.

Frenulum and retinaculum present, but rather weakly developed. Posterior tibiae without median spurs. Forewings with cell very short (about one-fourth); 2 from middle, 3 and 4 separate, 5 from upper angle, 6, 7, 8, 9, 10 stalked, 10 separating near margin, 11 connected by a bar with 9, 10 at two-thirds of wing, and thence closely approximated. Hindwings with cell very short (less than one-fourth), 5 from upper angle of cell, connate or stalked with 6, 7, 8 diverging from cell near base.

A peculiar and isolated genus; the structure of vein 11 of the forewing is unique. The sexes differ so remarkably that it is impossible to correlate them by mere inspection.

Type, *C. rubrescens* Wlk. from New Guinea.

1. Cotana serranotata.

♀ *Darala serranotata,* Luc., Proc. Linn. Soc. N.S.W., 1893, p. 138.—♀ *Hypercydas calliloma,* Turn., Trans. Roy. Soc. S. Aust., 1903, p. 23.

♂. 46-50 mm. Head, palpi, and thorax dark-ochreous-brown. Antennae ochreous-brown; pectinations in ♂ 6. Abdomen and legs orange. Forewings triangular, costa straight to beyond middle, thence gently arched, apex rounded termen slightly bowed, slightly oblique; pale ochreous-brown, towards base suffused with whitish-ochreous; sometimes a pale-centred discal dot at one-fourth; a brown line from mid-costa to dorsum before middle, slightly sinuate, variable in breadth; a more oblique, faintly-marked, outwardly-bowed line from three-fourths costa to dorsum beyond middle, succeeded by two slender, finely crenulate lines; cilia brownish. Hindwings with termen rounded, orange-ochreous; sometimes with several faint, transverse, fuscous lines, of which the subterminal is crenulate; cilia brownish.

♀. 60-75 mm. This sex has been sufficiently described.

N. Aust.: Melville Is.; N. Qland: Cape York, Claudie River, Coen River, Cairns, Dunk Is.

According to Lord Rothschild not from New Guinea.

2. Cotana neurina, n.sp.

νευρινος, with nervures.

♀. 62 mm. Head and thorax pale ochreous-brown. Palpi very short; fuscous. Antennae in ♀ simple, apical third very shortly pectinate; fuscous, towards base pale ochreous-brown. Abdomen reddish-brown; apical segment grey-whitish. Legs reddish-brown; tibiae and tarsi fuscous. Forewings broadly triangular, costa moderately arched, apex rounded, termen bowed, oblique; fuscous-brown; veins slenderly outlined with pale-ochreous; basal third partly covered with pale ochreous-brown hairs, which form a broad costal streak extending to middle, dilated at extremity; a circular pale-ochreous spot in cell beneath one-fourth costa; a coarse, strongly-dentate, pale-ochreous, subterminal line; slightly darker transverse shades across disc before middle, and along termen; cilia ochreous, apices fuscous-brown except at apex and towards tornus. Hindwings with termen rounded, somewhat bent between veins 4 and 5; as forewings but without discal spot. Underside similar.

This is near Bethune-Baker's *C. doricrana* (Nov. Zool., 1908, p. 175), and I cannot be sure that it is not the other sex of one of the Papuan species of which only the ♂ is known.

Type in National Museum, Melbourne.

N. Qland: Claudie River in January; one specimen taken at light by Mr. J. A. Kershaw.

Gen. 2. EUPTEROTE.

Eupterote, Hb., Verz., p. 187; Hmps., Moths Ind., i., p. 54.

Palpi short, porrect. Posterior tibiae without median spurs. Frenulum and retinaculum absent. Forewings with 5 from above middle, sometimes from near upper angle, 6 from angle, 7, 8, 9 stalked, or 6, 7, 8, 9 stalked, 10 absent. Hindwings with 3 and 4 separate, 5, 6, 7 separate but approximated at origin, 12 moderately well separated from cell, somewhat approaching it in middle.

Type, *E. fabia* Cram. from India.

3. EUPTEROTE EXPANSA.

Darala expansa, Luc., Proc. Linn. Soc. N.S.W., 1891, p. 286.—*Eupterote doddi*, Turn., Ann. Qland. Mus., x., 1911, p. 132.

This species, which varies considerably in colour, has been sufficiently described.

N. Qland: Kuranda near Cairns, Evelyn Scrub near Herberton. The locality Dawson River given by Lucas is an error.

Index to *Eupterotidae*.

Genera.

Species.

Synonyms in *italics*.

Fam. NOTODONTIDAE.

Tongue present or absent. Labial palpi developed or obsolete. Maxillary palpi obsolete. Forewings with areole present or absent; 5 from above middle of cell. Hindwings with two anal veins, 5 from middle of cell, usually weakly developed, rarely absent, 12 approximated and sometimes connected with cell at one-fourth or middle, usually approximated till towards end of cell.

Since my former revision (These Proceedings, 1903, p. 42) this family has been considerably enlarged by the inclusion of the *Cnethocampinae*. Apart from these the number of new additions is not large.

Subfam. CNETHOCAMPINAE.

Tongue absent. Labial palpi obsolete, or rarely present but small. Antennae of ♂ and usually also of ♀ pectinate to apex. Abdomen with a large apical tuft in both sexes, especially developed in ♀. Forewings with or without areole. Hindwings with 12 approximated, connected, or anastomosing with cell at one-fourth, occasionally approximated to or beyond middle.

A small group which diverged early from the *Notodontinae.* It is easily recognised by the combination of characters given, but with the doubtful exception of the abdominal tuft, none of these is by itself absolutely distinctive, hence it cannot be maintained as a distinct family. The typical genus *Cnethocampa* ranges from Europe to India. *C. processiona* Lin. has remarkable larval habits, which have been the subject of some classical observations by Fabre. The larvae of *Ochrogaster contraria* form similar "processions." There is another Indian genus, *Gazalina* Wlk., and several African genera. When the insect fauna of the ancient "Austral Land," now represented by Western Australia, became isolated, it contained species of this group, and these have since spread to the east, so that they are now found in all parts of Australia, in which the subfamily is unusually well represented.

1. Hindwings with 12 approximated to cell as far as or beyond middle		2.
Hindwings with 12 diverging from cell at about one-fourth		4.
2. Areole absent	3.	*Epicoma.*
Areole present		3.
3. Areole small, 10 connate or stalked with 7, 8, 9	8.	*Cynosarga.*
Areole large, 10 separate	9.	*Oenosanda.*
4. Areole absent		5.
Areole present		6.
5. Hindwings with 12 anastomosing with cell	1.	*Trichetra.*
Hindwings with 12 not anastomosing	2.	*Axiocleta.*
6. Areole moderate, 7 arising from it separately		7.
Areole small, 7 stalked with 8, 9		8.
7. Forewings with 10 connate or stalked with 8, 9; hindwings with cell two-thirds	4.	*Tanystola.*
Forewings with 10 separate; hindwings with cell not exceeding three-fifths	5.	*Sthenadelpha.*
8. Palpi obsolete	6.	*Ochrogaster.*
Palpi short, porrect	7	*Teara.*

Gen. 1. TRICHETRA.

Arcturus, Curtis, Brit. Ent., 336 (*praeocc.*).—*Trichetra,* Westw., Ins., ii., 1840, Generic Synopsis, p. 92.

Palpi obsolete. Patagia long, reaching beyond thorax. Abdominal tuft in ♂ very long. Posterior tibiae with terminal spurs very short, middle spurs absent. Forewings with 5 from middle of cell, 6 from upper angle, 7, 8, 9, 10 stalked, areole absent. Hindwings with 3 and 4 separate, 5 from slightly above middle of cell, 6 and 7 stalked, 12 anastomosing with cell at about one-third.

1. TRICHETRA SPARSHALII.

Arcturus sparshalii, Curtis, Brit. Ent., 336.—*Trichetra mesomelas,* Wlk., Cat. Brit. Mus., iv., p. 845.—*T. stibosma,* Butl., Cist. Ent., ii., 1877, p. 204.—*T. fraterna,* Butl., *ibid.,* p. 204.

♂. 40-50 mm. Head white or grey; face often ochreous-tinged, lateral margins usually fuscous. Antennae white or grey; pectinations ochreous-tinged. Thorax white or grey, sometimes blackish in centre. Abdomen white, sometimes blackish or grey on dorsum; tuft white or whitish-grey. Legs white; anterior pair usually fuscous. Forewings narrowly triangular, costa straight to two-thirds, thence arched, apex rounded, termen slightly bowed, rather strongly oblique; white or grey; cilia concolorous. Hindwings with termen rounded; colour as forewings.

♀. 45-58 mm. Differs in having thorax always fuscous or blackish, except outer half of patagia which is white or grey. Abdomen white or blackish; tuft pale-ochreous or fuscous.

Though my material is scanty, it is sufficient to show the presence of geographical variation. Queensland ♂ examples are wholly white; those from Hobart grey with blackish abdomen and centre of thorax; in Gisborne both forms occur, and also intermediates.

N. Qland: Cairns, Herberton, Townsville; Qland: Nambour, Brisbane, Mt. Tambourine, Toowoomba; N.S.W.: Sydney, Bulli; Vict.: Melbourne, Gisborne, Bairnsdale, Birchip; Tas.: Launceston, Hobart; S. Aust.: Mt. Gambier, Adelaide, Mt. Lofty, Waterloo, Wolseley; W. Aust.: Perth.

Gen. 2. AXIOCLETA.

Axiocleta, Turn., Ann. Qland. Mus., x., 1911, p. 133.

Palpi small but distinct. Patagia long, reaching beyond thorax. Abdominal tuft in ♂ short. Tibial spurs long; posterior tibiae with both middle and terminal spurs. Forewings with 5 from middle of cell, 6 from upper angle, 7, 8, 9, 10 stalked, areole absent. Hindwings with 3 and 4 separate, 5 from slightly above middle, 6 and 7 stalked, 12 approximated to cell at about one-fourth, thence diverging.

Only the one species is known.

2. AXIOCLETA PERISEMA.

Axiocleta perisema, Turn., Ann. Qland. Mus., x., 1911, p. 134.

N. Qland: Herberton.

Gen. 3. EPICOMA.

Epicoma, Hb., Verz., p. 160.

Palpi obsolete. Posterior tibiae without middle spurs. Forewings with 5 from middle of cell, 6 from upper angle, 7, 8, 9, 10 stalked, or 10 absent, no areole, 11 usually from shortly before end of cell, rarely from three-fourths. Hindwings with 3 and 4 separate, 5 from middle of cell, 6 and 7 stalked, 12 approximated to cell from one-fourth nearly or quite to its end.

Type, *E. tristis* Lew.

A genus of some size. The species are closely similar and need careful discrimination, especially as several present sexual differences and varietal forms. The Western Australian species are still imperfectly known.

1.	Forewing with discal spot	2.
	Forewing without discal spot	11.
2.	Discal spot wholly blackish	3.
	Discal spot not wholly blackish	6.
3.	Thorax blackish	4.
	Thorax white	5.
4.	Forewing without terminal spots	*melanospila.*
	Forewing with a series of whitish-ochreous spots	*asbolina.*
5.	Hindwing without spots	*signata.*
	Hindwing with fuscous discal dot and a subterminal series of white spots	*barytima.*

6.	Discal spot outlined with blackish	7.
	Discal spot not outlined with blackish	9.
7.	Hindwings ochreous (at least in ♂)	8.
	Hindwings fuscous	*melanosticta.*
8.	Discal spot white-centred	*anisozyga.*
	Discal spot ochreous in centre	*zelotes.*
9.	Hindwings whitish-ochreous	*chrysosema.*
	Hindwings not whitish-ochreous	10.
10.	Expanse 34-44 mm. Hindwings blackish	*tristis.*
	Expanse 22-36 mm. Hindwings fuscous	*protrahens.*
11.	Abdomen ochreous	*argentea.*
	Abdomen blackish	12.
12.	Forewings with ground colour white	13.
	Forewings with ground colour dark-fuscous	14.
13.	Hindwings white	*dispar* ♂
	Hindwings fuscous	*barnardi* ♂
	Hindwings ochreous	*phoenura* ♂, form *alba.*
14.	Hindwings ochreous	*phoenura.*
	Hindwings dark-fuscous	15.
15.	Forewings with basal white spot	*barnardi* ♀.
	Forewings without basal white spot	*dispar* ♀.

3. Epicoma melanospila.

Cnethocampa melanospila, Wlgrn., Wien. Ent. Mon., iv., 1866, p. 164.

♂. 40-50 mm. ♀. 46-58 mm. Head white; face more or less mixed with ochreous or fuscous; some ochreous hairs near antennal bases. Antennae fuscous; stalk sometimes partly whitish. Thorax blackish; tegulae in ♂ and sometimes in ♀ white or whitish. Abdomen blackish; a median dorsal series of ochreous spots; tuft ochreous, apices of hairs paler. Legs dark-fuscous. Forewings triangular, costa straight, apex round-pointed, termen bowed, oblique; shining-white; a blackish costal streak irrorated and edged with ochreous; a fairly large, circular, blackish, median discal spot; a broad oblique blackish line from costa before apex, near or rarely touching discal spot, then curved outwards to two-thirds dorsum, in ♀ usually entirely absent; a variable amount of fuscous irroration along dorsum, sometimes broadly suffused and prolonged along termen; cilia fuscous, with median series of ochreous or whitish-ochreous dots, apices partly whitish or ochreous. Hindwings with termen rounded; ochreous, more or less suffused with fuscous; a broad, median, fuscous, transverse line sometimes lost in suffusion; sometimes a terminal series of ochreous spots; cilia ochreous, sometimes mixed with fuscous.

Easily recognised by the silvery-white forewings with large blackish discal spot, but variable. In southern examples the dorsal suffusion is greater. In one ♀ from Gippsland there is a strong post-median oblique line.

N. Qland: Cairns, Atherton, Herberton; Qland: Gympie, Brisbane, Coolangatta, Toowoomba, Stanthorpe; N.S.W.: Sydney; Vict.: Melbourne, Wandin, Moe, Gisborne; Tas.: Launceston, Hobart.

4. Epicoma signata.

Teara signata, Wlk., Cat. Brit. Mus., iv., p. 849.

♂. 40 mm. Head whitish-ochreous; face ochreous. Antennae whitish; pectinations in ♂ 9, dark-fuscous. Thorax whitish-ochreous. (Abdomen broken). Legs fuscous with ochreous hairs. Forewings elongate-triangular, costa straight, apex round-pointed, termen slightly bowed, oblique; silvery white; a blackish costal streak containing some pale-ochreous scales; a short, transverse, discal mark beyond middle, not pale-centred; a semi-obsolete, oblique, post-median grey line; cilia ochreous, apices whitish, imperfectly barred with dark-fuscous. Hindwings with termen nearly straight; pale-ochreous; a thick, dark-fuscous, subterminal line ending in tornus; cilia pale ochreous.

This description is taken from Walker's type in the British Museum. It is an imperfect specimen, but appears to be a good species. The locality is given as Swan River.

5. Epicoma barytima.

Epicoma barytima, Turn., Proc. Roy. Soc. Qland., 1917, p. 74.
W. Aust.: Cunderdin.

6. Epicoma anisozyga, n.sp.

ἀνισοζυγός, unequally yoked.

♂. 33-36 mm. Head ochreous-brown. Antennae grey; pectinations 12. Thorax ochreous-brown. Abdomen dark-fuscous with dorsal and lateral ochreous lines; tuft ochreous, towards apex whitish-ochreous. Legs fuscous, with long ochreous hairs. Forewings triangular, costa straight, apex round-pointed, termen slightly bowed, oblique; white, a costal streak ochreous, mixed with blackish; a fuscous discal spot beyond middle, white-centred; a grey line from costa shortly before apex to mid-dorsum; a similar subterminal line connected with termen on veins; some fuscous irroration towards dorsum, blackish towards dorsal edge; cilia ochreous with basal and median dark-fuscous dots arranged alternately, beyond middle grey. Hindwings with termen gently rounded; ochreous; dorsal edge suffused with fuscous; median and subterminal fuscous lines, the latter connected with termen on veins; cilia ochreous.

♀. 38-43 mm. Antennal pectinations 5. Forewings white with general dense grey irroration, but without transverse lines; the irroration is absent on termen, except on veins, so as to form a terminal series of white spots; costal and dorsal irroration as in ♂; cilia ochreous with basal and apical lines and some cross bars dark-fuscous. Hindwings fuscous with a terminal series of ochreous spots; cilia ochreous, apices fuscous.

The ♂ resembles *zelotes* Turn., but in that species the discal spot of forewing is ochreous in the centre, and the hindwing has no median line. The ♀ is very different from that of *zelotes.*

N. Aust.: Adelaide River in October; seven specimens including the type in the British Museum; taken by Commander J. J. Walker.

7. Epicoma zelotes.

Epicoma zelotes, Turn., Trans. Roy. Soc. S. Aust., 1902, p. 183.
N. Qland: Cape York, Herberton, Townsville.

8. Epicoma chrysosema, n.sp.

χρυσόσημος, golden-marked.

♂. 32-34 mm. ♀. 42 mm. Head white; face in ♂ ochreous-tinged. Antennae whitish; pectinations in ♂ 11, ochreous-tinged; in ♀ 6. Thorax white, slightly ochreous-tinged. Abdomen dark-ochreous; apex of tuft paler. Legs ochreous with whitish hairs. Forewings rather narrowly triangular, costa straight, apex round-pointed, termen bowed, oblique; silvery-white; markings golden-ochreous; a discal spot at two-thirds; a sinuate line from five-sixths costa to two-thirds dorsum, sometimes incompletely developed, being represented only towards margins; a dentate line very near termen; cilia white with a basal series of golden-ochreous dots. Hindwings with termen moderately rounded; whitish more or less suffused with pale-golden-ochreous, leaving a terminal series of white spots; cilia white, bases narrowly ochreous.

N.W. Aust.: Sherlock River; three specimens including the type in the British Museum, taken by Mr. E. Clements.

9. Epicoma melanosticta.

Bombyx melanosticta, Don., Ins. N. Holl., 1805, p. 34.

♂. 38-44 mm. Head white, face ochreous. Antennae fuscous, sometimes mixed with ochreous. Thorax whitish-ochreous or pale-brownish. Abdomen blackish; a median dorsal series of ochreous spots, sometimes scarcely developed; tuft ochreous, apices paler. Legs fuscous mixed with ochreous. Forewings triangular, costa straight, apex round-pointed, termen bowed, slightly oblique; shining-white; an ochreous costal streak, irrorated with blackish; a small, ochreous, median, discal spot, with thick blackish margin; a tawny-fuscous oblique streak from costa before apex, posterior to or touching discal spot, beneath it angled outwards to two-thirds dorsum; a slight dorsal irroration of ochreous and blackish; a variable, narrow, fuscous, terminal band, containing a terminal series of white spots; cilia ochreous, more or less barred with blackish, apices whitish-ochreous. Hindwings with termen rounded; fuscous; a terminal series of rounded-triangular ochreous spots; cilia ochreous.

♀. 40-47 mm. Head and thorax ochreous-brown. Forewings more or less suffused with brown, usually with only thinly scattered white scales; discal spot larger, blackish with small ochreous-brown centre; post-median line not developed. Hindwings with ochreous spots smaller or dot-like.

The ♀ may be as dark as that of *tristis* but is distinguishable by the blackish discal spot. A ♂ example from Stanthorpe has the forewings mostly suffused with grey, and the hindwings without ochreous terminal spots. I regard it as an aberration of this species.

N. Qland: Atherton, Herberton; Qland: Nambour, Brisbane, Stradbroke Is., Mt. Tambourine, Toowoomba, Stanthorpe; N.S.W.: Ebor, Sydney; Vict.: Daytrap; Tas.: Launceston, Hobart; S. Aust.: Adelaide; W. Aust.: Busselton, Perth, Waroona.

10. Epicoma tristis.

Bombyx tristis, Lewin, Prodr. Ent., 1805, p. 9, Pl. viii.; Don., Ins. N. Holl., 1805, Pl. 34.—*Epicoma contristis,* Hb., Zutr., ii., 1823, p. 9, f. 217, 218.—*E. pontificalis,* Rosen., Ann. Mag. Nat. Hist., (5), xvi., 1885, p. 383.—? *Euproctis pelodes,* Low., Trans. Roy. Soc. S. Aust., 1893, p. 150.

♂. 34-50 mm. ♀. 40-44 mm. Head and thorax brown, rarely brown-whitish. Antennae fuscous. Abdomen blackish; sometimes a median dorsal series of ochreous dots; tuft ochreous. Legs fuscous. Forewings triangular, costa straight, apex round-pointed, termen bowed, slightly oblique; dark-fuscous or brown, more or less irrorated with whitish or whitish-ochreous, rarely with whitish suffusion; a small, ochreous, median, discal spot sometimes edged with fuscous (not blackish) scales; a terminal series of whitish or pale-ochreous dots; cilia fuscous with fine ochreous bars. Hindwings with termen rounded; dark-fuscous; rarely with a terminal series of ochreous dots; cilia ochreous.

The sexes are similar.

N. Qland: Cairns, Herberton; Qland: Nambour, Brisbane, Mt. Tambourine, Coolangatta; N.S.W.: Dorrigo, Sydney; Vict.: Melbourne, Wandin, Moe, Gisborne; Tas.: Hobart; S. Aust.: Mt. Lofty; W. Aust.: Waroona.

11. Epicoma protrahens.

Teara protrahens, Luc., Proc. Linn. Soc. N.S.W., 1889, p. 1090.

♂. 20-28 mm. ♀. 26-35 mm. Head whitish-ochreous; face brownish. Antennae fuscous, irrorated on stalk with whitish. Thorax pale-brown. Abdomen dark-fuscous; a series of dorsal median spots and tuft whitish-ochreous. Legs fuscous mixed with pale-ochreous. Forewings triangular, rather narrow, costa straight, apex round-pointed, termen bowed, oblique; fuscous-brown with some whitish irroration or suffusion; a rather large, circular, whitish-ochreous discal spot slightly beyond middle; a terminal series of whitish or whitish-ochreous spots; cilia pale-ochreous with dark-fuscous irroration, which forms indistinct bars. Hindwings with termen rounded; fuscous; a terminal series of whitish-ochreous spots in ♂; in ♀ these are usually absent; pale-ochreous, in ♀ irrorated with fuscous; on tornus and dorsum fuscous.

Qland: Brisbane; N.S.W.: Clarence River, Sydney.

12. Epicoma argentata.

Marane argentata, Wlk., Cat. Brit. Mus., xxxii., p. 355.—*M. subargentea,* Wlk., *ib.,* p. 397.—*Teara argentosa,* Luc., Proc. Linn. Soc. N.S.W., 1889, p. 1089.

♂. 32-44 mm. ♀. 50 mm. Head whitish-ochreous. Antennae ochreous-whitish; pectinations pale-fuscous. Thorax ochreous-whitish or whitish-ochreous. Abdomen ochreous; sides and bases of segments on dorsum sometimes dark-fuscous. Legs whitish-ochreous. Forewings triangular, costa slightly arched, more so in ♀, apex obtusely round-pointed, termen bowed, oblique; whitish more or less irrorated with pale-ochreous; when this irroration is well-marked, it leaves a terminal series of whitish spots; cilia whitish-ochreous, apices whitish. Hindwings with termen rounded; whitish-ochreous, in ♀ brownish-tinged; sometimes a terminal series of whitish spots; cilia whitish or ochreous-whitish.

Northern Territory examples are considerably smaller than those from the Peak Downs, and show no marginal spots.

N. Aust.: Darwin, Macdonnell Ranges; N. Qland: Townsville; Qland: Duaringa, Emerald, Clermont.

13. Epicoma barnardi.

Teara barnardi, Luc., Proc. Linn. Soc. N.S.W., 1889, p. 1088.

♂. 36-40 mm. Head and thorax pale-ochreous, the latter with central white spot. Antennae pale-fuscous. Abdomen blackish; tuft ochreous. Legs fuscous. Forewings triangular, costa straight, apex round-pointed, termen bowed, oblique; white, usually irrorated with brown; a narrow, brown, costal streak; an oblique line, slightly inwardly-curved, from costa before apex to about mid-dorsum; a brownish terminal band, sometimes nearly obsolete, its anterior edge suffusedly dentate, containing a terminal series of white spots; cilia brown with small white bars, or wholly white. Hindwings with termen rounded; fuscous; a terminal series of white spots; cilia white, bases mixed with fuscous.

♀. 40-42 mm. Head and thorax dark-brown. Forewings dark-fuscous with slight whitish irroration; a basal white spot; a terminal series of whitish-ochreous spots; cilia dark-fuscous. Hindwings dark-fuscous; a terminal series of pale-ochreous spots; cilia dark-fuscous.

In this species and the following the sexes are remarkably unlike.

N. Qland: Thursday Island, Cape York, Cooktown, Townsville; Qland: Duaringa.

14. Epicoma dispar, n.sp.

dispar, unlike, dissimilar.

♂. 38-40 mm. Head pale-fuscous; face ochreous-tinged. Antennae, stalk fuscous irrorated with white; pectinations ochreous-fuscous. Thorax pale-fuscous, with a large central white spot. Abdomen blackish; tuft ochreous, becoming paler towards apex. Legs dark-fuscous; tarsi annulated with whitish. Forewings triangular, costa straight, apex pointed, termen bowed, oblique; white, with some fuscous irroration; markings fuscous; a fine costal streak; a broad subcostal streak from near base running into post-median line; a thick oblique line from costa before apex to mid-dorsum, bent slightly outwards in middle, and inwards above dorsum; a narrow terminal band, containing a terminal series of white spots; cilia fuscous, barred with white, apices wholly white. Hindwings with termen rounded; white; cilia white; on dorsum fuscous.

♀. 34 mm. Head, thorax, antennae, and abdomen blackish; tuft pale-ochreous. Forewings dark-fuscous with scanty whitish-ochreous irroration; a subterminal series of ochreous spots; cilia fuscous, bases dark-fuscous with a few whitish-ochreous scales. Hindwings dark-fuscous; a subterminal series of large ochreous spots; cilia as forewings but without whitish-ochreous scales.

Allied to *E. barnardi*, the ♂ may be distinguished by the bent post-median line of forewings and white hindwings, the ♀ by the absence of basal white spot on forewings.

N. Aust.: Darwin in October and November; three specimens received from Mr. F. P. Dodd, 2 ♂ and 1 ♀, of which two are in Coll. Lyell.

15. Epicoma phoenura, n.sp.

φοινουρος, red-tailed.

♂. 30-34 mm. ♀. 36-38 mm. Head dark-fuscous; face in ♂ ochreous. Antennae, stalk ochreous, sometimes partly fuscous; pectinations fuscous. Thorax dark-fuscous. Abdomen blackish; basal segment in ♂ pale ochreous; tuft reddish, towards apex fuscous. Legs fuscous. Forewings triangular, costa straight, apex round-pointed, termen bowed, oblique; dark-fuscous with scanty whitish-ochreous irroration, especially towards base; a terminal series of whitish-ochreous dots, often obsolete; cilia dark-fuscous. Hindwings with termen rounded; ochreous; a broad transverse median line and a terminal band dark-fuscous, the two often fused; a terminal series of ochreous spots; cilia dark-fuscous.

Male form *alba*, 32 mm. Head, antennal stalk, and thorax whitish. Forewings whitish; a dark-fuscous broad line from three-fourths costa to dorsum before tornus; a fuscous terminal line containing a series of whitish spots; cilia fuscous. Abdomen and hindwings as in typical form. This would be taken for a new species if it had not been captured with the typical form (Mary River). I have one example and have seen another. but no intermediates.

N. Aust.: Darwin (F. P. Dodd); Mary River (W. D. Dodd); six specimens, and I have seen others in the South Australian Museum.

16. Epicoma asbolina.

Epicoma asbolina, Turn., Trans. Roy. Soc. S. Aust., 1902, p. 183.

N. Aust.: Darwin; N. Qland: Prince of Wales Island, Coen River, Cairns, Townsville, Bowen.

Also from New Guinea.

Gen. 4. Tanystola, n.g.

τανύστολος, long-robed.

Forewing with 2 from two-thirds, 3 from five-sixths, 4 from angle, 5 from middle of cell, 6 from upper angle, areole present, 7 arising separately from areole, 8, 9 stalked and 10 connate or short-stalked with them from areole, 11 from three-fourths. Hindwings with cell long (two-thirds), 2 from two-thirds, 3 from before angle of cell, well separated at origin from 4, which is from angle, 6 and 7 stalked, 12 approximated to cell near base.

The forewings are exceptionally long and narrow.

17. Tanystola ochrogutta.

Cnethocampa ochrogutta, H.-Sch., Ausser. Schmet., i., f. 460.

♂. 30 mm. Head whitish-ochreous; lower half of face, and hair tufts in front of antennae orange-ochreous. Antennae dark-fuscous; pectinations in ♂ 10. Thorax dark-fuscous, apices of hairs partly orange-ochreous. Abdomen dark-fuscous, tuft whitish-ochreous. Legs fuscous; hairs on middle and posterior tibiae and annulations on middle and posterior tarsi whitish. Forewings elongate, costa straight to middle, thence strongly sinuate, apex rounded, termen strongly bowed, strongly oblique; fuscous; a broad sub-basal fascia not reaching costa and narrowed on dorsum, whitish; an orange-ochreous discal spot beneath costa at middle, and a second beyond middle; a sinuate whitish oblique line from three-fourths costa to three-fourths dorsum; a terminal series of orange ochreous spots; cilia fuscous. Hindwings with termen slightly rounded; fuscous; cilia fuscous.

Described from an example in the British Museum labelled "Australia." I conjecture that it is from Western Australia. Herrich-Schaeffer's acumen in referring this species to the genus *Cnethocampa* must be acknowledged.

Gen. 5. Sthenadelpha, n.g.

σθέναδελφός, a sturdy brother.

Forewings with 2 from two-thirds, 3 from five-sixths, 4 from angle, 5 from middle of cell, 6 from upper angle, areole present, 7 and 10 arising separately from areole, 8, 9 stalked, 11 from five-sixths. Hindwings with 2 from two-thirds, 3 from before angle well separated at origin from 4, which is from angle, 6 and 7 stalked, 12 approximated to cell near base; cell one-half to three-fifths.

Structurally this genus is near the preceding, but the forewings are less elongate, and 10 arises separately from the areole, while in the hindwings the cell is much shorter.

18. Sthenadelpha isabella.

Trichetra isabella, White, Grey's Discov. Austral., ii., Appendix, p. 479.—*Teara suppressa,* Wlk., Cat. Brit. Mus., xxxii., p. 354.

♂. 46-56 mm. Head and thorax ochreous or whitish-ochreous. Antennae dark-fuscous; stalk usually ochreous. Abdomen ochreous or whitish-ochreous;

usually dark-fuscous posteriorly; tuft ochreous or whitish-ochreous sometimes fuscous towards apex. Legs ochreous; anterior pair and all tarsi sometimes fuscous. Forewings triangular, costa straight, apex rounded, termen bowed, moderately oblique; ochreous or whitish-ochreous, sometimes almost wholly suffused with fuscous; four transverse dark-fuscous lines, rarely obsolete and indicated in dark-ochreous only; first from one-sixth costa to one-fourth dorsum, second from two-fifths costa to near mid-dorsum, third from four-fifths costa to three-fourths dorsum, slightly bisinuate, fourth subterminal and usually connected with termen on veins, leaving a terminal series of ochreous or whitish spots; base and median area often fuscous; two, circular, orange, subcostal spots before and after middle; cilia ochreous sometimes mixed with fuscous. Hindwings with termen rounded; ochreous, more or less suffused with dark-fuscous, sometimes wholly so except at base; cilia as forewings.

♀. 56-68 mm. Forewings pale-ochreous or white; lines usually narrower and not suffused; discal spots usually absent. Hindwings wholly ochreous, or with suffused median and terminal bands, or wholly dark-fuscous.

Very variable in both sexes.

W. Aust.: Albany, Wilson's Inlet, Waroona, York.

Gen. 6. Ochrogaster.

Ochrogaster, Feld., Reise Nov.

Palpi obsolete. Posterior tibiae without middle spurs. Forewings with 5 usually from well above middle of cell, but sometimes from middle, 6 from upper angle of cell or from areole, 7, 8, 9, 10 stalked, or 7 and 10 from end of areole, areole rather small and narrow, 11 from near end of cell or from two-thirds. Hindwings with 3 and 4 separate or approximated at base, 5 from slightly above middle of cell, 6 and 7 stalked, 12 anastomosing or connected with cell at one-fourth or one-third.

There is considerable variability in the neuration. In one ♂ the areole is open on both forewings from absence of the inter-radial anastomosis. The genus contains only one species.

19. Ochrogaster contraria.

Teara contraria, Wlk., Cat. Brit. Mus., iv., p. 849.—*T. interrupta,* Wlk., *ibid.,* p. 850.—*Poecilocampa leucopyga,* Wlk., *ibid.,* vi., p. 1477.—*Darala cinctifera,* Wlk., Trans. Ent. Soc., 1862, p. 268.—*Ochrogaster circumfumata,* Feld., Reise Nov., Pl. 94, f. 5.—*O. ruptimacula,* Feld., Reise Nov., Pl. 95, f. 9.—*Marane rubricorpus,* Swin., Ann. Mag. Nat. Hist., (7), ix., 1902, p. 420.

♂. 40-60 mm. ♀. 52-70 mm. Head fuscous or ochreous-brown, rarely in ♂ whitish. Antennae pale-fuscous or pale-ochreous. Thorax fuscous-brown or ochreous-brown, tips of hairs often whitish, rarely wholly whitish in ♂. Abdomen brownish-orange; bases of segments usually fuscous; tuft whitish or ochreous-whitish. Legs fuscous or brownish-ochreous. Forewings elongate-triangular, costa straight, apex rounded, termen slightly bowed, slightly oblique; fuscous-brown or ochreous-brown; a small, white, median, transverse discal mark, rarely obsolete; a fuscous line from three-fourths costa to dorsum between three-fifths and four-fifths, at first outwardly rounded, then sinuate, usually faint, sometimes very distinct, in ♀ often obsolete; sometimes in ♂ there are broad longitudinal white lines variably developed, first along costa, second from discal mark to termen, third along fold curving downwards to tornus; in some examples the white markings are extensively suffused, and in these there may be incomplete sub-basal and ante-median fuscous transverse lines; cilia concolorous. Hindwings with termen rounded; colour as forewings; rarely a whitish discal mark before middle.

Variable in colour and in the development of white lines on forewing of ♂ in any one locality, but extensive series would show regional variation also. None of these forms are specifically distinct.

N. Aust.: Darwin, Margaret R., Macdonnell Ranges; N. Qland: Claudie R., Cloncurry; Qland: Clermont, Emerald, Gayndah, Brisbane, Mt. Tambourine, Toowoomba, Dalby, Charleville, Cunnamulla; N.S.W.: Sydney; Vict.: Bairnsdale, Birchip; S. Aust.: Adelaide, Mt. Lofty; W. Aust.: Bridgetown, Perth, Northam, Quairading, Cunderdin, Kalgoorlie, Dore Is., Bernier Is.; N.W. Aust.: Roeburne.

Gen. 7. TEARA.

Teara, Wlk., Cat. Brit. Mus., iv., p. 851; Swin., Cat. Oxf. Mus., i., p. 214.

Palpi short, porrect, densely hairy. Posterior tibiae with two pairs of spurs rather closely approximated. Forewings with 5 from middle of cell, 6 from areole or from upper angle of cell, 7, 8, 9 stalked, 10 connate from end of areole which is small, 11 from four-fifths. Hindwings with 3 and 4 separate, 5 from slightly above middle of cell, 6 and 7 stalked, 12 anastomosing with cell at about one-fourth.

Distinguished from *Ochrogaster* by the presence of palpi and of two pairs of spurs on the posterior tibiae. Walker, with his usual looseness, applied the name *Teara* to many species belonging to more than one family; but the type was fixed by Swinhoe (*loc. cit.*) as *variegata* Wlk. Since then this has remained the only species, but Mr. Hardy's interesting discovery enables me to add a second.

20. TEARA VARIEGATA.

Teara variegata, Wlk., Cat. Brit. Mus., iv., p. 851.

♂. 48-54 mm. ♀. 80-85 mm. Head whitish, crown sometimes partly fuscous; sides of face fuscous. Palpi fuscous; at apex ochreous-whitish. Antennae pale-fuscous or whitish. Thorax brownish-fuscous, with a few whitish and reddish hairs, sometimes mostly whitish. Abdomen on dorsum orange-ochreous or reddish-orange, bases of segments blackish, except in centre; beneath fuscous or whitish. Legs fuscous or partly whitish. Forewings triangular, rather broadly so in ♀, costa in ♂ straight, in ♀ gently arched, apex rounded-rectangular, termen bowed, in ♂ scarcely, in ♀ slightly oblique; brownish-fuscous more or less suffused or spotted with white; a dark, dentate, sub-basal line sometimes present; two small reddish discal spots arranged longitudinally in a variable white area, about middle; a finely dentate dark line from three-fourths costa to two-thirds dorsum, curved slightly outwards beneath costa, thence nearly straight; cilia fuscous barred with white. Hindwings with termen rounded; fuscous or pale-fuscous; cilia concolorous with indistinct whitish bars.

N. Qland: Herberton; Qland: Stradbroke Is., Toowoomba, Stanthorpe; N.S.W.: Newcastle, Sydney; S. Aust.: ——

21. TEARA PERIBLEPTA, n.sp.

περίβλεπτος, admired.

♂. 44 mm. Head white. Palpi very short, densely hairy; dark-fuscous. Antennae fuscous, apex and base of stalk whitish. Thorax white; patagia with some fuscous scales. Abdomen fuscous; tuft white. Legs fuscous; dorsal hairs on tibiae and tarsi white. Forewings triangular, costa straight, apex tolerably pointed, termen bowed, slightly oblique; white, markings fuscous and orange; an interrupted, sub-basal, orange, transverse line edged with dark-fuscous; a similar line from one-third costa, interrupted beneath costa, angled first outwardly, then inwardly, ending on two-fifths dorsum; a dark-fuscous discal dot, edged with orange, beneath mid-costa; a similar, larger, transversely oval dot posterior to this; a sinuate line of orange dots from five-sixths costa to four-fifths dorsum, edged posteriorly by a dentate fuscous line; central area between second and third lines broadly suffused with fuscous; a fuscous submarginal line not reaching costa or dorsum; cilia white with broad fuscous bars. Hindwings with termen rounded; white, irrorated with fuscous; a dark-fuscous median discal dot; broadly suffused, median and post-median, fuscous, transverse lines, separated by a waved white line; cilia white, bases barred with fuscous.

Tas.: Mt. Wellington in January; one specimen received from Mr. G. H. Hardy. Type in Queensland Museum.

Gen. 8. CYNOSARGA.

Cynosarga, Wlk., Cat. Brit. Mus., xxxii., p. 385.

Palpi short, porrect, hairy. Posterior tibiae with two pairs of large spurs. Forewings with 5 from middle of cell, 6 from upper angle, areole small, 7, 8, 9 stalked, 10 connate or short-stalked with them. Hindwings with 3 and 4 separate, 5 from slightly above middle of cell, 6 and 7 stalked, 12 not connected with cell, but approximated to it as far as or beyond middle.

There is only the one species.

22. CYNOSARGA ORNATA.

Cynosarga ornata, Wlk., Cat. Brit. Mus., xxxii., p. 386.

♂. 40 mm. ♀. 46 mm. Head reddish-brown; face and palpi usually fuscous. Antennae pale-ochreous. Thorax reddish-brown. Abdomen fuscous; tuft grey. Legs fuscous above, whitish-ochreous beneath. Forewings triangular, apex round-pointed, termen bowed, slightly oblique; fuscous, unevenly suffused with grey-whitish; a dark-fuscous, dentate, sub-basal, transverse line, partly edged posteriorly with reddish; two, short, longitudinal, dark-fuscous marks in disc beyond this; a dark-fuscous line from one-third costa to mid-dorsum, at first outwardly curved, sharply indented inwards above dorsum, edged throughout posteriorly with whitish and reddish; an obliquely oval, whitish, discal spot at three-fifths, containing a central reddish line; a dark-fuscous line from two-thirds costa to dorsum before tornus, at first directed outwardly, thence strongly bisinuate and dentate, edged throughout posteriorly, first with whitish, then with reddish; a subterminal series of triangular dark-fuscous spots; cilia white, with a continuous dentate fuscous line, dentations extending from bases to apices. Hindwings with termen rounded; fuscous or pale-fuscous; cilia whitish, bases partly pale-fuscous.

N. Qland: Cairns; Qland: Brisbane.

Gen. 9. OENOSANDA.

Oenosanda, Wlk., Cat. Brit. Mus., vii., p. 1713.

Palpi obsolete. Antennae in ♂ bipectinated to apex, in ♀ simple. Abdominal tuft in ♂ moderate, in ♀ large. Posterior tibiae with two pairs of spurs. Forewings with 5 from middle of cell, 6 from areole, which is large, 7, 8, 9 stalked from areole, 10 separate from areole. Hindwings with 3 and 4 short-stalked, 5 from middle or slightly below middle of cell, 6 and 7 long-stalked, 12 approximated to cell nearly to its end, but not connected.

There is only one species, which is narrower-winged than usual in this subfamily. It is the only Australian genus in which the antennae are simple in the ♀. In one ♂ 6 and 7 of hindwings are coincident on both sides. The large areole is a primitive character.

23. Oenosanda boisduvalii.

♀ *Oenosandra boisduvalii*, Newm., Trans. Ent. Soc., 1856.—♀ *O. duponchelii*, Wlk., Cat. Brit. Mus., vii., p. 1713.—♂ *Teara ? terminalis*, Wlk., *ibid.*, vii., p. 1733.—♂ *Pterygosoma squamipunctum*, Feld., Reise Nov., Pl. 98, f. 7.—♀ *Lomatosticha nigrostriata*, Möschl., Stet. Ent. Zeit., 1872, p. 359.—*Oenosanda boisduvalii*, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 58.

This species I have already sufficiently described.

Vict.: Gisborne, Moe; Tas.: Hobart; S. Aust.: Adelaide; W. Aust.: Bridgetown, Perth, Donnybrook.

Subfam. NOTODONTINAE.

Tongue strongly developed, weak, or obsolete. Labial palpi always present. Antennae of ♂ usually bipectinate, of ♀ usually simple. Forewings with or without areole. Hindwings with vein 5 rather weak, rarely absent, 12 usually approximated to cell to near its end, always to middle, rarely connected or anastomosing.

Having already treated most of the species at some length (Proc. Linn. Soc. N.S.W., 1903, p. 42) I can dispose of them here more briefly. The group is of moderately large size and is present in all continental areas, but is most largely developed in South America. The species derived from the old "Austral" fauna are few, comprised in the genera *Hyleora, Neola, Sorama, Destolmia, Ecnomodes, Antimima, Danima, Discophlebia* and *Gallaba*. Probably all the remaining genera are Oriental immigrants. None of the genera are of large size, and they are rather closely connected, so that it is difficult to construct a satisfactory key.

1.	Forewings with a strong dorsal tuft	*Rosama.*
	Forewings without dorsal tuft	2.
2.	Thorax with an acute anterior crest, crown of head also crested	3.
	Thorax without acute anterior crest, crown of head not crested	5.
3.	Hindwings with 12 approximated to cell but not connected ..	4.
	Hindwings with 12 connected with cell	*Sorama.*
4.	Forewings with 8, 9, 10 stalked from areole	*Hyleora.*
	Forewings with 10 arising separately from areole	*Neola.*
5.	Areole absent	6.
	Areole present	9.
6.	Hindwings with 5 absent	*Icthyura.*
	Hindwings with 5 present	7.
7.	Forewings with 7 arising before 10	8.
	Forewings with 10 arising before 7	*Hoplitis.*
8.	Posterior tibiae without middle spurs	*Stauropus.*
	Posterior tibiae with two pairs of spurs	*Syntypistis.*
9.	Palpi less than 3, terminal joint short	10.
	Palpi over 3, terminal joint long	23.
10.	Hindwings with 6 and 7 stalked	11.
	Hindwings with 6 and 7 not stalked	*Polychoa.*
11.	Forewings with 6 from end of areole	*Cerura.*

Forewings with 6 from cell or from before end of areole	12.
12. Tongue obsolete	13.
Tongue developed	14.
13. Forewings with 8, 9, 10 stalked; retinaculum of ♂ very slender, long, bar-shaped	*Pheressaces.*
Forewings with 10 separate from areole; retinaculum of ♂ not bar-shaped	*Pheraspis.*
14. Eyes with long incurving cilia from posterior inferior quadrant	15.
Eyes not ciliated	17.
15. Head and thorax smooth	*Discophlebia.*
Head and thorax rough-haired	16.
16. Areole narrow	*Themerastis.*
Areole broadly quadrangular	*Gargetta.*
17. Areole extremely long, extending more than halfway from cell to apex	*Cascera.*
Areole moderate	18.
18. Forewings with 6 from middle or beyond middle of areole	*Phalera.*
Forewings with 6 from cell or areole before middle	19.
19. Head, palpi, and pectus clothed with long, dense, shaggy hairs ..	*Danima.*
Head, palpi, and pectus only shortly hairy	20.
20. Thorax with an anterior crest	21.
Thorax not crested	22.
21. Tongue absent	*Ecnomodes.*
Tongue present	*Destolmia.*
22. Frons with rounded corneous prominence	*Antimima.*
Frons without corneous prominence	*Omichlis.*
23. Forewings with 7, 8, 9, 10 stalked from areole, which is small ..	*Osica.*
Forewings with areole moderate, 10 arising from it separately ..	*Gallaba.*

Gen. 10. Rosama.

Rosama, Wlk., Cat. Brit. Mus., v., p. 1066.—*Spatalia,* Turn., Proc. Linn. Soc. N.S.W., 1903, p. 51 (*nec* Hb).

Tongue present but short. Palpi moderate (slightly over 1), porrect, hairy; terminal joint minute. Antennae with a spreading anterior tuft from first joint, bipectinated in both sexes, apex simple. Thorax with an acute anterior crest. Posterior tibiae with two pairs of spurs. Forewings with an incision preceded by a large tuft of scales on dorsal margin; areole long and very narrow, 6 from upper angle of cell or from areole, 7 from end or near end of areole, 8, 9, 10 stalked from areole, or 10 closely approximated at origin. Hindwings with 12 approximated to cell to three-fourths.

Type, *R. strigosa* Wlk. from Java.

An Oriental genus of which one species has reached Australia. It is our only representative of a large section of the family distinguished by the presence of a dorsal tuft of scales on the forewing.

24. Rosama indistincta.

Spatalia indistincta, Roths., Nov. Zool., 1917, p. 231.—♀ *S. costalis,* Turn., Proc. Linn. Soc. N.S.W., 1903, p. 52 (*nec* Moore).—♂ *S. argentifera,* Turn., Proc. Linn. Soc. N.S.W., 1904, p. 832 (*nec* Wlk).

Antennae of ♂ with pectinations 2, apical one-third simple; of ♀ two-thirds, apical one-third simple.

Rothschild's name for this fine species is unfortunately chosen. Both sexes, which differ markedly, are closely similar to *argentifera* Wlk., but differ in antennal structure. In the latter species the antennal pectinations are actually longer in the ♀ than in the ♂.

N. Qland: Townsville.

Gen. 11. HYLEORA.

Hylaeora, Dbld., Proc. Zool. Soc., 1848, p. 117.—*Hyleora*, Turn. (ὑλῃωρός) Proc. Linn. Soc. N.S.W., 1903, p. 46.

Head with an erect crest on crown springing from bases of antennae. Tongue present. Palpi very short, hairy, porrect. Antennae in ♂ bipectinate nearly to apex, in ♀ simple. Thorax with an acute anterior crest. Posterior tibiae with two pairs of spurs. Forewings with areole small, 6 from upper angle of cell or from areole, 7, 8, 9, 10 stalked from areole, or 7 connate. Hindwings with 5 from above middle of cell, 12 approximated to cell from base to near its end.

Type, *H. eucalypti* Dbld.

25. HYLEORA EUCALYPTI.

Hylaeora eucalypti, Dbld., Proc. Zool. Soc., 1848, p. 117, Pl. 5.—*Hyleora sphinx*, Feld., Reise Nov., Pl. 96, f. 4.—*H. eucalypti* Turn., Proc. Linn. Soc. N.S.W., 1903, p. 47.

N.S.W.: Sydney; Vict.: Melbourne.

26. HYLEORA INCLYTA.

Sorama inclyta, Wlk., Trans. Ent. Soc., 1862, p. 79.—*Hyleora lacerta*, Druce, Ann. Mag. Nat. Hist., (7), vii., p. 78.—*H. inclyta*, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 47.

N.S.W.:————; Vict.: Melbourne, Gisborne, Timberoo; Tas.: ————; S. Aust.: Mt. Lofty; W. Aust.: ————

27. HYLEORA DILUCIDA.

Hyleora dilucida, Feld., Reise Nov., Pl. 96, f. 5; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 48.

Vict.: Birchip, St. Arnaud; S. Aust.: Adelaide; W. Aust.: Merredin, Dowerin.

Gen. 12. NEOLA.

Neola, Wlk., Cat. Brit. Mus., v., p. 1033; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 49.

Head with an erect crest on crown. Tongue present. Palpi short, hairy, porrect. Antennae of ♂ bipectinate, extreme apex simple, of ♀ simple. Thorax with an acute anterior crest. Posterior tibiae with two pairs of spurs. Forewings with areole moderate, 6 from areole or from upper angle of cell, 7, 8, 9 stalked from areole, or 7 connate, 10 separate. Hindwings with 5 from above middle of cell, 12 closely approximated to cell from base nearly to end.

Type, *N. semiaurata* Wlk. The neurational differences between this genus, *Hyleora*, and *Sorama* appear to be constant.

28. NEOLA SEMIAURATA.

Neola semiaurata, Wlk., Cat. Brit. Mus., v., p. 1033; H.-Sch., Aus. Schmet., f. 549; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 49.

Antennae of ♂ bipectinate nearly to apex.

Qland: Emerald, Gayndah, Brisbane, Coolangatta; N.S.W.: Lismore, Newcastle, Sydney, Nowra; Vict.: ———; Tas.: ———.

29. Neola capucina.

Hyleora capucina, Feld., Reise Nov., Pl., 98, f. 1.—*Neola capucina*, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 50.

Antennae of ♂ bipectinate to three-fourths, thence simple.

N. Qland: Cairns; N.S.W.: Sydney; Vict.: Melbourne, Gisborne.

Gen. 13. Sorama.

Sorama, Wlk., Cat. Brit. Mus., v., p. 1034; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 50.

Head with an erect crest on crown. Tongue present. Palpi short, hairy, porrect. Antennae in ♂ bipectinate, towards apex simple, in ♀ simple. Thorax with small acute anterior and larger posterior crests. Posterior tibiae with two pairs of spurs. Forewings with areole rather long and narrow, 6 from areole or upper angle of cell, 7, 8, 9 stalked from areole, or 7 connate, 10 separate. Hindwings with 5 from slightly above middle of cell, 12 widely separate from cell at base, approaching and connected with it at about one-third, thence approximated nearly to its end.

Type, *S. bicolor* Wlk.

30. Sorama bicolor.

Sorama bicolor, Wlk., Cat. Brit. Mus., v., p. 1034; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 51.

Qland: Gympie; N.S.W.: Sydney; Vict.: Wandin, Moe, Gisborne; Tas.: Ulverstone.

Gen. 14. Icthyura.

Icthyura, Hb., Verz., p. 162.

Eyes hairy. Head with radiating tufts from inner side of bases of antennae. Tongue obsolete. Palpi slightly over 1, ascending, evenly-haired; terminal joint minute. Antennae bipectinate to apex in both sexes. Thorax with a rounded median crest. Anterior tarsi very short and broad, hairy. Posterior tibiae with two pairs of spurs. Forewings with 5 from near upper angle of cell, no areole, 6, 7, 8, 9, 10 stalked, but 6 only shortly and perhaps sometimes connate, 7 arising before 10. Hindwings with 5 absent, 6 and 7 short-stalked, 12 approximated to cell from before middle to near end.

Type, *I. anastomosis* Lin.

31. Icthyura anastomosis.

Bombyx anastomosis, Lin., Syst. Nat., p. 506.

♂♀. 30-42 mm. Head dark fuscous-brown; tufts from bases of antennae brown-whitish. Palpi slightly over 1, ascending; brown-whitish, upper surface fuscous-brown. Antennae pale-brown; pectinations in ♂ very long, becoming shorter in apical third; in ♀ moderately long. Thorax pale-brown, an anterior triangular area dark fuscous-brown, its apex nearly reaching centre. Abdomen whitish-brown. Legs pale-brown; posterior pair whitish-ochreous. Forewings rather narrowly triangular, costa nearly straight, apex rectangular, termen slightly sinuate, hardly oblique; pale-brown; several slender whitish lines, first short, transverse, from costa near base not reaching middle of disc; a similar line commencing posterior to termination of first line, to one-third dorsum; an oblique line from one-fourth costa to mid-dorsum; a transverse line from two-thirds costa to dorsum before tornus; a faintly outlined ochreous-whitish circle beneath mid-costa, often incomplete; usually a fine, oblique, ochreous-whitish line from beneath this to dorsal end of post-median transverse line; a fine, reddish-brown, subterminal, wavy line, indented in centre, becoming fuscous towards tornus; a submarginal, interrupted fuscous line not reaching tornus; cilia brown, apices whitish. Hindwings with termen rounded; whitish-brown; cilia as forewings.

N. Qland: Kuranda near Cairns in June; Evelyn Scrub near Herberton in December; three specimens received from Mr. F. P. Dodd. Also from New Guinea, China, Ceylon, and Europe. I can see no specific difference in specimens from all these localities.

Gen. 15. STAUROPUS.

Stauropus, Germar, Prod., 1811, p. 45.

Head with long rough hairs forming an anterior tuft. Tongue obsolete. Palpi moderate, ascending; second joint evenly haired; terminal joint minute. Antennae of ♂ bipectinate, towards apex simple, of ♀ simple. Abdomen with a small dorsal crest on basal segment. Posterior tibiae without middle spurs. Forewings with 6 from upper angle of cell, no areole, 7, 8, 9, 10 stalked, 7 arising before 10. Hindwings with 5 from above middle of cell, 6 and 7 stalked, 12 approximated and connected with cell near middle, thence approximated to near its end.

Type, *S. fagi* Lin. from Europe.

32. STAUROPUS HABROCHLORA, n.sp.

ἁβροχλωρός, softly green.

♂. 48 mm. ♀. 60 mm. Head ochreous-whitish mixed with brownish or fuscous, and on crown also with green hairs. Palpi ascending, slightly over 1; brownish-fuscous, internal surface whitish-ochreous. Antennae ochreous-grey; pectinations in ♂ very long, ceasing abruptly at three-fourths, thence simple; in ♀ simple. Thorax green with a few fuscous hairs. Abdomen ochreous-whitish irrorated with brown, which prevails towards base. Legs ochreous-whitish; anterior pair mixed with green and fuscous. Forewings triangular, costa gently arched, apex rounded-rectangular, termen bowed, strongly oblique; pale-green, finely irrorated with fuscous; markings fuscous; ante-median line from one-sixth costa to three-fifths dorsum, very fine, irregularly dentate, bent outwards beneath costa and on dorsum, inwards in middle, preceded by a similar parallel line, both lines may be interrupted beneath costa; more or less transverse fuscous suffusion posterior to this line; a small, transverse, oval, pale-centred, discal spot slightly beyond middle; a finely dentate, slender, sinuate, post-median line from two-thirds costa to three-fourths dorsum, sometimes indistinctly double, the two being separated by a pale line; a terminal series of small fuscous marks between veins; cilia pale-greenish. Hindwings with termen strongly rounded; pale brown; costal and apical areas green, crossed by a double wavy fuscous line; ochreous-whitish, mixed with brown except on tornus and dorsum.

N. Qland: Kuranda near Cairns in September and March; two specimens, of which the ♀ is in Coll. Lyell, received from Mr. F. P. Dodd.

Gen. 16. SYNTYPISTIS.

Syntypistis, Turn., Proc. Linn. Soc. N.S.W., 1906, p. 679.

Differs from *Stauropus,* to which it is closely allied, by having two pairs of spurs on posterior tibiae. My examples differ in the antennae of both sexes being bipectinate except towards apex and in 12 of the hindwings being only approximated and not connected with cell; but these latter differences may not be constant. It is possible that this genus may be the same as *Netria* Wlk. and *Desmeocraera* Wlgrn.; if so, it extends to India and Africa.

Type, *S. chloropasta* Turn.

1.	Forewings without discal spots	2.
	Forewings with three pale discal spots	*sciera.*
2.	Forewings with ante-median line single	*chloropasta.*
	Forewings with ante-median line double toward dorsum	*opaca.*

33. SYNTYPISTIS CHLOROPASTA.

Syntypistis chloropasta, Turn., Proc. Linn. Soc. N.S.W., 1906, p. 679.

♂. 20-23 mm. Head and thorax whitish-ochreous, more or less mixed with brown and partly tinged with green. Palpi about 1, ascending; whitish-ochreous, on upper surface fuscous. Antennae fuscous; pectinations in ♂ very long, ceasing abruptly at three-fourths, thence simple. Abdomen brownish. Legs brownish; anterior pair mixed with whitish and fuscous. Forewings rather narrow, costa rather strongly arched, apex rounded, termen bowed, strongly oblique; grey-whitish or brown, finely irrorated throughout with greenish; three, very slender, transverse, fuscous lines, sometimes indistinct or almost obsolete; first from one-third costa inwardly-oblique and nearly straight to one-sixth dorsum; second from two-thirds costa, directed outwards parallel to costa, then bent downwards, and soon after inwards obliquely to two-thirds dorsum, with a slight median indentation; third subterminal, bowed outwards above and below middle; cilia brown, with indistinct pale bars. Hindwings with termen strongly rounded; pale-brown; a darker apical blotch irrorated with greenish; cilia brown, apices paler.

I have redescribed this species, as a second example in Coll. Lyell shows much better the characteristic lines in the forewing, which in the type are so obscure that they escaped description.

N. Qland: Kuranda near Cairns.

34. SYNTYPISTIS OPACA, n.sp.

opacus, darkly shaded.

♂. 46 mm. ♀. 54 mm. Head whitish, on crown and lower half of face mixed with brown. Palpi $1\frac{1}{2}$, ascending; ochreous-whitish, upper surface brown. Antennae brownish-fuscous; pectinations very long in ♂, fairly long in ♀, ceasing rather abruptly at four-fifths, thence simple. Thorax ochreous-whitish mixed with fuscous-brown. Abdomen ochreous-whitish, more or less suffused or irrorated with brown. Legs whitish-brown. Forewings suboval, rather elongate, costa rather strongly arched, apex rounded, termen bowed, strongly oblique; ochreous-whitish, finely irrorated with fuscous-brown and greenish; markings dark fuscous-brown; a blotch on base of dorsum; a dentate line from one-third costa, inwardly oblique, sharply bent outwards above costa to end on one-third dorsum, closely followed by a similar parallel line, often partly obsolete; a triangular, subapical, costal blotch containing some greenish irroration; a double incompletely developed post-median line from posterior edge of costal blotch to two-thirds dorsum; an irregularly waved subterminal line; cilia whitish mixed with brownish. Hindwings with termen rounded; pale-brown; a greenish apical blotch, its centre occupied by a large fuscous-brown spot; cilia brownish with obscure whitish bars, on dorsum whitish. Underside uniform pale-brown.

N. Qland: Kuranda near Cairns in November and March; two specimens, of which the ♂ is in Coll. Lyell, received from Mr. F. P. Dodd.

35. SYNTYPISTIS SCIERA, n.sp.

σκιερός, shaded.

♀. 50-53 mm. Head and thorax fuscous. Palpi 1; whitish-brown, external surface fuscous. Antennae with long pectinations, apical one-fifth simple; fuscous. Abdomen fuscous, underside whitish-brown. Legs whitish-brown irrorated with fuscous. Forewings triangular, costa moderately arched, apex rounded, termen bowed, oblique; whitish-brown with fuscous suffusion causing darker and paler markings; a dark subcostal streak to one-fourth; a dark line from one-fourth costa to one-fourth dorsum; immediately followed by a pale, circular, dark-centred median spot; two large pale spots with darker centres beneath costa about middle, first nearly circular, second closely approximated to first, transversely oval; some dark suffusion between these and dorsum; a broadly suffused, ill-defined, dark, post-median line; a fine, blackish, wavy, submarginal line, not reaching costa; cilia fuscous mixed with whitish-brown. Hindwings with termen gently rounded; pale-fuscous; cilia pale-fuscous.

N.W. Aust.: Wyndham; two specimens received from Mr. L. J. Newman.

Gen. 17. HOPLITIS.

Hoplitis, Hb., Verz., p. 147.—*Teleclita*, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 53.

Head shortly rough-haired. Tongue very short, nearly obsolete. Palpi short, hairy, porrect. Antennae in both sexes bipectinate, towards apex simple. Posterior tibiae with two pairs of spurs. Forewings with no areole, 6, 7, 8, 9, 10 stalked, 10 arising before 7. Hindwings with 5 from above middle of cell, 6 and 7 stalked, 12 approximated and sometimes connected with cell before middle, thence approximated to near its end.

Type, *H. milhauseri* Fab. from Europe.

36. HOPLITIS CYDISTA.

Teleclita cydista, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 53.

This species is closely allied to *H. strigata* Moore from India.

N. Qland: Townsville.

Gen. 18. CERURA.

Cerura, Schrank, Fauna Boica, ii., pt. ii., p. 155.

Tongue obsolete. Palpi very short, hairy, porrect. Antennae pectinate to apex in both sexes. Posterior tibiae without middle-spurs. Forewings with second anal prolonged towards dorsum after anastomosing with first anal; 5 from above middle of cell, 6 from end of areole, separate, connate, or short-stalked with 7, 7, 8, 9 stalked, 10 separate, connate, or even short-stalked with them. Hindwings with 5 from middle of cell, 6 and 7 stalked, 12 approximated and sometimes connected with cell about middle.

Type, *C. furcula* Schrank from Europe.

37. Cerura multipunctata.

Cerura multipunctata, B.-Bak., Nov. Zool., 1904, p. 381, Pl. 6, f. 9.

Differs from *C. australis* in the series of five large pale-centred spots from one-fifth costa to before mid-dorsum being replaced by small blackish spots, which are not arranged in line, the third from costa being considerably posterior to the second, while the fourth is preceded by an additional spot not found in the former species. By some these forms would be considered subspecies, but, unless intermediates are discovered, I think they are better treated as nearly allied species.

N. Qland: Kuranda near Cairns in April, Stannary Hills near Herberton in September and October. Also from New Guinea.

38. Cerura australis.

Cerura australis, Scott, Aust. Lep., Pl. v.; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 55.

N.S.W.: Newcastle.

Gen. 19. Pheressaces.

Pheressaces, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 56.

Tongue obsolete. Palpi very short (less than 1), porrect, short-haired. Antennae pectinate in both sexes, towards apex simple. Posterior tibiae with two pairs of spurs. Retinaculum in ♂ very slender, long, bar-shaped. Forewings with 5 from above middle of cell, areole moderate, 6 from before middle of areole, 7 from end of areole, 8, 9, 10 stalked from areole. Hindwings with 5 from above middle of cell, 6 and 7 stalked, 12 approximated to cell from base to near its end.

Type, *P. cycnoptera* Low.

39. Pheressaces cycnoptera.

Notodonta cycnoptera, Low., Trans. Roy. Soc. S. Aust., 1894, p. 78.—*Pheressaces cycnoptera,* Turn., Proc. Linn. Soc. N.S.W., 1903, p. 56.

N. Qland: Townsville; Qland: Duaringa.

40. Pheressaces spirucha.

Pheressaces spirucha, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 57.

Qland: Brisbane. The type is still unique.

Gen. 20. Pheraspis.

Pheraspis, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 61.

Head with spreading hairs from bases of antennae forming an anterior tuft. Tongue obsolete. Palpi moderate (about 1), ascending; second joint evenly haired; terminal joint minute. Antennae of ♂ bipectinate to apex, of ♀ shortly bipectinate or simple. Thorax with a small rough posterior crest. Posterior tibiae with two pairs of spurs. Forewings with 5 from middle or above middle of cell, areole moderate, 6 from areole before middle, 7 connate or short-stalked from end of areole, 8, 9 stalked, 10 separate. Hindwings with 3 and 4 connate or separate, 5 from above middle of cell, 6 and 7 stalked, 12 approximated to cell from base to near its end, or less often approximated in middle third only.

Type, *P. polioxutha* Turn.

41. Pheraspis polioxutha.

Pheraspis polioxutha, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 62.

This species varies in the distinctness of the dentate transverse lines on forewings.

N. Aust.: Darwin; N. Qland: Cooktown, Cairns, Cardwell, Townsville.

42. Pheraspis mesotypa.

Pheraspis mesotypa, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 62.

N. Qland: Thursday Is., Townsville.

43. Pheraspis symmetra.

Pheraspis symmetra, Turn., Proc. Roy. Soc. Qland., 1917, p. 73.

I am not sure as to the distinctness of this species. My description shows that it resembles *polioxutha* rather than *mesotypa,* but with short antennal pectinations. It is possible that I mistook the sex, and that the type is a ♀ of *polioxutha.*

N.W. Aust.: Derby.

44. Pheraspis spodea.

Pheraspis spodea, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 63.

Exceptional in 12 of hindwings being approximated to middle of cell only, and 3 and 4 being rather widely separate.

N. Qland: Claudie River (Kershaw); Qland: Brisbane.

Gen. 21. Discophlebia.

Discophlebia, Feld., Turn., Proc. Linn. Soc. N.S.W., 1903, p. 65.

Head smooth, with a more or less marked rounded projection of frons. Eyes with a posterior inferior tuft of incurved cilia. Tongue strong. Palpi short (less than 1), porrect, rough-scaled; terminal joint short. Antennae of ♂ laminate or very shortly pectinate with fascicles of cilia; of ♀ simple. Thorax smooth, without crests. Posterior tibiae with two pairs of spurs. Forewings with 2 from shortly before end of cell, 5 from middle of cell, areole long, 6 from near end of areole, 7, 8, 9 stalked, 10 separate or short-stalked with them. Hindwings with 3 and 4 connate or approximate at origin, 5 from middle of cell, 6 and 7 long-stalked, 12 approximated to cell to its end.

Type, *D. catocalina* Feld.

45. Discophlebia catocalina.

Discophlebia catocalina, Feld., Reise Nov., Pl. 96, f. 8; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 66.

Vict.: Birchip; S. Aust.: Adelaide.

46. Discophlebia blosyrodes.

Discophlebia blosyrodes, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 67.

N. Qland: Townsville.

47. Discophlebia lucasii.

Discophlebia lucasii, Rosen., Ann. Mag. Nat. Hist., 1885, p. 421, Pl. 11, f. 4; Turn., Proc. Linn. Soc. N.S.W., 1906, p. 680.

N.S.W.: Sydney; Vict.: Trafalgar, Warburton.

48. Discophlebia lipauges.

Discophlebia lipauges, Turn., Proc. Roy. Soc. Qland., 1917, p. 74.
W. Aust.: Nannup.

Gen. 22. Themerastis.

Themerastis, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 63.

Eyes with a tuft of long incurved cilia from posterior inferior quadrant. Tongue strong. Palpi short or moderately long, porrect or ascending, shortly hairy. Thorax with a rounded anterior crest. Posterior tibiae with two pairs of spurs. Forewings with areole long and narrow, 5 from middle of cell, 6 from areole beyond middle, 7, 8, 9 stalked, 10 arising separately from areole. Hindwings with 5 from middle of cell, 6 and 7 stalked, 12 closely approximated to near end of cell, sometimes anastomosing with it in middle.

Type, *T. celaena* Turn.

49. Themerastis celaena.

Themerastis celaena, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 64.
Vict.: Melbourne.

50. Themerastis amalopa.

Themerastis amalopa, Turn., Proc. Linn. Soc. N.S.W., 1904, p. 833.

In the unique type vein 12 of hindwings anastomoses with middle of cell, a very exceptional structure.

N. Qland: Cairns.

51. Themerastis acrobela, n.sp.

ἀκροβέλος, with apical darts.

♀. 52 mm. Head whitish-brown. Eyes with long incurving cilia from posterior inferior quadrant. Palpi slightly over 1, ascending; whitish-brown, upper surface fuscous. Antennae fuscous, towards base whitish. Thorax whitish-brown, darker brown in centre. Abdomen and legs brown-whitish. Forewings elongate-triangular, costa straight to middle, thence gently arched, apex rounded-rectangular, termen bowed oblique; basal half bounded by a wavy line from mid-costa to dorsum before tornus, rather dark brown; terminal area whitish-brown; a whitish-brown quadrangular patch on mid-dorsum; a few fuscous scales in terminal area; two acute, dart-shaped, blackish, longitudinal, subcostal streaks before apex, that nearer costa being most apical; a submarginal series of interneural, transversely elongate, blackish dots, each partly outlined with whitish; cilia whitish-brown mixed with brown. Hindwings with termen gently rounded; ochreous-whitish; towards costa and termen with pale-fuscous suffusion; a dark-fuscous tornal spot bisected by a transverse whitish line; cilia pale-fuscous, on dorsum ochreous-whitish.

Type in Coll. Lyell.

N. Qland: Cape York in April; one specimen received from Mr. Elgner.

Gen. 23. Gargetta.

Gargetta, Wlk., Cat. Brit. Mus., xxxii., p. 455; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 70.

Frons with an anterior corneous projection. Tongue strong. Eyes with a tuft of long incurved cilia from posterior inferior quadrant. Palpi moderately long, ascending, shortly hairy; terminal joint small. Antennae bipectinate almost to apex in both sexes. Posterior tibiae with two pairs of long spurs. Forewings with 5 from about middle of cell, 6 from upper angle, areole broadly quadrangular, 7 connate or short-stalked with 8, 9 from end of areole, 10 widely separate from areole. Hindwings with 3 and 4 connate, 5 from middle of cell, 6 and 7 stalked, 12 approximated to cell as far as middle, thence gradually diverging.

Type, *G. costigera* Wlk. from India.

52. Gargetta acarodes.

Gargetta acarodes, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 71.

N. Qland: Townsville.

Gen. 24. Cascera.

Cascera, Wlk., Cat. Brit. Mus., xxxii., p. 460; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 73.

Head rough-haired with large tufts from bases of antennae. Tongue strong. Palpi moderately long (1 to 2), ascending, shortly hairy; terminal joint short or moderate. Antennae of ♂ bipectinate to three-fifths or two-thirds, thence simple; of ♀ simple. Thorax with a small rough posterior crest. Posterior tibiae with two pairs of spurs, inner spurs twice as long as outer. Forewings with 5 from middle or slightly above middle of cell, areole very long and narrow, reaching more than halfway from cell to apex, 6 from about middle of areole, 7 separately from areole or short-stalked with 8, 9, 10 separate. Hindwing with 5 from middle or above middle of cell, 6 and 7 stalked, sometimes only shortly, 12 approximated to near end of cell, sometimes anastomosing with cell in middle.

Type, *C. muscosa* Wlk.

53. Cascera muscosa.

Cascera muscosa, Wlk., Cat. Brit. Mus., xxxii., p. 461; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 73.

N. Qland: Cairns; Qland: Brisbane, Mt. Tambourine.

54. Cascera amydra.

Cascera amydra, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 74.

A second ♂ shows no white markings on forewings. In both 12 of hindwings anastomoses with the cell. This does not occur in any of my examples of *muscosa.*

N. Qland: Cairns, Townsville.

Gen. 25. Phalera.

Phalera, Hb., Verz., p. 146; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 64.

Head shortly hairy, with dense tufts from bases of antennae. Tongue present. Palpi short or moderate, porrect or ascending, more or less hairy; terminal joint short. Antennae of ♂ simple or very shortly pectinate with strong fascicles of cilia; of ♀ simple. Thorax with a small posterior crest. Abdomen with a dorsal crest on basal segment. Posterior tibiae with two pairs of spurs. Forewings with 5 from slightly above middle of cell, areole long and narrow, 6 from middle or beyond middle of areole, 7 from end of areole, connate with 8, 9, 10, which are stalked. Hindwings with 5 from above middle of cell, 6 and 7 stalked, 12 approximated to cell almost to its end.

Type, *P. bucephala* Lin. from Europe.

The stalking of 8, 9, 10 from areole, not including 7, is exceptional, but occurs also in *Pheressaces* and *Destolmia*.

55. PHALERA RAYA.

Phalera raya, Moore, Lep. E. I. Co., p. 433; Butl., Ill. Het., vi., Pl. 103, f. 1; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 65.—*P. grotei*, Moore, *loc. cit.*, p. 434.—*P. cossoides*, Wlk., Trans. Ent. Soc., 1862, p. 80.—*Acrosema amboinae*, Feld., Reise Nov., Pl. 96, f. 2.

N. Qland: Cape York, Cooktown; N.W. Aust.: Wyndham (L. J. Newman). Also from New Guinea, Amboyna, China, and India.

Gen. 26. DANIMA.

Danima, Wlk., Cat. Brit. Mus., v., p. 1053; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 58.

Head roughly hairy. Tongue strongly developed. Palpi short, porrect, clothed with long spreading hairs; terminal joint concealed. Antennae of ♂ pectinate, apical half simple; of ♀ simple. Pectus and femora clothed with long, dense, shaggy hair. Posterior tibiae with two pairs of spurs. Forewings with areole moderate, 6 from upper angle of cell or from areole near base, 7, 8, 9 stalked, or 7 connate, 10 separate. Hindwings with 3 and 4 connate or separate, 5 from above middle of cell, 6 and 7 stalked, 12 approximated to cell from base to near its end.

Type, *D. banksiae* Lew.

56. DANIMA BANKSIAE.

Bombyx banksiae, Lew., Lepid. N.S.W., Pl. ix.—*Danima banksiae*, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 59.

N. Qland: Townsville; Qland: Emerald, Brisbane, Coolangatta; N.S.W.: Sydney; Vict.: Melbourne, Wandin; S. Aust.: Adelaide; W. Aust.: Perth, Geraldton.

Gen. 27. ECNOMODES.

Ecnomodes, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 69.

Tongue obsolete. Palpi moderately long, ascending, hairy; terminal joint short. Thorax with a loose anterior crest. Antennae pectinated to apex in both sexes. Posterior tibiae with two pairs of spurs. Forewings with 5 from middle of cell, areole rather long, 6 from near base of areole, 7 connate or stalked with 8 and 9, 10 separate. Hindwings with 5 from about middle of cell, 6 and 7 stalked, 12 approximated to middle third of cell.

Type, *E. sagittaria* Luc.

57. ECNOMODES SAGITTARIA.

Chlenias sagittaria, Luc., Proc. Roy. Soc. Qland., 1899, p. 148.—*Ecnomodes sagittaria*, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 70.

Qland: Brisbane, Toowoomba.

Gen. 28. DESTOLMIA.

Destolmia, Wlk., Cat. Brit. Mus., v., p. 991; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 59.

Tongue present but weakly developed. Antennae in ♂ bipectinate to somewhat beyond middle, in ♀ simple. Palpi short or moderate, hairy, porrect or ascending. Thorax with a rounded anterior crest. Posterior tibiae with two pairs of spurs. Forewings with areole narrow, 6 from slightly beneath upper angle of cell, from angle, or from areole before middle, 7 connate or closely approximated from end of areole, 8, 9, 10 stalked, or 10 connate or separate. Hindwings with 5 from above middle of cell, 12 well separated from cell at base, becoming approximate, and sometimes connected before middle, thence scarcely diverging.

Type, *D. lineata* Wlk.

58. Destolmia lineata.

Destolmia lineata, Wlk., Cat. Brit. Mus., v., p. 992; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 60.—*Collyta lanceolata,* Wlk., Cat. Brit. Mus., xxxii., p. 452.—*Notodonta cinerea,* Luc., Proc. Roy. Soc. Qland., 1891, p. 78.

N. Aust.: Darwin; N. Qland: Claudie River; Qland: Nambour, Brisbane, Toowoomba; N.S.W.: Taree, Springwood; S. Aust.: Mt. Lofty.

59. Destolmia nigrolinea.

Notodonta nigrolinea, Luc., Trans. Nat. Hist. Soc. Qland., 1894, p. 107.—*Destolmia nigrolinea,* Turn., Proc. Linn. Soc. N.S.W., 1903, p. 61.

Qland: Brisbane.

60. Destolmia hesychima, n.sp.

ἡσύχιμος, quiet.

♀. 36 mm. Head whitish. Palpi scarcely over 1; whitish, with a few fuscous scales. Antennae pale-grey. Thorax whitish, with a few fuscous scales. Abdomen grey-whitish. Legs ochreous-whitish. Forewings elongate-triangular, costa slightly arched, apex round-pointed, termen slightly bowed, oblique; 10 separate; whitish; a very short, dark-fuscous, median streak from base; a large fuscous suffusion extending on costa from base to middle, not reaching dorsum, and much narrower towards dorsum; a short blackish longitudinal mark above middle of disc; a fuscous subterminal fascia from beneath apex, inwardly curved to dorsum before tornus, broadly connected in middle with basal suffusion and with termen, crossed above middle by a short blackish streak; cilia fuscous. Hindwings with termen rounded; whitish, towards termen broadly suffused with grey; cilia grey, apices whitish, on dorsum whitish.

Type in Coll. Lyell. Except in the development of the tongue this species approximates to the genus *Ecnomodes.*

W. Aust.: Waroona in January; one specimen received from Mr. G. F. Berthoud.

Gen. 29. Antimima.

Antimima, Turn., Proc. Roy. Soc. Qland., 1917, p. 73.

Face with rounded corneous prominence. Tongue strongly developed. Palpi moderate (slightly over 1), porrect, shortly hairy. Antennae of ♂ bipectinate for about two-thirds, thence simple; of ♀ simple. Thorax without crests. Posterior tibiae with two pairs of spurs. Forewings with areole narrow, 6 from areole before middle, 7 from end of areole, 8, 9 stalked, 10 separate. Hindwings with 5 from above middle of cell, 6 and 7 stalked, 12 approximated to cell from base nearly to end.

61. Antimima cryptica.

Antimima cryptica, Turn., Proc. Roy. Soc. Qland., 1917, p. 73.
The sexes are alike. Antennal pectinations of ♂ 4.
W. Aust.: Quindalup, Waroona, Perth, Kelmscott.

Gen. 30. Omichlis.

Omichlis, Hmps., Trans. Ent. Soc., 1895, p. 279; Moths Ind., iv., p. 454.

Tongue strong. Palpi rather long, ascending, appressed to frons, reaching vertex, shortly hairy; terminal joint short. Antennae in ♂ bipectinate, towards apex simple. Posterior tibiae with two pairs of spurs, the inner very long, twice as long as outer. Forewings with 5 from slightly above middle, 6 from cell or from areole before middle, areole moderately large, 7 connate with 8 and 9, 10 separate. Hindwings with 5 from above middle of cell, 6 and 7 stalked, 12 approximated to cell from base to beyond middle.

A small Oriental genus, of which one Indian and several Papuan species are known.

Type, *O. rufotincta* Hmps. from India.

62. Omichlis hadromeres, n.sp.

ἁδρομερης, stoutly built.

♂. 38-44 mm. Head and thorax brown-whitish or pale-brown. Palpi 1½, ascending, appressed to frons, reaching vertex; brown-whitish, upper surface fuscous-brown. Antennae brown-whitish or pale brown; in ♂ with long pectinations, apical one-third simple. Abdomen pale-brown; tuft and underside brown-whitish. Legs brown-whitish; anterior and middle tarsi annulated with fuscous-brown. Forewings triangular, costa gently arched, apex rounded-rectangular, termen obtusely angled on vein 4; brown-whitish or pale-brown; markings fuscous; three or four small dots between base of costa and fold; sometimes a subbasal spot above dorsum; a curved transverse series of dots at about one-sixth; an outwardly-curved, very slender, interrupted line from one-third costa to two-fifths dorsum; a suffused line or dark shade from mid-costa at first outwards, bent inwards in middle, thence inwardly curved to three-fifths dorsum; this is followed by an indistinct parallel line of dots, of which one on fold is sometimes enlarged; a similar subterminal series of dots; a fine, dentate, but interrupted, submarginal line; cilia brown. Hindwings rather large, termen rounded; brown; cilia ochreous-whitish.

N. Qland: Kuranda near Cairns in December, January, and April; four specimens received from Mr. F. P. Dodd.

Gen. 31. Osica.

Osica, Wlk., Cat. Brit. Mus., xxxiii., p. 766; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 71.

Tongue strong. Palpi long, curved, ascending; second joint thickened with appressed hairs, which form a slight, rounded anterior tuft; terminal joint rather long, acute. Antennae simple; in ♂ shortly ciliated. Abdomen with a small dorsal crest on basal segment. Posterior tibiae with two pairs of long spurs, the inner longer. Forewings with 5 from above middle, areole short and narrow, 6 from end or near end of areole, 7, 8, 9, 10 stalked from areole, 7 arising before 10. Hindwings with cell rather short (about one-third), 5 from above middle, 6

and 7 stalked, 12 approximated to cell from base to about three-fourths.
Type, *O. glauca* Wlk.

63. OSICA GLAUCA.

Osica glauca, Wlk., Cat. Brit. Mus., xxxiii., p. 767; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 72.—*O. turneri*, B.-Bak., Nov. Zool., 1904, p. 374, Pl. 6, f. 31.—*O. funerea*, B.-Bak., Nov. Zool., *loc. cit.*, p. 374.

N. Qland: Cairns; Qland: Brisbane. Also from New Guinea.

Gen. 32. GALLABA.

Gallaba, Wlk., Cat. Brit. Mus., xxxii., p. 457; Turn., Proc. Linn. Soc. N.S.W., 1904, p. 67.

Frons with a long anterior tuft. Tongue present. Palpi long, porrect or ascending, hairy; terminal joint long. Antennae pectinated to apex in both sexes. Patagia long, dense, erect, projecting beyond and above thorax. Abdomen with a small dorsal crest on basal segment. Posterior tibiae with two pairs of spurs, the inner very long, twice as long as outer. Forewings with 5 from middle or slightly below middle, areole rather large, 6 from near base of areole, 7 and 10 separate, or rarely 10 connate. Hindwings with 5 from middle or below middle, 6 and 7 stalked, 12 closely approximated to cell from base to near its end, sometimes anastomosing.

Type, *G. duplicata* Wlk.

1. Thorax grey .. .. *ochropepla*.
   Thorax fuscous .. .. 2.
2. Forewing with post-median lines slender, denticulate .. .. *duplicata*.
   Forewings with post-median lines not denticulate, the most posterior thickened .. .. *eugraphes*.

64. GALLABA OCHROPEPLA.

Gallaba ochropepla, Turn., Proc. Linn. Soc. N.S.W., 1903, p. 69.
Vict.: Sale.

65. GALLABA DUPLICATA.

Gallaba duplicata, Wlk., Cat. Brit. Mus., xxxii., p. 458; Turn., Proc. Linn. Soc. N.S.W., 1903, p. 68.

Qland: Brisbane, Stradbroke Is., Coolangatta; N.S.W.: Glen Innes, Sydney.

66. GALLABA EUGRAPHES, n.sp.

εὐγρᾰφής, well finished.

♂. 42 mm. Head and thorax fuscous with some whitish hairs. Palpi 3½, terminal joint two-thirds; fuscous, anteriorly ochreous-whitish. Antennae pale-fuscous. Abdomen grey. Legs fuscous; posterior pair ochreous-whitish. Forewings sub-oblong, costa arched at base, thence nearly straight, apex subrectangular, termen bowed, oblique; whitish finely irrorated with fuscous, more closely so as to appear grey in ante-median area excluding basal portion; markings dark-fuscous; a short line from base along fold; a double strongly-waved line from one-third costa to one-third dorsum, angled inwards above dorsum; a strongly marked line from two-thirds costa, transverse towards tornus, bent inwards, thickened and waved above dorsum, preceded by two, fine, parallel, transverse lines, but the first of these is strongly bent inwards towards costa; a series of fine, transverse, interneural lines very near termen; cilia whitish mixed with fuscous. Hindwings with termen rounded, wavy; fuscous becoming paler towards base; cilia pale-fuscous.

Type in Coll. Lyell.

N.S.W.: Jervis Bay near Nowra in November; one specimen received from Mr. L. H. Moss-Robinson.

Gen. 33. POLYCHOA.

Polychoa, Turn., Proc. Linn. Soc. N.S.W., 1906, p. 681.

Tongue present. Palpi rather long, ascending; second joint thickened with closely appressed hairs which form a rounded anterior tuft; terminal joint moderately long, stout, acute, porrect. Antennae in ♂ bipectinate to apex Abdomen with a dorsal crest on basal segment. Posterior tibiae with two pairs of long spurs except outer terminal spur, which is less than one half of inner. Forewings with tufts of raised scales; 5 from middle of cell, 6 from upper angle of cell, areole moderate, 7 and 10 separate. Hindwings with 5 from middle of cell, 6 and 7 connate, 12 connected with cell at one-fourth, thence very gradually diverging.

Type, *P. styphlopis* Turn.

67. POLYCHOA STYPHLOPIS.

Polychoa styphlopis, Turn., Proc. Linn. Soc. N.S.W., 1906, p. 681.

N. Qland: Cairns. Also from New Guinea in British Museum.

Species unrecognised or wrongly referred.

68. *Clathe arida*, Wlk., Cat. Brit. Mus., v., p. 994, belongs to the Lasiocampidae.
69. *Nadiasa parvigutta*, Wlk., *l.c.*, v., p. 1015, belongs to the genus *Pinara* (Lasiocampidae).
70. *Listoca lignaria*, Wlk., *l.c.*, v., p. 1021.
71. *Sorema nubila*, Wlk., *l.c.*, v., p. 1065.
72. *Sorema contracta*, Wlk., *l.c.*, v., p. 1065.

(70–72) Synonyms of *Clathe arida*.

73. *Ptilomacra senex*, Wlk., *l.c.*, v., p. 1099, belongs to the Zeuzeridae.
74. *Destolmia ? liturata*, Wlk., *l.c.*, xxxii., p. 409.
75. *Rilia distinguenda*, Wlk., *l.c.*, xxxii., p. 435, is a synonym of *Olene mendosa* Hb. (Liparidae).
76. *Rigema tacta*, Wlk., *l.c.*, xxxii., p. 438, is a synonym of *Psalis securis* Hb. (Liparidae).
77. *Vunga delineata*, Wlk., *l.c.*, xxxii., p. 453, is a synonym of *Smyriodes aplectaria* Gn. (Boarmiadae).
78. *Asteroscopus nodosus*, Swin., Cat. Oxf. Mus., i., p. 299, is a synonym of *Chlenias banksiaria* Le G. (Boarmiadae).
79. *Teinocladia cuculloides*, Feld., Reise Nov., Pl. 96, f. 9, is a synonym of *Capusa senilis* Wlk. (Boarmiadae).
80. *Stauropus ? euryscia*, Low., Trans. Roy. Soc. S. Aust., 1903, p. 28, belongs to the Oenochromidae.
81. *Cerura ? melanoglypta*, Low., Trans. Roy. Soc. S. Aust., 1905, p. 177.

Index to *Notodontidae*.

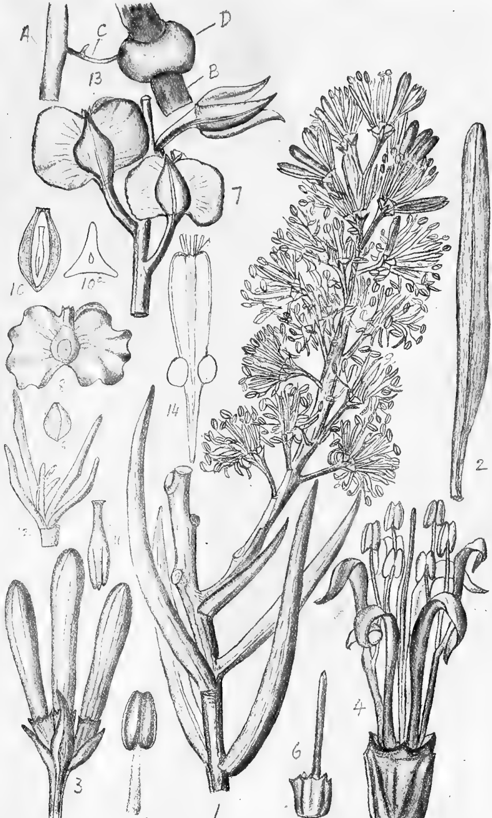
Genera.

(New genera in SMALL CAPITALS.)

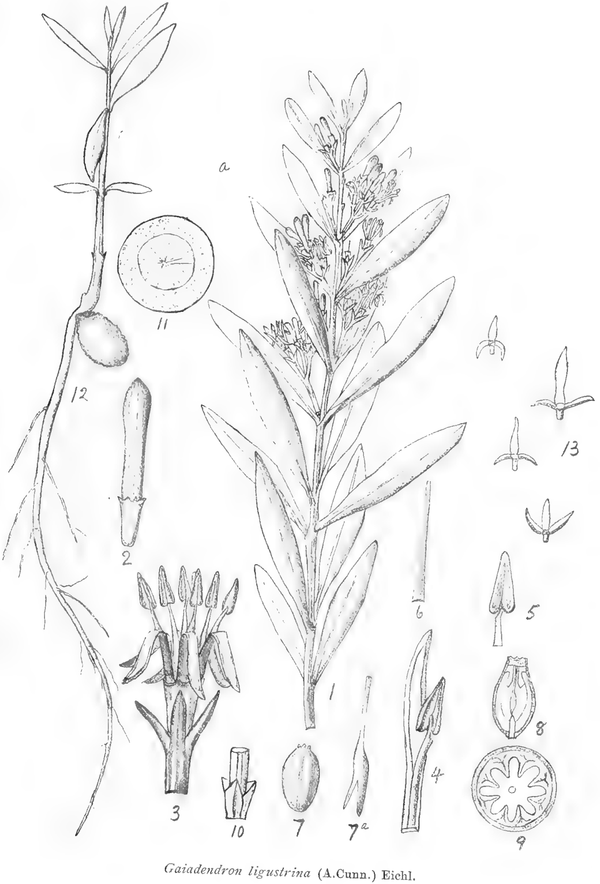
Species.

Synonyms and species wrongly included or unrecognised in *italics*.

[Printed off 7th September, 1922.]

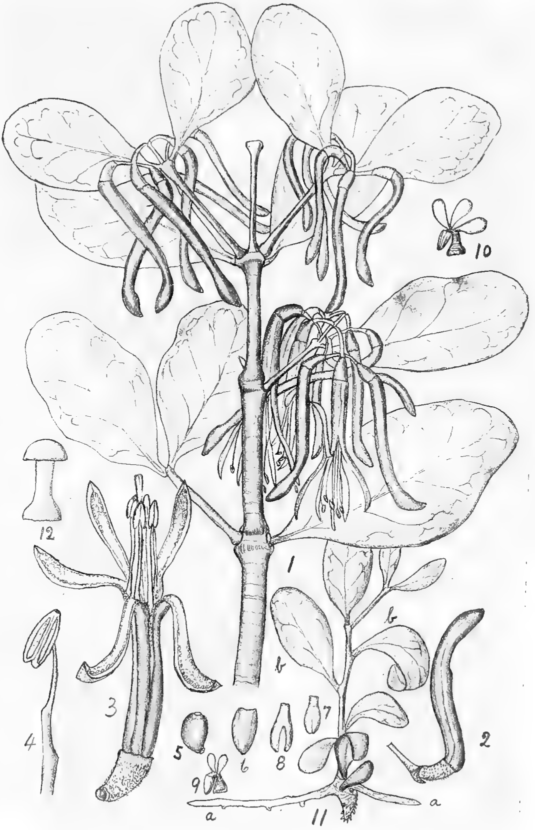


Nuytsia floribunda R.Br.



Gaiadendron ligustrina (A.Cunn.) Eichl.

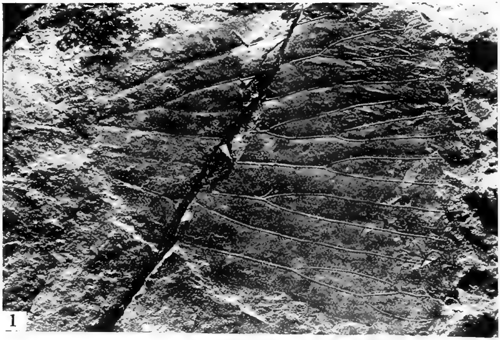
Phrygilanthus eucalyptifolius (Sieber) Engler.

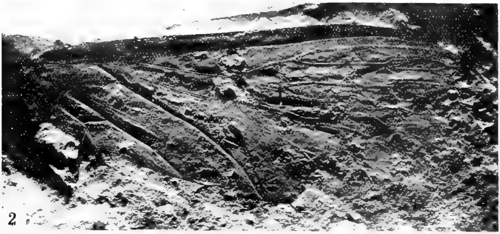


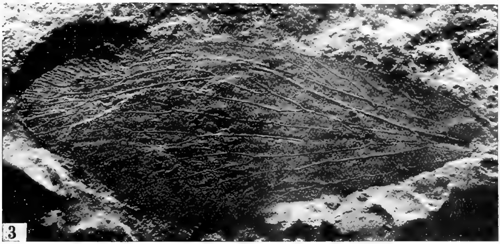
Phrygilanthus celastroides (Sieber) Eichl.

Phrygilanthus myrtifolius (A.Cunn.) Eichl.

Phrygilanthus Bidwillii (Benth.) Eichl.

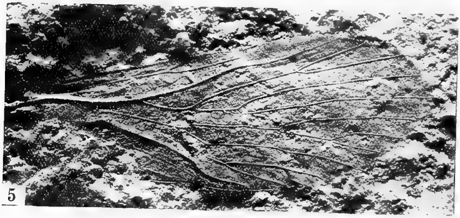






1. *Archipanorpa (?) bairdae*, n.sp. 2. *Parabelmontia permiana*, n.g. et sp. 3. *Permithone belmontensis*, n.g. et sp.

4


5


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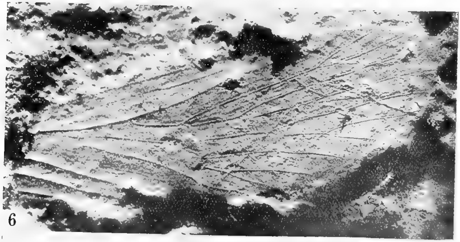

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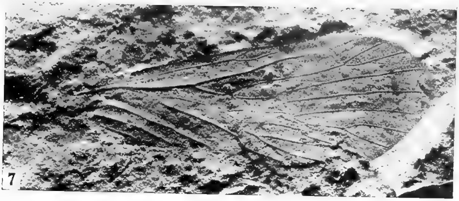
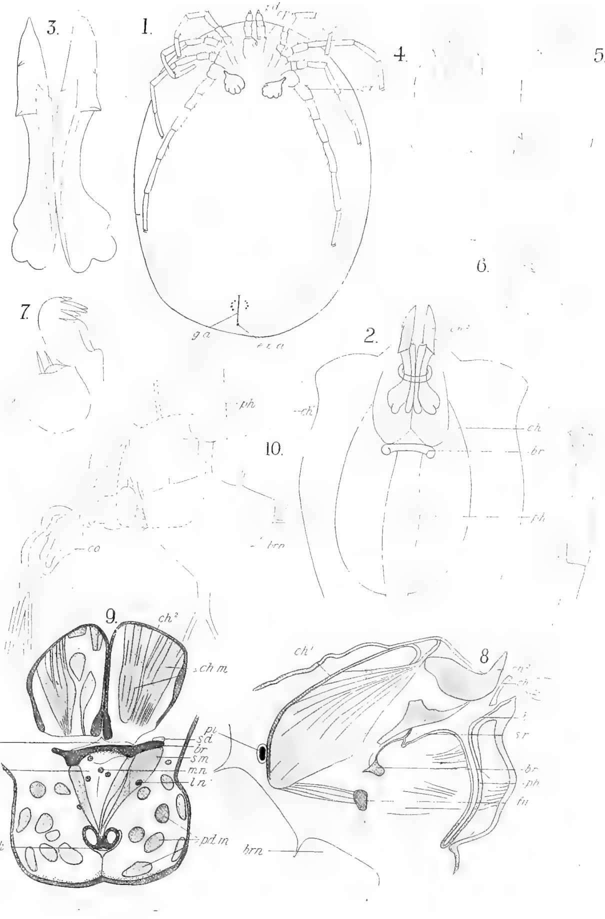


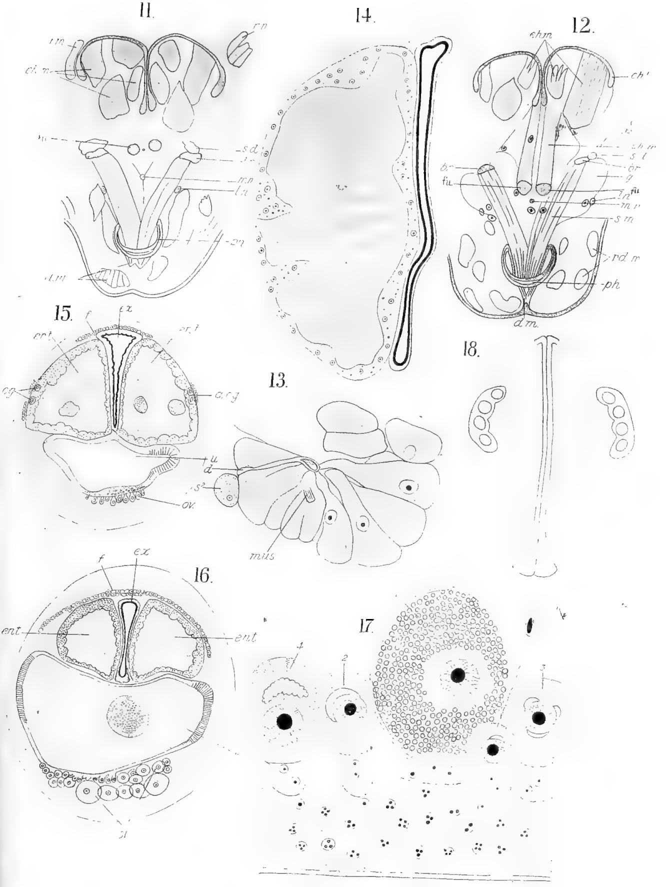
4. *Pincombea mirabilis*, n.g. et sp. 5-6. *Permochorista sinuata*, n.sp.
7. *Permochorista affinis*, n.sp.

Photo. H. G.Gooch.

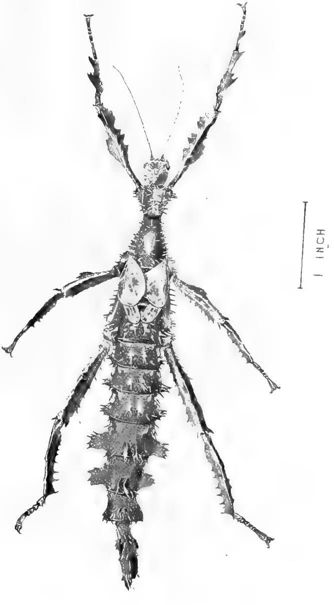
Platyschisma allandalensis, n.sp.



Astacocroton molle, n.g. et sp.



Astacocroton molle, n.g. et sp.



Extatosoma elongatum, n.sp. (x$\frac{3}{4}$)

THE *LORANTHACEAE* OF AUSTRALIA. Part iii.

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

(Plates xxxix.-xlvii.)

[Read 27th September, 1922.]

Loranthus L.

Flowers hermaphrodite. Calyx short, dentate or truncate. Corolla symmetrical or only slightly irregular, resting upon a small, somewhat raised disc. Petals 4 to 6, free or partly united. Filaments usually adnate to the centre of the petals, convexed or compressed; anthers usually linear, two- to four-celled, the cells opening vertically, basifixed. Style filiform, terete or angular, sometimes geniculate below the small conical or sub-capitate stigma. Fruit baccate, crowned by the persistent calyx; epicarp thick, coriaceous. Seeds albuminous, issuing basally or apically from the epicarp, surrounded by viscin; embryo usually green, straight or curved, clavate or awl-shaped; cotyledons usually two, obtuse or acute, often remaining in the endosperm when germination takes place.

Leafy parasitic shrubs with brittle, jointed branches without stipules. Leaves opposite or alternate, penninerved, tri-, or quinque-nerved. Flowers solitary, or the common peduncle bifurcate, cymose or racemose, each flower supported by a single, deciduous or persistent, sessile or pedicellate bract.

The genus as defined by Engler represents over 300 species, but subsequent additions probably more than double that number.

The countries best represented are South Africa, Asia, Pacific Islands, New Guinea, and Australia. Australia has 41 species.

Subgenus Euloranthus Benth.

Key to the species.

Buds usually clavate; flowers 4- to 6-merous, petals free or very shortly united at the base. Anthers adnate.

Sect. Amyema.

Petals 4 or 5, rarely 6. Fruit with strange inter-running scleroids.

§. EUAMYEMA.

Flowers sessile or pedicellate, standing against or opposite to each other.

A. Biflorati. Peduncles once or twice branched, with a pair of pedicellate flowers to each branch.

i. Leaves compressed or terete.

1. Buds densely woolly-tomentose. Petals 4. Leaves tomentose. 1. *L. gibberulus.*

Leaves glabrous. .. .. var. *Tateii.*

ii. Leaves flat, ligulate.

1. Buds glabrous, slender, inflated at the base. .. .. 2. *L. bifurcatus.*

1a. Buds densely ferruginous-tomentose, robust, scarcely inflated at the base. Leaves broadly lanceolate. .. .. 3. *L. ferruginiflorus.*

Buds nearly glabrous. Leaves linear. .. .. var. *linearifolia.*

B. Umbellulati. Inflorescence in simple or compound umbels.

i. Umbels simple, large, 1-2 in the axils.

1. Flowers 25—35 mm. long. Leaves oblong-lanceolate or ligulate, 3—5-nerved. .. .. 4. *L. sanguineus.*

Flowers 50—60 mm. long. Leaves short and thick, 5—7-nerved, or the smaller ones 3-nerved. .. .. var. *pulcher.*

ii. Umbels diminutive.

1. Flowers clustered at the nodes. Leaves elliptical to orbicular. 5. *L. Whiteii.*

iii. Umbels compound, 3—7-branched, each branch with 3 pedicellate flowers.

1. Leaves ligulate, usually 10—16 cm. long, 3-nerved. .. .. 6. *L. Miquelii.*

Buds white. .. .. (*a*) var. *micranthus.*

Buds reddish. Leaves 3—5 cm. long. .. .. (*b*) var. *minor.*

C. Cymulati. Inflorescence cymose. Cymes 2—7-branched, each branch bearing 3 flowers, the central flower sessile, or all the flowers sessile.

I. Branches of the cyme 3 to 7, sometimes 2-branched in *L. Gaudichaudi*, *L. miraculosus*, and its varieties. Central flower of each triad sessile.

i. Leaves flat.

1. Young shoots and buds ferrugineous. Leaves 7 to 24 cm. long, ligulate. Fruit brownish. .. ..7. *L. pendulus.*

1a. Young shoots and buds minutely hoary-pubescent. Leaves oblong-lanceolate 5—12 cm. long, obscurely 3-nerved. Fruit green. 8. *L. congener.*

2. Glabrous. Leaves spathulate to orbicular, strongly veined. Buds robust, 3 cm. long. Bracts rather large. .. .. 9. *L. Queenslandicus.*

3. Leaves thick, obscurely 3—5-nerved. Buds 15—20 mm. long. Bracts small, obtuse. Calyx urceolate. .. .. 10. *L. Cycneus-Sinus.*

3a. Leaves thin, orbicular, obscurely 3-nerved. Buds slender, about 2 cm. long. Bracts small, acute. Calyx cylindric. .. .. .. 11. *L. Mackayensis.*

4. Leaves broadly oblong to elliptical, usually glaucous. Buds 15—20 mm. long. Fruit urceolate, yellow. .. .. 12. *L. miraculosus.*

Leaves narrow cuneate-spathulate, 2—3 cm. long. ... (*a*) var. *Melaleucae.*

Leaves narrow, oblong, 2—10 cm. long. .. .. (*b*) var. *Boormani.*

Young tips and buds pubescent. .. .. (*c*) var. *pubigera.*

2a. Young shoots and buds minutely scurfy-pubescent. Leaves linear-spathulate to linear-oblong. Buds 10 mm. long. Fruit globose, red. 13. *L. Gaudichaudi.*

ii. Leaves terete.

1. Glabrous. Leaves short. Buds robust, reddish. Flowers in triads. 14. *L. Preissii.*

Flowers in pairs on long peduncles. .. .. var. *didyma.*

1a. Pubescent or tomentose. Leaves long and slender. Buds slender, scurfy. 15. *L. Cambagei.*

2. Leaves thick. Buds stout, woolly-tomentose. .. .. 16. *L. linophyllus.*

II. Branches of the cyme 2 to 4. All flowers sessile.
i. Cymes 2-branched.
1. Cymes in dense almost sessile clusters. Buds 10—15 mm. long. Leaves thick, mostly elliptical, usually 5-nerved. .. .. .. 17. *L. conspicuus.*
1a. Cymes elongated, not dense. Buds 20—25 mm. long. Leaves obovate-oblong, 3-nerved. .. .. 18. *L. Betchei.*
Leaves ovate to elliptic, 3—4 cm. x 1.5—2 cm. Cymes solitary. .. .. .. (*a*) var. *dubia.*
Leaves elliptical, 4—6 cm. x 3 cm. Cymes in clusters of 3—8. Buds hoary. .. .. (*b*) var. *tomentilla.*
2. Glabrous. Leaves almost sessile, somewhat obliquely oblong, 3-nerved. 19. *L. obliqua.*
Young shoots and buds densely woolly-tomentose. Leaves petiolate, penninerved. Bracts large, the central one narrower and longer than the two lateral ones. Buds robust. .. .. 20. *L. Nestor.*
Young shoots minutely woolly-tomentose. Leaves 3—5-nerved. Bracts small, buds slender. .. .. 21. *L. Hilliana.*
ii. Cymes 2—4-branched.
1. Leaves elliptical to oblong, 3—5-nerved. Calyx hoary pubescent at the base. .. .. 22. *L. Lucasi.*
III. Branches of the cyme usually 2. Central flower of each triad sessile.
1. Leaves petiolate, oblong lanceolate, usually 3-nerved. Buds and fruits hoary. .. .. 23. *L. Quandang.*
Leaves broadly lanceolate, 3—5-nerved .. .. var. *Bancrofti.*
1a. Leaves usually sessile, cordate to oblong, 3—7-nerved. Buds glabrous. Fruit semi-tomentose, yellowish. .. .. 24. *L. Benthami.*
D. Capitellati. Inflorescence capitate. Flowers 4—6, sessile on the summit of the peduncle, or the outer flowers on very short pedicellate bracts.
1. Flowers 6, closely capitate. Bracts conspicuous, semifoliaceous. Leaves narrow to broad oblong, 2—5 cm. long. .. .. 25. *L. Maideni.*
1a. Flowers 4—5, not closely capitate. Bracts small. Leaves obovate, oblong, about 2.5 cm. long. .. .. 26. *L. Fitzgeraldi.*

Sect. Diplatia.

Inflorescence capitate. Flowers 4—6, sessile on the dilated apex of the peduncle, between two large bracts or floral leaves, with a small deciduous scarious bract under each flower. Petals 5.
Leaves usually ligulate. .. .. 27. *L. grandibracteus.*

Sect. Neotreubella.

Inflorescence racemose, racems, secund. Flowers sessile, in triads on the apex of the short secondary peduncles, each subtended by a small subcordate sessile bract. Petals 5 or 6, free or sometimes united 1—2 mm. from the base. Calyx and fruit striped with light streaks.
i. Branches terete.
1. Leaves petiolate, narrow-lanceolate to falcate-lanceolate, 5—20 cm. long. 28. *L. Britteni.*
1a. Leaves oblong to broad lanceolate, 5—10 cm. long. .. 29. *L. signatus.*
2. Leaves sessile, amplexicaul, cordate-lanceolate .. .. .. 30. *L. amplexans.*
ii. Branches compressed—angular.
1. Leaves lanceolate, somewhat decurrent. .. .. 31. *L. biangulatus.*

Subgenus Euloranthus Benth.

Benth. et Hook. f., Gen. Plant., iii., 1880, 207; Engl. et Prantl, Pflanzenfam., Nachtr., 1897, p. 127.

Buds cylindrical or clavate. Flowers 4—6-merous. Petals free or very shortly united at the base. Filaments nearly always longer than the adnate anthers.

Sect. AMYEMA Engler.

Engl. et Prantl, Pflanzenfam., Nachtr., 1897, 127; genus *Amyema* van Tiegh., Bull. Soc. bot. France, lxi., 1894, 506.

Buds candelabriform, cylindrical or clavate, invariably more or less inflated at the base. Petals 5 or 6. Filaments usually longer than the anthers, the adnate portion always slightly convex on the inner face of the segment. Anthers firm, oblong, obtuse or acute. Style usually angular and geniculate about 3 mm. below the sub-capitate stigma. Fruit pear-shaped, urceolate to globose. Viscin not copious. Embryo claviform or subulate; embryonic cotyledons usually elongated, remaining in the endosperm on germination. Primary leaves linear-lanceolate. Pendulous or divaricate shrubs; union ball-like, without adventitious roots. Leaves usually opposite, flat or terete, 1—7-nerved. Inflorescence mostly cymose. Fruit with strange inter-running scleroids.

§ *Euamyema* Engler.

Flowers sessile or pedicellate, standing against or opposite to each other. Inflorescence variously disposed, bifurcate, umbellate, cymose, or capitate.

(A) *Biflorati*, n. subser.

Peduncles once or twice branched, with a pair of pedicellate flowers to each branch.

LORANTHUS GIBBERULUS Tate. (Plate xxxix.)

Trans. Roy. Soc. S. Aust., viii., 1884-5, 71.

Additional notes to the description.

Branches mealy or woolly-tomentose when young, glabrous, and with a few scattered orbicular lenticels when old. Leaves woolly-tomentose for the first year or two, becoming glabrous, except on the inside near the base, opposite, alternate, or in clusters of 3-4 crowding the short branches, mostly straight and acute. Inflorescence densely woolly-tomentose, the indumentum white on the calyces, pinkish on the buds. Flowers pedicellate, in pairs; the common peduncle woolly-tomentose, shorter than the pedicels. Buds robust, straight, cylindrical, clavate at the top, 3 cm. long. Bracts orbicular, almost enveloping the calyces, thick, concave, 4 mm. long and nearly as broad. Calyx cupular, densely woolly-tomentose, the limb very conspicuous, or about half the length of the calyx. Petals 4, free, thick, narrow-linear except for the ovate-spathulate, concave apex, pinkish inside. Filaments adnate, for their entire length, sulcate. Anthers adnate, the cells in 4 vertical rows, the backs sometimes woolly-tomentose. Style angular, firm, the same colour as the inside of the petals, geniculate on a level with the base of the anthers; stigma dark coloured, scarcely enlarged. Disc thick, tetragonal, larger than any of the allied species, with the articulation scars of the filaments rather conspicuous upon it. Fruit densely woolly-tomentose, globose, 7 mm. in diameter, but not seen ripe. Cotyledons unknown.

Range.—South Australia: William Tableland, West side of Lake Eyre, on *Grevillea nematophylla* (Malcolm Murray). The type.

Northern Territory: Near Hermannsburg, Finke River (G. F. Hill, No. 77; Ewart and Davies, Flora N.T., 88); Camp ii. (G. F. Hill, No. 242a; Ewart and

Davies, Flora N.T., 88); Running Waters, Finke River ("this fine plant was in full blossom, and it grows equally well on *Grevillea* or *Hakea*," Trans. Roy. Soc. S. Aust., xxxviii., 1914, 462); (Herb.) J. M. Black. Young shoots woolly-pubescent; between James Range and Alice Creek, on *Hakea leucoptera* (R. Tate, Rept. Horn Exped., Part iii., 160); Palm Creek, on *Grevillea aquifolia*; Alice Springs, on *Grevillea striata*; Todd River, Burt Plain; Goyder Pass (R. Tate, *l.c.*); Mount Francis (R. Tate, *l.c.*); Glen Hellen, Tietkens (Mueller and Tate, Trans. Roy. Soc. S. Aust., xiii., 1889-90, 101).

Western Australia: Cavanagh Range, on *Hakea lorea* (R. Helms, 28.7.91); Mount Squires (R. Helms), Mueller and Tate in Botany Elder Expedition, Trans. Roy. Soc. S. Aust., xvi., 1882, 360; Comet Vale, on *Grevillea juncifolia* (J. T. Jutson, No. 150); Austin and Murrun Murrun Districts (W. J. George) (herb.), Diels and Pritzel, Bot. Jahr., xxxv., 1905, 175.

Affinities: As Professor Tate points out, its nearest affinity is with *L. linophyllus* Fenzl., forma c. of Bentham, which I regard as the typical *L. linophyllus*.

From herbarium specimens the plant appears to be an erect grower, whilst its nearest ally is pendulous in the majority of cases. Sometimes the flowers of *L. linophyllus* are tetramerous, but the filaments are long and free at the top with narrow anthers, not united for their entire length, with broad, 4-celled, almost sessile anthers as in *L. gibberulus*. In these two characters it differs from all the other Australian species. Its immature fruits are exactly like those of *L. Nestor* S. Moore; the large orbicular bracts are similar to those of *L. ferruginiflorus* W. V. Fitz.; but the foliage of both species is totally different. It is interesting to note that *L. gibberulus* has so far been recorded from *Proteaceous* food-plants only. Professor Tate was of the opinion that it confined itself to the Grevilleas but it has since been noted on Hakeas.

Hosts.—Proteaceae: *Grevillea striata* R.Br., *G. aquifolia* A. Cunn., *G. nematophylla* F.v.M., *G. juncifolia* Hook. and *Hakea leucoptera* R.Br.

Var. Tateii, n. var.

Folia glabra, teretes crassa, nonnumquam rigida, apposita vel fasciculata 5—9 cm. longa. Alabastra graciles non tam robusta quam in forma typica.

Leaves and young shoots strictly glabrous, the former terete, thick, somewhat rigid, opposite, alternate or in fascicles of 3—5, 2—3 inches long. Inflorescence woolly-tomentose, buds slender, less robust than the typical form; petals thin; anthers glabrous on the back in all the flowers examined.

L. gibberulus Tate, var ? referred to by Mueller and Tate in Botany Elder Exploring Expedition (Trans. Roy. Soc. S. Aust., xvi., 1882, 360) from Yilgarn, Western Australia, about 36 miles N.W. from Southern Cross, parasitic on *Hakea* sp. R. Helms.

Mr. W. V. Fitzgerald also found it at Arrino, 175 miles N.W. of Southern Cross, parasitic on *Hakea decurva*, Sept. 1903. The specimen is in early bud, but the segments are separable into four only, and the anthers are glabrous at the back.

It is only known from Western Australia.

Named in honour of the late Professor R. Tate.

Hosts.—Proteaceae: *Hakea lorea* R.Br., *H. decurva* Meissn.

2. Loranthus bifurcatus Benth. (Plate xl.)

B.Fl., iii., 1866, 393; Britt., Ill. Bot. Cook's Voy., iii., p. 85, tab. 275, as *L. pendulus* Sieb.

Supplementary notes to the description.

The following additional notes are taken from Dr. T. L. Bancroft's No. 862, from Eidsvold, Queensland. There are no records as to the mode of attachment, or habit of the plant, but no doubt it is similar to *L. pendulus* Sieber.

Leaves thin, pale-coloured, the young ones slightly glaucous, narrow to broad lanceolate, 3- or 5-nerved, 2 to 8 inches long, the petiole rather long and terete. Peduncles two or three together in the axils of the leaves, slender, 6 to 10 cm. long; pedicels slender, 9-10 mm. long. Buds minutely pubescent when quite young, glabrous when mature, shading from green to reddish-purple in colour, 2.5 cm. long, considerably inflated at the base, striate and somewhat quadrangular-clavate at the top. Bracts cordate, concave, not large, slightly enlarged under the ripe fruit, but not nearly to the same extent as in some species. Calyx obconical, minutely rusty tomentose, the limb minute. Petals dark purple-brown inside. Filaments the same colour as the petals, the adnate portion ending in a spur-like callosity at the base. Anthers 3-4 mm. long, linear, adnate. Style angular, rather persistent on the fruit, straw-coloured; stigma slightly enlarged, capitate. Fruit cylindrical-urceolate or bottle-shaped, yellowish-green when ripe, glabrous, or sometimes minutely scurfy; upper portion of the epicarp much thicker than the basal portion. Seeds cylindrical, slightly corrugated, 12 mm. long; viscin scanty. Endosperm white; embryo green; hypocotyl very short, green, verrucose; disc not much enlarged; embryonic cotyledons not withdrawn from the endosperm on germination. Primary leaves linear-lanceolate, but not seen when fully developed.

Range.—*L. bifurcatus* Benth. is so far found in Queensland, Northern Territory, and Western Australia. The following are the localities.

Queensland: Mt. Lindsay, on *Eucalyptus microcorys* (C. T. White); Eidsvold (Dr. T. L. Bancroft, August, 1911, in Queensland Herbarium), parasitic on *Eucalyptus dichromophloia,* Nov., 1918. Dr. Bancroft states that it is common on the Bloodwoods; Mount Perry, on *Eucalyptus* sp. (Jas. Keys, No. 165, in Queensland Herbarium); Barcaldine, on *Eucalyptus terminalis* (C. T. White, No. 11, April, 1919. Fruits infested with insects); Endeavour River (Banks and Solander, 1770). This specimen was received from the British Museum. It is depicted in James Britten, Illustrations Botany Cook Voyage, iii., p. 85, Tab. 275, under *L. pendulus* Sieber, and will be a useful reference to those who are unable to obtain specimens of this somewhat rare species.

Bentham does not appear to have seen the specimens collected by Banks and Solander, for he does not refer to it in his "Flora Australiensis," notwithstanding the fact that it was found thirty-two years before Robert Brown collected it. The specimen is of special interest as it was doubtless collected while the Endeavour was undergoing repairs in the river which Captain Cook named after his vessel.

Northern Territory: Gulf of Carpentaria (Robert Brown, 1802. The type. Quoted by Bentham, *l.c.*); Camp ii., N.T., parasitic on No. 241, *Eucalyptus transcontinentalis* (G. F. Hill, No. 242, *vide* Ewart and Davies, Flora Northern Territory, 1917, p. 88).

Western Australia: Derby. "Common on *Eucalyptus clavigera,* var. ?, a very characteristic species, with young unripe fruits" (No. 1181, C.H. Ostenfeld, Dansk. Botanisk Arkiv., Bot. 2, Nr. 8, 14, 1918). Roebuck Bay (in Adelaide Herbarium, kindly lent by Professor Osborn).

Affinities.—*L. bifurcatus* Benth. appears to be more closely allied to *L. ferruginiflorus* W.V.Fitz. than to any other species. It is, however, smaller and more glabrous in the inflorescence, and the bracts and buds are different in shape.

It bears a general resemblance to *L. Miquelii* Lehm. The Endeavour River specimen is particularly like it, with opposite, linear-lanceolate, triplinerved leaves, 2-7 inches long, on slender terete pedicels 1¼ inches long. The bifurcate peduncle is very marked, and is even distinguishable in the minute cymes. The swelling at the base of the corolla, when in bud, is greater than that of *L. Miquelii* Lehm., although the buds and bracts are almost identical in both species.

Bentham (B.Fl., *l.c.*) pointed out that it is allied to *L. sanguineus* F.v.M. and *L. pendulus* Sieber, "differing from both chiefly in the ramifications of the peduncles."

Hosts.—Myrtaceae: *Eucalyptus clavigera* A. Cunn., var ?, *E. dichromophloia* F.v.M., *E. microcorys* F.v.M., *E. terminalis* F.v.M., *E. transcontinentalis* Maiden.

3. LORANTHUS FERRUGINIFLORUS W. V. Fitz. (Plate xli.)

Proc. Roy. Soc. W.A., iii., 1916-17, 35.

Additional notes to the description.

Mr. Fitzgerald presented his specimens to the National Herbarium, Sydney, which enabled me to make a closer examination of his type, and to supplement his description with a few morphological notes.

Large pendulous shrubs with a ball-like union, branches 2-7 feet long (taken from N.S.W. plants). Buds densely ferruginous tomentose when young, robust, 2½ cm. long, clavate, about the same diameter at the top as at the base, sulcate, the lines indicating the demarcation of the petals; calyx cupular, 5 mm. long, the border very prominent; bract entirely embracing the calyx when young, broadly cordate, gibbose. Petals 5-6, narrow linear to narrow lanceolate, ferruginous-tomentose below the free portion of the filaments, and considerably broader at the base, filaments short, compressed, sulcate, the adnate portion thickened into a concave callosity about 4 mm. from the base, forming a nectar-like cup for the secretion of nectar; filaments usually terminating in a spur-like callosity at the base; anthers oblong, with conspicuous cells; style firm, angular; stigma somewhat compressed, with 3-5 depressions at the top. Fruit with a prominent pentagonal disc.

I have been unable to procure fresh fruits of this species, and therefore its cotyledons and method of germination are still unknown.

Range.—The range of this species at present extends from North-Western Australia to the northern districts of New South Wales.

Western Australia: Roebuck Bay (J. W. C. Tepper, No. 92, July, 1890, in Adelaide Herbarium; kindly lent by Professor Osborn); Summit of Mount Haste (W. V. Fitzgerald, No. 1291, July, 1905. The material is mixed—one specimen in flower has broad lanceolate falcate leaves, the other is in the juvenile fruiting stage, with pedicels 10 mm. long; the leaves are narrow linear, obscurely nerved, 17 cm. long); Summit of Mount Rason (W. V. Fitzgerald, July, 1905. Leaves broad lanceolate, obtuse, 3—5-nerved, 23 cm. long; fruits sub-globose, almost glabrous. This specimen is less tomentose than the preceding); Broome (W. V. Fitzgerald, July, 1906. Leaves narrow linear like the Mt. Haste specimen; buds robust about half grown; the broad bracts completely embracing the calyces. These three specimens constitute the type).

Queensland: Rockhampton (Amelia Dietrich, No. 1134, in Herb. Melb. One leaf is fully 10 inches long, with the petiole nearly 2 inches); Eidsvold (Dr. T. L. Bancroft, August, 1911, in Queensland Herbarium); 10 miles from Eidsvold, on *Eucalyptus maculata* (Dr. T. L. Bancroft, No. 431. Petals purplish inside, also the style and filaments, the former with a minute tuft of hairs inside at the apex); Fraser Island (Hon. Mrs. Lovell, No. 869, Queensland Herbarium); Glass House Mountain, on *Eucalyptus trachyphloia* (F. M. Bailey, No. 870, May, 1910, Queensland Herbarium, kindly lent by Mr. C. T. White, as also were the four preceding specimens). All the Queensland specimens are typical.

New South Wales: Casino, on *Eucalyptus maculosa* (L. G. Irby); Narrabri, on *Angophora intermedia* and *Eucalyptus tessellaris* (W. Bauerlen, No. 2841. Inflorescence densely ferruginous-tomentose, the common peduncle ½ to 1 inch long, bearing 2-4 branches, each with two pedicellate flowers); Gunnedah (W. MacDonald).

Affinity.—This species has masqueraded under *L. pendulus* Sieb., *L. bifurcatus* Benth. and *L. sanguineus* F.v.M.

Its nearest affinity is *L. bifurcatus* Benth., from which it can be distinguished by the relatively larger and more robust buds, densely ferruginous-tomentose inflorescence, larger calyx with its prominent limb, and in the larger orbicular bracts.

It is very much after the habit and general appearance of *L. pendulus* Sieb., but the whole plant is coarser and the flowers are exceedingly ferruginous-tomentose, and stouter than those of *L. pendulus* Sieb. and, like it, grows extensively on *Eucalyptus*. The filaments also are more or less hirsute on the adnate portion.

Hosts.—Myrtaceae: *Angophora intermedia* DC., *Eucalyptus clavigera* A. Cunn., *E. maculata* Hook., *E. trachyphloia* F.v.M., *E. tessellaris* F.v.M.

Var. LINEARIFOLIA, n.var. (Plate xli., fig. B.)

Foliis linearibus subflexuosis, 6-17 cm. longis, 5-8 mm. latis; alabastris arcte glabris, 25-28 mm. longis.

Leaves long and narrow, somewhat flexuose, 6-17 cm. long, 5-8 mm. broad; buds nearly glabrous, 25-28 mm. long.

Eidsvold, Queensland (Dr. T. L. Bancroft, No. 1187, Nov., 1920).

(B) *Umbellulati* van Tiegh.

(Ombellulées) in Bull. Soc. bot. France, xli., 1894, 507.—*Pilostigma*, van Tiegh., *ibid.*, p. 483.—Sect. *Pilostigma*, Engl. in Engler et Prantl, Pflanzenfam., Nachtr., 1897, 128.

Inflorescence in simple or compound umbels.

4. LORANTHUS SANGUINEUS F.v.M. (Plate xlii.)

Fragm., i., 1859, 177.

Supplementary notes to the description.

Branches quite glabrous, with a few scattered lenticles. Leaves thick, glaucous, opposite or subopposite, broad-lanceolate, oblong to falcate, 5-15 cm. long, tapering into a terete petiole 1-2 cm. in length, nerves 3-5, slightly raised beneath, depressed or grooved above. Flowers glabrous, axillary; the common peduncle stout. 1-2½ cm. long, bearing an umbel of 3-5 pedicellate flowers; the pedicels 4-7 mm. long. Bracts glabrous, spreading, narrow, navicular, acute or acuminate, 2-3 mm. long. Calyx cylindrical-obconical, 7 mm. long, the limb truncate. Buds slender, reddish pink, 2-2½ mm. long, clavate and angular at the apex, and of a greater diameter than the enlarged base. Petals 6, free, very acute, thick, concave or flat, longer than the free portion of the filaments and anthers. Filaments compressed, narrow, 5-7 mm. long. Anthers adnate, slender, curved, about the same length as the free portion of the filaments, or sometimes longer. Style slender, angular, curved in bud, crowned by a large, dark-coloured, capitate stigma. Fruit cylindrical or pear-shaped, 12 mm. long, but not seen ripe, curved as in *Phrygilanthus eucalyptifolius*; disc prominent. Cotyledons unknown.

Range.—This is a sub-tropical and coastal species. The typical form, so far, is only recorded for the Northern Territory and North Queensland, whilst the variety *pulcher* Ewart extends to Western Australia.

Northern Territory: Victoria River (Mueller. The type, *vide* Mueller's Report Burdk. Exped., *l.c.* thus "A species well marked by its blood-red petals and large black stigma. The limb of the expanded calyx exceeds in its diameter that of the tube"); Darwin (Professor Baldwin Spencer, No. 649); Camp iii., Lander Creek (G. F. Hill, No. 319, *vide* Flora N. Terr., 88); Islands of Gulf of Carpentaria (R. Brown, *see* B.Fl., *l.c.*); Bentinck's Island (Henne, B.Fl., *l.c.*).

Queensland: Albert River (Henne, B.Fl., *l.c.*); Rockingham Bay ("Beautiful scarlet," F. Mueller, 4. 12. 1895, in Queensland Herbarium, kindly lent by Mr. C. T. White); near Winton, on *Eucalyptus microtheca* ("Drooping Mistletoe," S. W. Jackson; leaves 4-8 inches long, obscurely 3-nerved, thick and glaucous. This is its most southern record).

Affinities.—*L. sanguineus* F.v.M. shows no really close affinity with other Australian species; its nearest allies appear to be *L. bifurcatus* Benth. and *L. Miquelii* Lehm., both of which have the same characteristic pedicellate flowers as *L. sanguineus*, but are totally different in foliage and floral characters.

The style of *L. sanguineus* is remarkably large, and in this respect it is different from any other Australian species.

L. Whiteii shows affinity with this species in the shape of the buds, but differs from it in other characters.

Host.—Myrtaceae: *Eucalyptus microtheca* F.v.M.

Var. PULCHER Ewart. (Plate xliii.)

Proc. Roy. Soc. Vict., xxiv., 1911, 69.

The flowers are 2½ instead of 1½ inches long, and the leaves shorter and broader than usual, but otherwise the plant agrees with the type specimens.

Range.—Napier-Broome Bay, North West Australia (G. F. Hill, No. 156. The leaves of the type are 2½ x 3½ inches, oblong, obtuse); Spring Vale, Port Darwin (Alfred Giles, in Queensland Herbarium, kindly lent by Mr. C. T. White).

There is only one very young leaf attached to the specimen; the flowers are 2½ inches long with the style distinctly bowed in bud in the middle, which no doubt greatly assists in opening the flower, not apically, but in the centre of the segments. The bent portion of the style had forced its way between the perianth segments whilst the latter were still united at the apex.—Darwin to Gulf of Carpentaria (Professor Baldwin Spencer). The anthers are seen in this specimen adhering to the base of the stigma which causes the style to bend outward in the middle and, when released, it exceeds the anthers by 3-4 mm. Stigma verrucose. Old branches prominently lenticulate.—Darwin (Dr. H. I. Jensen, No. 203. Communicated by C. E. F. Allen, 1913). Leaves short, broad elliptical to broad lanceolate, very thick, 3—5-nerved, channelled above, slightly raised on the lower surface, 4½ x 2½ inches; petiole terete, ¼-½ inch long.

It is not surprising to find this variety farther north than its first record. The indications are that its range will extend to the north-eastern coast of Queensland in precisely the same latitude as the typical form.

I am not certain as to its characters being constant, but there are marked differences between it and the typical form, which can only be satisfactorily worked out when ample material is available. Field work is also necessary in connection with certain characters.

5. LORANTHUS WHITEII, n.sp. (Plate xliv.)

Frutex glaber confertus ramis divaricatis maturioribus furfuraceis junioribus glabris; lignum durum futrum. Folia opposita superne nitentia orbicularia ad elliptica, 3-5 cm. diam. subito in petiolum compressum attenuata. Inflorescentia. Flores plerumque singuli in axillaribus vel nodosis fasciculis ut in *L. alyxifolius,* at nonnumquam communis pedunculus 2 bracteatos flores breviter pedicellatos fert. Gemmae clavatae superne angulares 2-4 cm. Bracteae crassae orbicularos concave. Calyx cupularis truncatus. Corolla 5-6 petalis liberis rubescentibus firmis spongiosis. Filamenta breviora antheris adnatis linearibus. Stylus parvus capitatus. Fructus non visus.

Glabrous and apparently compact shrubs with divaricate branches, old branches scurfy, the young ones smooth; wood hard, pale brown. Leaves opposite, shining above, orbicular to elliptical, 3-5 cm. long, and nearly as broad, abruptly narrowed into a short compressed petiole, 4-6 mm. long, thick at the base, much thinner towards the margin, somewhat coriaceous, the spreading nerves almost obscure.

Flowers nearly all single, in axillary or in nodose clusters, as in *L. alyxifolius,* but occasionally the very short common peduncle bearing biflorate, shortly pedicellate, bracteate flowers. Peduncles, pedicels, bracts, and calyces minutely ferruginous-tomentose. Bracts thick, orbicular, concave, acute or truncate, the margins ciliate. Calyx cupular, truncate, 3 mm. long, the limb slightly spreading. Buds clavate, slightly angular, nearly twice as thick at the top as at the base, in some specimens contracted in the middle, 2-4 cm. long. Petals 5-6, free, reddish, thick and spongy, usually lanceolate. Filaments somewhat shorter than the linear adnate anthers. Style terete, exceeding the anthers by about 2 mm.; stigma small, capitate. Fruit not seen.

Named in honor of Mr. Cyril Tenison White, Government Botanist of Queensland.

Syn.—*L. alyxifolius* F.v.M. (bis.)

Range.—It is, so far, confined to the north-east coast of Queensland, and has been collected in the following localities:—

Mount Bellenden Ker, 5,200 ft. (W. S. Sayer, 1887. Labelled *L. alyxifolius* in Melbourne Herbarium in Mueller's handwriting); Mount Bartle Frere, Bellenden Ker, Top Camp (F. M. Bailey, Bellenden Ker Expedition, 1889); Atherton Scrub (R. Mitchell, 8. 1911. The type).

Affinities.—Its nearest affinity appears to be *L. sanguineus* F.v.M., from which it is distinguished by the differently shaped and broader leaves, inflorescence, the shape of the calyx, and the vestiture.

This species has the peculiar appearance of *L. alyxifolius* F.v.M., both in the leaves and in the mode of flowering, but the clavate and somewhat angular bud, together with the free petals, places it in a different section from *L. alyxifolius.*

When not in flower it could easily be mistaken for *Phrygilanthus celastroides,* as the leaves are very similar.

The wood of this species appears to be considerably harder than most species, and is darker in colour.

Hosts not stated.

6. LORANTHUS MIQUELII Lehm. Mss. (Plate xlv.)

Lehm., Plantae Preiss., 1844, 280; Walp., Rept. Bot. Syst., v., 1845-46, 938; Etting., Uber Die Blatts. der Lor., 1871, tab. iii., fig. 10-11, lit. p. 18.

The following is a translation of the original description:—Glabrous, branches terete, leaves opposite or slightly alternate, with long petioles, the lowest obovate or obcordate, the remainder linear-lanceolate, slightly falcate, blunt or very obtuse, attenuate at the base, one- to three-nerved, the marginal veins purplish. Cymes axillary, solitary, on long peduncles, as long as or longer than the leaves, 4—5-branched, the branches triflorous. Flowers all pedicellate, supported at the base by a single rounded or navicular bract; calyx limb-truncate or very imperfectly denticulate. Parasitic on *Eucalyptus*, York district, 13.3.1839. Herb. Preiss No. 1617. *Loranthus pendulus* Sieb. (Fl. Nov. Holl., n. 241. DC. Memoir Loranth., tab. i.) is its nearest affinity, but the species nevertheless is very distinct in the leaves and pedicellate, bracteate flowers. Branches very long and pendulous, brownish-grey, branchlets nodose, terete, turning purple. Leaves somewhat opposite, or many quite opposite, glabrous, coriaceous with purplish margins, petioles long, semi-terete, 1½-3 cm. long, the lower usually obovate or obcordate, 2-4 cm. long, the remainder somewhat obliquely-falcate, lanceolate, or the upper linear, obtuse, contracted into the petiole, 5-9 cm. long, 1½-4 mm. broad, distinctly one- to three-nerved or veiny, the veins somewhat reticulate. Cymes axillary, solitary, the peduncles purple, 2½-4 cm. long; umbels terete, 4-5 branched, 1½ cm. long, the partial cyme triflorous; pedicels 5-8 mm. long. Bracts somewhat rounded under the flowers, concave, carnose, the apex very minutely ciliate. Buds straight, terete-clavate, about 3 cm. long. Calyx obconic-cylindrical, 3-4 mm. long, the limb somewhat dilated-truncate or denticulate. Petals 5, reddish, linear, the apex subspathulate, dilated, elliptical, concave. Stamens adnate to almost a third of the petals, and about equal to them; anthers linear, attenuate at the base, nearly 4 mm. long. Style filiform, slightly exceeding the stamens, angular or sulcate. Stigma yellow, verrucose, subcapitate.

I have given a full description of *L. Miquelii* Lehm. as there appears to be some justification in recognising it as being distinct from *L. pendulus* Sieber, notwithstanding that Bentham (B.Fl., *l.c.*) thought they were the same.

Botanically, *L. Miquelii* is an imperfectly known plant and, at the same time, it is the most widely diffused of all the Australian species. I have not seen the type. According to Professor Le Comte, Paris, it consists of a few leaves and a couple of buds which, he states, do not differ in any way from Drummond's No. 510. I have seen a leaf and bud of No. 510, which matches numerous specimens from Western Australia and other States. It is also identical with *L. aurantiacus* A. Cunn. It appears to me that *L. Miquelii* Lehm. was described from a somewhat smaller specimen than *L. aurantiacus* A. Cunn., but there is not sufficient difference between them, if any, to keep them apart, as there are numerous gradations without distinctive or stable characters. All the Western Australian specimens that I have seen display the same constancy of characters with the rest of the material from other States, except a specimen from Coolgardie, which has smaller leaves and buds, and to some extent is referable to *L. Miquelii* Lehm., varietas Miq., *l.c.*

Ettingshausen (Uber Die Blattskelette der Loranthaceen, Tab. iii., Fig. 10, 11) depicts two deformed leaves of *L. Miquelii* Lehm. This type of leaf deformity is common throughout many specimens, not only of this, but of other species.

Supplementary notes to the description.

Pendulous plants of medium size with a ball-like union with the host, branches glabrous, and frequently slightly glaucous, slender, attaining 7 feet in length. Leaves glabrous (except the very young ones which are minutely mealy pubescent) usually broad lanceolate, opposite, or the upper one more distantly alternate than in *L. pendulus* Sieber, ranging from 7-28 cm. long (about 3-11 inches); the average length is about 5 inches, yellowish-green. Inflorescence cymose; flowers all pedicellate. Buds cylindric, minutely mealy, or nearly glabrous, faintly angular towards the base, swollen above the calyx limb, yellowish-green, shaded pink on the outside, the inside including the filaments and style a dull purple lake (No. 4, Plate 170, Dauthenay, Rep. de Coul.). Style angular, longer than the stamens, geniculate a little below the capitate stigma, often persistent on the ripe fruit. Disc usually prominent, raised around the base of the style and quite free from it, forming a pentagonal toothed tube, the minute teeth are noticeable on the fruit throughout its various stages of development. Fruit amber white, changing to yellowish-green (Plates 12 and 13, Rep. de Coul.), oblong-cylindrical to urceolate, contracted into a very short neck, or sometimes flat-topped, opening apically, or nearly so when ripe. Epicarp thin. Seeds oblong-cylindrical, contracted at the base; viscin not copious; endosperm white; embryo green, cylindrical, narrower and slightly curved towards the disc, 4 mm. long, verrucose or tuberculate; suctorial disc scarcely thickened, at first quite flat, becoming elongated and somewhat tubular by an outward growth, the hollow cavity secreting a transparent fluid. Embryonic cotyledons not withdrawn from the endosperm.

The fruits are frequently found to be distorted by insects; some assume the appearance of half-grown Quandangs, *Fusanus acuminatus* R.Br., with a cesia-like hue, some become abnormally elongated, while others are pentagonal in shape, or sometimes distinctly ringed.

The *Loranthus* fruit-fly *Ceratitis loranthi* W. W. Frogg., was hatched from fruits of *L. Miquelii* by Mr. J. J. Fletcher (*vide* These Proceedings, xxxv., 1910, 862-3, under *L. pendulus* Sieber).

The figure attributed to *L. pendulus* by Ewart (Weeds and Poison Plants and Naturalized Aliens of Victoria) appears to be this species. It has the same general appearance as *L. Miquelii* Lehm., while the flowers and fruits appear to be all pedicellate. I have not seen a plant of *L. pendulus* the same colour as *L. Miquelii*; the former is always rusty looking, whilst *L. Miquelii* is of a light yellowish-green colour.

Synonym.—L. aurantiacus A. Cunn.

I have made a very careful comparison of specimens of *L. aurantiacus* from the type locality with those of *L. Miquelii* Lehm., and can come to no other conclusion but that they are conspecific. Lehmann's species, having priority over Cunningham's species by 4 years, must stand.

Range.—Western Australia: Near Perth, host *Eucalyptus calophylla* (Dr. J. B. Cleland, No. 432, 4.1907. The mistletoe fruit-fly, already referred to, was hatched from specimens supplied by Dr. Cleland); Swan River (Drummond, No. 510. This specimen is not quoted by Bentham in the Flora); Oldfield, quoted by Bentham under *L. pendulus* Sieber; York District (Preiss, No. 1617, 3.3.1839; the type); Darling and Swan Rivers, on *Eucalyptus gomphocephala* (Diels and Pritzel, Bot. Jahr., xxxv., 176 under *L. pendulus* Sieber); Avon, near Clackline, on *Eucalyptus redunca* Schau. (Folia lutescenti-viridia; perianthium coccineum, Fl. Feb. D. 2595. Diels and Pritzel, *l.c.*); Comet Vale, host *Eucalyptus Oldfieldii* F.v.M. (Flowers prawn-red, shading to shrimp pink, Plate 75, Rep. de Coul. J. T. Jutson, No. 249a: The leaves are narrow lanceolate 3 to 5 in. long); Victoria Desert, Camp 36, Elder Expedition, on *Eucalyptus* (R. Helms, No. 1013, 31.8.1891. In Adelaide Herbarium); near Barrow Range, Mt. Squires, on *Eucalyptus*. [Elder Expedition, R. Helms, No. 1015, 28.8.1891. In Adelaide Herbarium. Both were kindly lent by Professor Osborn. These specimens are also recorded by Mueller and Tate, under *L. pendulus* (Bot. Elder Exped. and Trans. Roy. Soc. S. Aust., xvi., 1892, 360)].

Northern Territory: Finke River [Great masses of this lovely plant hung down from many Red Gums (*Eucalyptus rostrata*). Trans. Roy. Soc. S. Aust., xxxviii., 1914, 462. This specimen was kindly lent by Mr. J. M. Black, who determined the plants collected by Captain White]; Glen Edith (Tietkens, R. Tate, Rept. Horn Exped., iii., 160); "Parasitic on Gum" (R. Helms, No. 1014, in Adelaide Herbarium; *vide* also Mueller and Tate, Trans. Roy. Soc. S. Aust., xvi., 1912, 360; Bot. Elder Exped., as *L. pendulus* Sieb.); Hermannsburg (R. Kemp, Trans. Roy. Soc. S. Aust., v., 1881-2, 21, included in the list of plants collected by Chas. Winnecke, as *L. pendulus* Sieb.); Mt. Connor, west of McDonnell Ranges (Tietkens); Stuarts' Pass (R. Tate, Rept. Horn Exped., iii., 160, as *L. pendulus* Sieb.); 70 miles W. of Camp 4, on Lander Creek (G. F. Hill, No. 372, 22.5.1911. Recorded in Flora N. Terr., 88 as *L. pendulus* Sieb.); Boorroloola, on Box Gum, *Eucalyptus Spenceriana* (G. F. Hill, No. 602, 2.10.1911, *vide* Flora N. Terr., 88); Victoria River (F. Mueller, quoted by Bentham under *L. pendulus* Sieb.); Port Darwin (N. Holtze, No. 452. Identical with G. F. Hill's No. 372); Port Essington (Armstrong, quoted by Bentham as *L. pendulus* Sieb.); Round the Gulf of Carpentaria to Melbourne (F. Mueller, Appendix to Landsborough Exped., Carpentaria to Melbourne, 116, as *L. pendulus* Sieb. This is too far north for *L. pendulus*, therefore I think I can safely transfer it to *L. Miquelii*).

South Australia: South Coast (R. Brown, quoted by Bentham, as *L. pendulus*); Holdfast Bay (quoted by Bentham); Halifax Bay (F. Mueller, Ned. Kr. Arch., iv., 1856, 105; Emu Flat (W. Gill); Clarendon (J. S. O. Tepper, Sep. Abd. Bot., Band lxiii., 1895, as *L. pendulus* Sieb.); Tanunda, near Adelaide, hosts *Eucalyptus leucoxylon* and *Casuarina stricta* (Dr. J. B. Cleland. Cymes large and spreading. Petals 6, on some of the flowers); Athelston, on various species of *Eucalyptus* (W. J. Burton); Unley Scrub on *Casuarina* (No. 1017, August 27th, in Adelaide Herbarium); Glen Osmond, host *Eucalyptus odorata* Behr. (Flowers biternate, perianth red inside, yellowish outside; stamens red. Herb. J. M. Black); Black Hill, on *Eucalyptus fasciculosa* (Herb. J. M. Black, 16.5.1905); Caroona, Lake Gilles (F. Mueller, Trans. Roy. Soc. S. Aust., x., 1896-7, 79, as *L. pendulus*); Gawlertown and Lyndoch Valley, on *Eucalyptus* (F. Mueller, Ned. Kr. Arch., iv., 1856, 105; Horshall's Gully, on *Eucalyptus rostrata*, (Herb. J. M. Black, 10.12.04); as *L. pendulus*, Lofty and Bungle Ranges (Mueller, quoted by Bentham under *L. pendulus*; F. Mueller, Ned. Kr. Arch., *l.c.*); Booleroo Centre, Feckina Hills, on *Casuarina stricta*, also plentiful on *Santalum lanceolatum* (Chas. F. Johncock, Trans. Roy. Soc. S. Aust., xxvi., 1902, 34, as *L. pendulus* Sieb.); Moolooloo Station, between Beltana and Blinman (Mrs. R. S. Rogers); Mt. Lyndhurst. Native name "Weedla" (Max Koch, Trans. Roy. Soc. S. Aust., xxii., 1898, 101, as *L. pendulus*); Lake Eyre Basin (R. Tate, Trans. Roy. Soc. S. Aust., ii., 1877-78, as *L. pendulus*); Officer's Creek, West of Everard Ranges ("Quantities of this parasitical plant was found growing upon the 'Mulga,' *Acacia aneura*" Captain S. A. White, *vide* J. M. Black, Trans. Roy. Soc. S. Aust., xxxix., 1915, 827, as *L. pendulus*).

Victoria: Bairnsdale, on *Loranthus pendulus*, the latter on *Eucalyptus eugenioides* (T. S. Hart); Bendigo, on *Eucalyptus sideroxylon* (D. W. C. Shiress); Fairview, near Wycheproof (Rev. W. W. Watts, No. 875); [Petals purple-brown inside, as well as the filaments and the upper portion of the style; yellowish-brown outside. Buds clavate, acute, $3\frac{1}{2}$ cm. long. Calyx cylindric, 4 mm. long. Anthers 6 mm. long. The host plant is probably *Eucalyptus dumosa* (W.F.B.)]; Dumosa (Rev. W. W. Watts, No. 213a); Sea Lake (Rev. W. W. Watts, No. 175).

New South Wales: Euston, host *Eucalyptus bicolor* (Senior Constable Siebner); South West Plains below Narandera, parasitic on *Eucalyptus hemiphloia* var. *microcarpa* (Bishop Dwyer, No. 1244); Zara, Wangenella, on *Eucalyptus bicolor* (E. Officer, No. 320a. Flowers dull purple lake—Plate 170, Dauthenay Rep. de Coul.); 40 miles from Hay, on *Eucalyptus bicolor* (W. S. Murray, per D.W.C.S.—Flowers and fruits showing effects of attack by insects); Lake Cargelligo (G. Horan, per E. Cheel); on *Eucalyptus dumosa* (Bishop Dwyer, No. 804); Wyalong (Bishop Dwyer, No. 488); Barmedman, on *Eucalyptus hemiphloia*, var. *microcarpa*, and *E. sideroxylon* (Bishop Dwyer, No. 515); Albury Road, near Wagga Wagga, on *Eucalyptus dealbata* (Bishop Dwyer, 7.1920); Tumut (J. H. Maiden and J.L.B.); Queanbeyan (E. Breakwell); Bowning, on *Eucalyptus elaeophora* (R. H. Cambage, mixed with *L. pendulus*, No. 2214); between Bullio and Wollondilly, on *Eucalyptus melliodora* (E. Cheel); Grenfell (W. Bauerlen, No. 2731.—Fruits deformed by insects); Cowra to Trunkey, on *Eucalyptus maculosa* (J.L.B.); Nowra (W. Bauerlen); Nattai River, on *Eucalyptus viminalis* (Mrs. E. Reilly, per Dr. A. V. Dallow); Liverpool, on *Eucalyptus Baueriana* Schau. (J.L.B.). *West of Sydney*: St. Mary's, on *Eucalyptus sideroxylon* and *E. hemiphloia* (W.F.B. and J.L.B.); Kingswood, on *E. sideroxylon* and *E. tereticornis* (W.F.B. and D.W.C.S.); Toongabbie, on *E. hemiphloia* (Dr. E. C. Chisholm and W.F.B.); Black Mount, on *Eucalyptus macrorrhyncha* (Large pendulous plants of a yellowish-green colour (W.F.B.); Bowan Park, near Cudal, on *Eucalyptus Blakelyi* (Fruits deformed by insects, W.F.B.); Hill End, on *Eucalyptus elaeophora* (Miss A. L. Messurier); Euchareena (J.L.B.); Upper Meroo, Mudgee (J.L.B.); Rylstone and Goulburn River District ("A large leaved variety; the leaves measuring sometimes over a foot long," R. T. Baker, These Proceedings, xxi., 1896, 452, as *L. pendulus*. I have seen this specimen; the longest leaf is 8 inches long. Other examples of this species measured 11 inches long); Minore (J.L.B.); Warren-Coonamble Road (H. Deane); Coonamble (E. Breakwell); Girilambone, on various species of *Eucalyptus* (W. Bauerlen, No. 2647); Coolabah (R. N. Peacock. This specimen is remarkable for the long flowering peduncles, 5 cm. long, and the pedicels 1 cm. long. The bracts are also broadly cordate and very concave); Terry-hie-hie, Moree, on *Eucalyptus hemiphloia* (E. Julius); Howell, "A strong pendulous plant growing principally on *Eucalyptus Caleyi*" (R. H. Cambage, These Proceedings, xxxi., 1906, 69; J.L.B.—Fruits badly infested with insects; some are mitre-shaped, others resemble young Quandangs); 40 miles North-west of Collarenebri, on *Eucalyptus bicolor* (S. W. Jackson); Narran River, near Bokhara, on *Eucalyptus* sp. (Sir T. L. Mitchell, 28.3.1846. The type of *L. aurantiacus* A. Cunn., Mitchell's "Trop. Aust.", p. 101); Balonne River, on *Eucalyptus*, Sir T. L. Mitchell, No. 88, 23.4.1846. This last locality is a copy of a label on a drawing of the specimen referred to, received from Kew, which was determined as *L. pendulus* Sieber by Bentham. The figure has the characteristic inflorescence of *L. Miquelii* Lehm., with pedicellate flowers. Mitchell (Trop. Aust., p. 135) refers to this specimen thus,—"The beautiful *Loranthus aurantiacus* A. Cunn., occupied the branches of a *Eucalyptus*." *North of Sydney*: Killara, on *Eucalyptus paniculata* and *E. saligna* (W.F.B.), also on *Angophora intermedia*, and parasitic on *Phrygilanthus eucalyptifolius*, the latter on the *Angophora* (W.F.B. and D.W.C.S.); Beecroft on *E. pilularis* (Dr. E. C. Chisholm and W.F.B.); Pymble, on *Eucalyptus saligna* (Pendulous plants 2-5 feet long and 2 feet in diameter; leaves light-green, shading into yellow, making a pleasant contrast with the dark-green foliage of the host, and also with the dark-green foliage of *Phrygilanthus eucalyptifolius* which was parasitic on the same plant (W.F.B.); Bobbin Head Road, near Turramurra, on *Eucalyptus resinifera, Acacia decurrens* Willd. var. *mollis* (W.F.B.); Gibberagong Creek, Hornsby, about one mile above the head of the salt water, on *Eucalyptus pilularis* (W.F.B.); Berowra Creek, Berowra, near Punt, on *Eucalyptus punctata*, overhanging the salt water. Another tree of *E. punctata* about 100 yards up from the water had nine large bunches of the parasite upon it. These were the only plants seen, although a diligent search was made, with the object of ascertaining if there were others in the neighbourhood (W.F.B.); Brooklyn Park, Hawkesbury River, on *Eucalyptus umbra* and *E. maculata* var. *citriodora* (W.F.B. and D.W.C.S.); Lower Castlereagh, Hawkesbury River, on *Eucalyptus tereticornis* Sm. (R. Farlow); Glendon, Singleton, on *Angophora* (Dr. Leichhardt, 1843); Rocky Creek, Bengalla, on Box, *Eucalyptus* sp. (Dr. Leichhardt, 1843); Pokolbin, on *Eucalyptus siderophloia* (R. H. Cambage, No. 1497); Scone (E. Breakwell); Owen's Gap, near Scone, host *Eucalyptus hemiphloia* var. *albens* (R. H. Cambage, No. 1688.—Fruits infested with insects, which give them a pruinose appearance); Tamworth, on *Callitris calcarata* (W. M. Carne); Gunnedah, on *Eucalyptus hemiphloia* (M. H. Swain); 7 miles from Coonabarabran, on the Gunnedah Road, on *Eucalyptus Blakelyi* (H. I. Jensen); Coonabarabran, on Grey Gum, *Eucalyptus micrantha* and on *L. pendulus*, the latter parasitic on *E. micrantha* and also on *Angophora intermedia* (B. G. Meek); Bugaldie, 17 miles N.W. of Coonabarabran, on *Casuarina Cunninghamii* (B. C. Meek); Borah Creek, north of Rocky Glen, on *Eucalyptus melliodora* (H. I. Jensen); Baradine District (H. I. Jensen); Donald, near Armidale, on *Eucalyptus melliodora* (G. Campion); Narrabri, host *Eucalyptus odorata* Behr. var. *Woollsiana* (G. Burrow; since recorded by J. H. Maiden, Dr. J. B. Cleland and Gordon Burrow, Botany of Pilliga Scrub, 1920, p. 10); Attunga State Forest No. 724 ("Habitat—Wide range throughout the whole of the North-west districts: altitude 1200 ft. This specimen was obtained from a "Yellow Box," *Eucalyptus melliodora*. It also attacks "White Box" *Eucalyptus hemiphloia* in very large numbers. As many as 40-50 plants may be seen on some of the trees where this specimen was obtained," T. W. Taylor); Stannum, via Deepwater, on *Eucalyptus eugenioides* (R. H. Cambage, No. 1601.—An interesting small-flowered form. Recorded by Mr. Cambage in These Proceedings, xxxiii., 1908, 51, as *L. pendulus*); Sawpit Creek, Woodburn (W. Bauerlen, No. 1598.—Leaves up to 12 inches long, ½ inch broad); Wallangarra, host *Loranthus linophyllus* Fenzl. which was parasitic on *Casuarina Cunninghamii*.—Leaves 10 inches long and 1 inch broad; also on *Eucalyptus siderophloia*, (J.L.B.).

Queensland: Warwick, Darling Downs (J. Shirley, Aug., 1915); Brisbane River, on "Ironbark" (F. M. Bailey, Mar., 1876, in Queensland Herbarium); Toowoomba, on *Eucalyptus* sp. (H. A. Longman, June, 1909); Goodna (C. T. White, Apr., 1910, in Queensland Herbarium. The specimen is very imperfect, being attacked by gall-forming insects); Georgina River (E. W. Bick, Sept., 1910, in Queensland Herbarium); Gilbert River (F. Mueller, quoted by Bentham under *L. pendulus* Sieb.); Gulf of Carpentaria (Dr. T. L. Bancroft, in Queensland Herbarium. This and the other specimens from the Queensland Herbarium were kindly lent by Mr. C. T. White, Government Botanist).

Affinities.—It is closely allied to *L. bifurcatus* Benth. The chief points of difference are its broader leaves, larger corymbose cyme with the flowers arranged ternately. From *L. pendulus* Sieb., it differs in the paler and more glabrous leaves, smooth, often glaucous branchlets, pedicellate flowers, and differently shaped bracts.

This species, when not in flower, strongly resembles *L. ferruginiflorus* W. V. Fitz. It is, however, more glabrous and, when the buds are present, the species are easily distinguished one from the other, by the different inflorescence and the vestiture of *L. ferruginiflorus*.

Hosts.—Pinaceae: *Callitris calcarata* R.Br. (An unusual host). Casuarineae: *Casuarina Cunninghamii* Miq., *C. stricta* Ait. Loranthaceae: *Phrygilanthus eucalyptifolius* (Sieb.) Engl., *Loranthus linophyllus* Fenzl. Leguminosae: *Acacia decurrens* Willd. var. *mollis* Benth. Myrtaceae: *Angophora intermedia* DC., *Eucalyptus Baueriana* Schau., *E. bicolor* A. Cunn., *E. Blakelyi* Maiden, *E. Caleyi* Maiden, *E. calophylla* R.Br., *E. dealbata* A. Cunn., *E. dumosa* A. Cunn., *E. elaeophora* F.v.M., *E. eugenioides* Sieber, *E. fasciculosa* F.v.M., *E. gomphocephala* F.v.M., *E. hemiphloia* F.v.M., *E. hemiphloia* var. *albens* F.v.M., *E. hemiphloia* var. *microcarpa* Maiden, *E. leucoxylon* F.v.M., *E. macrorrhyncha* F.v.M., *E. maculata* Hk. var. *citriodora* Hook., *E. melliodora* A. Cunn., *E. micrantha* DC., *E. odorata* Behr., *E. odorata* var. *Woollsiana*, *E. Pillagaensis* Maiden, *E. Oldfieldii* F.v.M., *E. paniculata* Sm., *E. pilularis* Sm., *E. piperita* Sm., *E. redunca* Schau., *E. resinifera* Sm., *E. rostrata* Schlecht., *E. saligna* Sm., *E. siderophloia* Benth., *E. sideroxylon* A. Cunn., *E. tereticornis* Sm., *E. umbra* R. T. Baker.

(*a*). Var. MICRANTHUS F.v.M. (Ned. Kr. Arch., iv., 1856, 105).

Corolla alba, calyce antherisque duplo paene minoribus, corymbis plerumque ternis, nervis foliorum conspicuis.

In tracta littorali ad Halifaks-bay. "Stirps a Cl. Preiss, Grantham Novae Hollandiae occid. collecta, ex nota evidentei non differt" (*Cf.* Pl. Preiss., i., 281, varietas).

I have not seen anything approaching var. *micranthus*. All the South Australian specimens of *L. Miquelii* from the vicinity of Halifaks Bay that I have investigated are typical of that species.

Miquel's (varietas) referred to by Mueller is described thus: "Foliis lanceolatis perspicue triplinerviis, floribus brevioribus (an nascentibus?) a specie differens. Baccae immaturae ovatae.

Parasiticus in *Eucalyptus*, districtus Grantham, 7. Mart. 1840 Herb. Preiss. No. 1612. Ulteris inquirendum num revera a specie differat, nam flores in praesente specimine ½ breviores juvenilis videntur et pressione tantum aperti."

Probably an imperfect or undeveloped form of the species.

(*b*). Var. MINOR, n. var. (Plate xlv., fig. B.)

Ramis glaber tenuissimis, foliis oppositis, tenuis, oblongis obtusis, uninerviis vel triplinerviis 4-8 cm. longis. Corymbis brevioribus, 3-ramulis; alabastra 18 mm. long, Coolgardie, L. C. Webster, 1898, (herb.) Chas. Walter.

Branches glabrous, very slender. Leaves opposite, narrow, oblong, obtuse, 1- to 5-nerved, usually 3-nerved and somewhat penninerved, 2-3 inches long. Cymes axillary and terminal, short, 3-branched. Buds small, red-brown, clavate, 18 mm. long. Segments purple-brown inside, the same colour as the typical *L. Miquelii.*

Differing from all the other specimens of *L. Miquelii* in the size and thin-

LORANTHUS PENDULUS Sieb.

The following three pages, numbered 409*a-c*, were inadvertently omitted, and should be read following line 30 on page 409, i.e., as part of the account of *Loranthus pendulus*.

New South Wales: Eden (E. Cheel); Mount Dromedary (Reader); Bermagui, on *Eucalyptus eugenioides*; six miles from Bermagui, and about one mile from tidal water (W. Dunn, No. 151); half-way up Wagonga Range, Bermagui district, on *Eucalyptus Muelleriana* (W. Dunn, No. 164); Batlow-Tumbarumba Road, about one mile from Batlow, on *Eucalyptus radiata, Acacia decurrens* var. *dealbata* (with very long coarse leaves, Miss M. Breading); Talbingo, on *Acacia decurrens* var. *dealbata* (W. A. W. de Beuzeville); Canberra, on *Eucalyptus dives* (R. H. Cambage, No. 3092, These Proceedings, xliii., 1918, 703); Queanbeyan (R. H. Cambage, No. 3360); Burrin Juck, on *Eucalyptus Stuartiana* (E. Cheel); on the Albury Road, a few miles out from Wagga Wagga, on *Eucalyptus melliodora* (Miss C. M. Le Plastrier, Aust. Nat., iv., 1920, 139); Bowning, on *Eucalyptus elaeophora* (R. H. Cambage, No. 2214); Bungendore, on *Eucalyptus macrorrhyncha* (W. Bauerlen, No. 395); Goulburn, on *Eucalyptus dives* (Bishop Dwyer); Mount Bolton, Nowra, on *Eucalyptus macrorrhyncha* (W. Bauerlen, No. 2743); Berrima, on *Eucalyptus dives* (J. H. Maiden); Mittagong, on *Eucalyptus radiata* (W. Dunn), on *Eucalyptus eugenioides,* and *Cassinia aculeata* ("Some of the plants weigh about half a ton," D.W.C.S.); Wollongong (A. Gray, Botany American Exploring Expedition, 1854, 741); Hill-Top, on *Eucalyptus haemastoma, E. Sieberiana* (E. Cheel. Leaves up to 9 inches long); Colo Vale, on *Acacia melanoxylon* (D.W.C.S. and E. Cheel); Nattai River, on *Acacia decurrens* var. *normalis* (D.W.C.S. and E. Cheel); Picton, on *Acacia decurrens* (Miss M. Everit); Camden (Dr. E. C. Chisholm); between Camden and Parramatta (Dr. Leichhardt); Glenfield, on *Acacia decurrens* var. *normalis, Eucalyptus haemastoma, E. micrantha* (W.F.B. and D.W.C.S.); Cabramatta, on *Eucalyptus eugenioides* (W.F.B., D.W.C.S. and H. Bott); Fairfield, on *Eucalyptus Baueriana* (same collectors).

Port Jackson and Western Localities: Port Jackson (Sieber, Nos. 241, 243 and Fl. Mixta, 622, quoted by Bentham, B.Fl., *l.c.*, Robert Brown, A. Cunningham, *vide* Bentham *l.c.*); near Prospect, on *Eucalyptus hemiphloia* (R. T. Baker, These Proceedings, xxx., 1905, 491); Blue Mountains (Sieber, R. Brown, quoted by Bentham); Springwood (H. Deane); Linden to Lawson, noted on the following hosts: *Eucalyptus corymbosa, E. piperita, E. eugenioides, E. haemastoma, E. micrantha* and *Acacia decurrens* var. ? (W.F.B. and D.W.C.S.); Wentworth Falls, near Golf Links, very common on *Eucalyptus eugenioides* (H. Bott); within a radius of about one mile from Wentworth Falls, it was observed on the following hosts, *E. stricta, E. ligustrina, E. radiata, E. Sieberiana, E. maculosa, E. piperita, E. micrantha, E. eugenioides* (W.F.B. and D.W.C.S.); Mt. Victoria, on *Eucalyptus rubida* (J. H. Maiden and R. H. Cambage), on *Eucalyptus maculosa* (W.F.B.); Hartley Vale, on *Eucalyptus Moorei* (W.F.B.); Mount Wilson, on *Eucalyptus Blaxlandi* (J. Gregson, also A. G. Hamilton, These Proceedings, xxiv., 1899, 359); on the road to Mt. Wilson, parasitic on the following hosts, *Eucalyptus haemastoma, E. micrantha, E. piperita, E. radiata* and *E. Sieberiana* (W.F.B.); Marrangaroo, on the following hosts, *Acacia decurrens* var. *dealbata, Eucalyptus altior, E. aggregata, E. Dalrympleana, E. dives, E. Blaxlandi, E. maculosa, E. micrantha, E. eugenioides, E. rubida, E. radiata, E. Sieberiana, E. vitrea, E. Stuartiana* (W.F.B. and Dr. E. C. Chisholm); Colong and Mt. Werong, on *Eucalyptus dives*, and *E. radiata* (R. H. Cambage, These Proceedings, xxxiv., 1911, 574); Jenolan Caves, on *Eucalyptus dives, E. eugenioides* and *Acacia penninervis* var. *falciformis* (very common on *E. eugenioides* on the east side of the Grand Arch, W.F.B. and V. Wyburd); Bathurst ("Is not uncommon on gum trees growing on the Silurian, but I have not found it on those growing on the granite," W. J. Clunies-Ross, Aust. Assoc. Adv. Sci., vii., 1898, 475-480); Blayney, on *Acacia decurrens* var. *dealbata,* also parasitic on *Eucalyptus Stuartiana* (B. C. Meek); Trunkey Creek, Trunkey, on *Eucalyptus polyanthemos* (J.L.B.); Bowen Park, parasitic on *Loranthus Cambagei* which in turn was parasitic on *Eucalyptus hemiphloia* var. *albens,* also on *Eucalyptus dealbata* (W.F.B.); Eugowra, on *Eucalyptus conica* (R. H. Cambage, also recorded in These Proceedings, xxvii., 1902, 564); Mt. Vincent, on the watershed between the Capertee and the Turon Rivers (R. T. Baker, Nov., 1892. This specimen is remarkable for its long internodes, 3½ to 4 inches long. The flowers are also in cymules of four, with the central flower sessile); Hill End, on *Eucalyptus macrorrhyncha* (R. H. Cambage, No. 2777; leaves up to eight inches long); Lachlan River (E. Betche); Lake Cargelligo (G. Horan, *per* E. Cheel; buds rather large and angular, the calyx larger than in most specimens, leaves above 8 inches long); Mudgee (A. G. Hamilton, These Proceedings, ii., 1897, 282); Cobar district, on almost any shrub in the district (The commonest form here flowers in November in many varieties, Archdeacon F. E. Haviland, These Proceedings, xxxvi., 1911, 523. I have not seen this specimen and I am rather dubious about it, as I have not seen *L. pendulus* from this district, although I have investigated quite a number of species from Cobar; it is probably referable to *L. miraculosus* Miq., var. *Boormanni,* or *L. Miquelii*); Darling River (F. Turner, These Proc., xxviii., 1903, 411); Bourke, on *Eucalyptus rostrata* (J.L.B. This is the most westerly locality for *L. pendulus.* The specimen is in fruit which is on rather longer pedicels than the typical form; the leaves are almost normal).

North of Port Jackson: Hornsby, on *Loranthus vitellinus,* the latter parasitic on *Eucalyptus haemastoma,* also on the following hosts, *Phrygilanthus eucalyptoides,* the latter on *Eucalyptus eugenioides, E. haemastoma, E. piperita, Acacia linifolia* (W.F.B.); 1 mile west of Berowra Station, on *Eucalyptus eugenioides* (W.F.B. and D.W.C.S.); Kurrajong Heights, on *Acacia decurrens* (R. H. Cambage, No. 1232); Mount Vincent and Camboon (R. T. Baker, These Proceedings, xxi., 1896, 452); Cessnock, on *Acacia* sp. (A. G. Hamilton); Singleton District (A. C. Barwick, These Proceedings, xxviii., 1903, 940); Hastings and Macleay Rivers (Beckler, quoted by Bentham, *l.c.*); Koulah Peak, to White Swamp (J. H. Maiden); Yarrawitch, on *Eucalyptus acaciaeformis* (J. H. Maiden); near Armidale, on *Eucalyptus* sp. The food plant of *Gallerucella McDonaldi* (A. M. Lea, These Proceedings, (2), ix., 1894, p. 634); Glenferrie Forest Reserve (J. H. Maiden, Agric. Gaz. N.S.W., v., 1894, 615); Glen Innes, on *Eucalyptus viminalis* (J.L.B. Leaves 8 to 11 inches long, flowers identical with Port Jackson specimens); New England (C. Stuart, B.Fl., *l.c.*); Clarence River (Beckler, *vide* B.Fl., *l.c.*); Kyogle, on *Eucalyptus propinqua,* and double parasitic with *L. linophyllus,* same host, also on *Angophora* (H. C. Hayes, Q'land Nat., iii., 1922, 58).

Queensland: Brisbane River, Moreton Bay (Mueller and others, B.Fl., *l.c.,* F. M. Bailey and Rev. J. E. Tenison-Woods, These Proceedings, iv., 1879-80, 160); Buderim Mountain (C. T. White, Q'land Nat., Nov., 1891); Blackall Range (C. T. White, Nov., 1916, Q'land Herb.); Eidsvold [Dr. T. L. Bancroft, also in Q'land Herb. This and the following specimen are nearly glabrous, but the leaves and flowers are not unlike the Port Jackson specimens. The locality is not far from where Bidwill collected his plant which Hooker described as *L. longifolius,* and which Bentham regarded as a synonym of *L. pendulus* Sieber. Hooker's fig. (Ic. Pl., t. 880) seems to be identical with Sieber's plant, except for the length of the leaves. I have very carefully examined the above but fail to find any essential difference, except that the plants are more glabrous]; Gayndah (Dr. F. H. Kenny, Dec., 1912); Mt. Ferry (F. M. Bailey, Proc. Roy. Soc. Q'land, i., 1884, 72); Wide Bay (Bidwill, quoted by Bentham); Rockhampton (Dallachy, *vide* B.Fl., *l.c.*; I have not seen the specimens, but express the opinion that they may prove to be *L. Miquelii* Lehm., if critically examined); the Northern Territory localities quoted by Bentham (B.Fl., iii., 394) are probably referable to *L. Miquelii* Lehm., as *L. pendulus* does not appear to extend to the Northern Territory.

Affinities.—Its closest affinity is with *L. Miquelii* Lehm., from which it differs in the central flowers of the triads being sessile, in the thicker and more uniformly 3-nerved leaves which are usually a dull russet-brown colour changing to a very dark green with age, in contradistinction to the livery or light green leaves of *L. Miquelii* Lehm.

From *L. congener* Sieber it is sharply separated by its narrower and longer leaves, more highly coloured and robust flowers, the differently shaped fruits, and rusty tomentum.

L. miraculosus Miq. var. *Boormani* is somewhat homoblastic with it in the shape of the leaves, but the flowers are totally different.

L. pendulus Sieb., owing to its wide range, flowers all the year round, although the month of August appears to be its chief flowering period.

This species was proclaimed a noxious weed under the "Thistle Act" for the whole State of Victoria in October, 1904. It is not as destructive as some species, and it is invariably parasitic on the Eucalypti; no less than 31 different species of *Eucalyptus* are noted as its food plants, besides 6 *Acacias.*

Hosts.—Loranthaceae: *Phrygilanthus eucalyptifolius* (Sieb.) Engl., *Loranthus Cambagei* Blakely, *L. vitellinus* F.v.M., *L. linophyllus* Fenzl. Leguminosae: *Acacia decurrens* Willd. var. *normalis* Benth., var. *mollis* Benth., var. *dealbata* Benth., *A. linifolia* Willd., *A. melanoxylon* R.Br., *A. penninervis* Sieb. var. *falciformis* Benth, **Robinia Pseudo-acacia* L., **Cytisus proliferus* L. Myrtaceae: *Eucalyptus acaciaeformis* Deane & Maiden, *E. altior* Maiden, *E. Baueriana* F.v.M., *E. conica* Deane & Maiden, *E. Blaxlandi* Maiden & Cambage, *E. corymbosa* Sm., *E. Dalrympleana* Maiden, *E. dealbata* A. Cunn., *E. dives* Schau., *E. elaeophora* F.v.M., *E. eugenioides* Sieb., *E. haemastoma* Sm., *E. micrantha* DC., *E. hemiphloia* F.v.M. and var. *albens* F.v.M., *E. ligustrina* DC., *E. macrorrhyncha* F.v.M., *E. maculosa* R. T. Baker, *E. Muelleriana* Howitt, *E. Moorei* Maiden & Cambage, *E. pilularis* Sm., *E. piperita* Sm., *E. propinqua* Deane & Maiden, *E. polyanthemos* Schau., *E. radiata* Sieb., *E. rostrata* Schlecht., *E. rubida* Deane & Maiden, *E. Sieberiana* F.v.M., *E. stricta* Sieb., *E. Stuartiana* F.v.M., *E. viminalis* Labill., *E. vitrea* R. T. Baker. Compositae: *Cassinia aculeata* R.Br. (A rather unusual host).

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*Denotes exotic plants

ness of the leaves, and the smallness of the flowers. This variety needs further investigation, as it may after all be only a depauperate state of the species.

(C) *Cymulati* van Tiegh.

(cymulées) van Tiegh., Bull. Soc. bot. Fr., xli., 1894, 507.

Inflorescence cymose. Cymes 2—7-branched, each branch bearing 3 flowers, the central flower sessile, or all the flowers sessile.

7. LORANTHUS PENDULUS Sieb. (Plate xlvi.)

Spreng. Cur. Poster, 1827, 139; Hook. Ic. Pl., t. 880, as *L. longifolius*; DC., Coll. Mem. Lor., vi., t. i; DC., Prod., iv., p. 295; G. Don, Gen. Hist., iii., p. 491; Benth., B.Fl., iii., 394; Etting., Uber die Blatts. der Loranth., 1871, Tab. iii., Fig. 18-80, Lit. 18 (Leaves only); Mueller, Key Vic. Pl., 273; Bail. Fl. Q'land., v., 1380 (in part); Moore and Betche, Fl. N.S.W., 1893, 228.

The following is the original description: "Ramis teretibus glabris foliis oppositis linear-lanceolatis longissimis coriaceis laevibus, pedunculis umbelliferis, corollis longissimis, Nov. Holl." It is further supplemented by De Candolle thus: Sieb. No. 241, folia 6-8 poll longa, 5 lin. lata, petiolo 10-lin. Corolla 15 lin, longa. Bacca ovata.

The following is a more complete description from field observations in the Port Jackson District, the type locality: Pendulous shrubs, 2-5 ft. in diameter, with a rather large ball-like union with the host, minutely mealy-ferruginous throughout, especially on the young shoots, but ultimately becoming quite glabrous with age, though still retaining the rusty appearance. Branches elongated, slender, 3-10 feet long. Leaves opposite, chiefly narrow-lanceolate, falcate obtuse, or acute, 2-12 inches long, $\frac{1}{4}$ to $\frac{1}{2}$ inch broad in the middle, thick, nerveless, or usually 3-nerved in the typical form, petiole semi-terete, $\frac{1}{4}$ to $1\frac{1}{2}$ inches long. Inflorescence minutely mealy-ferruginous; flowers in axillary cymes, the common peduncle usually stout, $\frac{1}{2}$-$1\frac{1}{2}$ in. long, bearing an umbel of 3 to 5 rays, each with a partial cyme of 3 flowers, the central one of each triad sessile, the two lateral ones on short, stout, 3 mm. pedicels, each flower supported by a small coriaceous acute bract. Calyx obconical, slightly contracted at the top, the limb prominent, entire, irregularly denticulate, minutely ciliate. Buds usually slender, 3 cm. long, somewhat angular, the top clavate. Petals 5, spathulate, acute, the inside Lemon Yellow No. 1 (Plate 21, Dauthenay, Rep. de Coul.); inside of corolla, together with the filaments and style Crimson Red No. 1 (Plate 114, Rep. de Coul.). Anthers adnate, 3-5 mm. long. Style angular, geniculate about 3 mm. below the stigma, and with a small denticulate or pentagonal sheath at its base, somewhat resembling the leaf-sheath of *Casuarina torulosa*. Stigma very small, usually subcapitate. Fruit urceolate, rarely exceeding 10 mm. long, 5 mm. broad, of a russet-brown colour, contracted at the top into a short neck; epicarp very thick, coriaceous. Seeds elliptical; endosperm white, embryo green, linear oblong, terete. Hypocotyl pink, thick and verrucose; disc rather large, domed. Cotyledons narrow-elliptic. Primary leaves linear lanceolate, purple-brown (I cannot say whether the colour of the primary leaves is constant or due only to the season of the year). Embryonic cotyledons remaining in the endosperm after germination takes place.

The following species have been included under *L. pendulus* Sieber, by Bentham (B.Fl., iii., 394): *L. congener* Sieb., *L. longifolius* Hook., *L. aurantiacus* A. Cunn., *L. Miquelii* Lehm. Of these, Hooker's species is the only synonym. Hooker, commenting on his species says, "assuredly the leaves often more than a foot long." Of the numerous specimens of *L. pendulus* Sieber that I have examined from four States, none of the leaves were more than 11 inches long. The figure of *L. longifolius* (Hook. Ic. Pl. t. 880) is typical of Sieber's plant in every character except for the length of the leaves, which (DC. Prod., iv., 295) are 6-8 inches long in the type of *L. pendulus.* On the evidence before me I am not unmindful of the fact that the length of the leaves is largely influenced by seasonal and climatic conditions, and is not always a stable morphological character.

Mueller commenting on this species (Report Burdekin Expedition, 1860, 13) says: "*Loranthus pendulus* Sieber, ranges over the whole of Australia, forming in different climatic zones, and whilst deriving nutriment from trees of many different orders, showing most singular variations. The examination of a large series of specimens in our collection leads to the conclusion that *L. longifolius* Hook., *L. nutans* A. Cunn., *L. Cunninghamii* A. Gray, *L. canus* F.v.M., *L. Quandang* Lindl., *L. congener* Sieber, *L. aurantiacus* A. Cunn., *L. miraculosus* Miq., *L. Miquelii* Lehm., and *L. Melaleucae* Lehm., are to be regarded as varieties of this plant."

Looking at Mueller's statement in the light of my recent investigations, I am of the opinion that some of the species mentioned by him are synonyms, for instance, *L. longifolius* Hook. = *L. pendulus* Sieber; *L. nutans* A. Cunn., and *L. canus* F.v.M. = *L. Quandang* Lindl; while *L. Cunninghamii* A. Gray = *L. congener* Sieber, and *L. aurantiacus* A. Cunn. is proved to be only a large form of *L. Miquelii* Lehm. The same remarks apply to *L. Melaleucae* Lehm., and *L. miraculosus* Miq., as sufficient evidence has not yet been produced to show whether they can be kept apart as species or regarded as forms of one species.

It appears to me quite problematical as to whether *L. pendulus* Sieber should be looked upon as the parent plant from which those species enumerated by Mueller had their origin. It is quite reasonable to assume that their origin is hovering between *L. pendulus* Sieber, *L. Miquelii* Lehm. and *L. Quandang* Lindl., but the question as to which is the oldest species is beyond comprehension at present; the most widely diffused of all is *L. Miquelii.*

Synonyms.—*L. longifolius* Hook., *Dendrophthoe pendulus* G. Don.

The type is from Port Jackson, which perhaps means (if we follow Sieber who collected it in 1825) from Sydney to Hill Top, a distance of 69 miles by rail or from Sydney to the Blue Mountains. I have examined a series of specimens collected at various places in the Port Jackson District, as well as specimens from the Blue Mountains and the Southern Tableland, and I cannot find any sharp change in them; in fact they are uniformly constant in all essential characters, except perhaps that the Hornsby specimens have smaller and narrower leaves than any collected in the above area; nevertheless, they are not far from being typical, and can be regarded as being a little on the small side.

It is not a very common species in the Port Jackson District, but is more frequently met with in the mountain ranges away from the coast, although in some parts of the South Coast it is fairly common. On the Blue Mountains it is a striking feature of the forest vegetation, where it forms graceful pendulous russet-brown shrubs, one to above five feet long on almost every species of *Eucalyptus,* and also on other forest trees.

Many of the records in various publications under *L. pendulus* Sieb. are not referable to it, but, where possible, I have examined a number of the specimens referred to and the corrections will be found under the various species attributed to *L. pendulus* Sieb. The North Australian, South Australian and Western Australian localities quoted by Bentham (B.Fl., iii., 394) are in all probability referable to *L. Miquelii,* as I have not yet seen any authentic specimens of *L. pendulus* Sieb. from these States, except two from South Australia.

Range.—From herbarium material that I have carefully examined, the range of the species is limited to South Australia, Victoria, New South Wales and Queensland.

South Australia: Blackwood (A. Morris, No. 498); Dismal Swamp, on *Eucalyptus* sp. (in Adelaide Herbarium, No. 1018, without collector's name. It bears the date 22.11.92). The former is fairly typical of the species, while the latter has the flowers more crowded than the normal form. Blackwood is a little north of Adelaide, while Dismal Swamp is not far from the Victorian border towards the south-eastern corner of South Australia, so that the localities are fairly wide apart, and the latter indicates the southern limit of its range, according to our present knowledge.

Victoria: Murray River (Mueller, *vide* B.Fl., *l.c.*); Hawkesdale (H. B. Williamson); Wando Vale (J. G. Robertson, No. 47, Ex. Herb. W. H. Harvey); Grampians and Pyrenees (D. Sullivan, Aust. Ass. Adv. Sc., ii., 1890, 509); Dandenong Creek (C. French, Nov., 1902, the host of *Cercospora Loranthi,* D. McAlpine, Proc. Linn. Soc. N.S.W., xxviii., 1903, 96); North-west portion of Victoria (Morton, quoted by Bentham, B.Fl., *l.c.*); Geelong district (G. H. Adcock, Census Pl. Geelong District); Hurt's Bridge (Drooping mistletoe, F. Pitcher, per J. Cronin, Vict. Nat., xxxiii., No. 5, p. 69, 1916); Diamond Creek, on *Robinia Pseudo-acacia* and *Cytisus proliferus* (A. J. Ewart, Proc. Roy. Soc. Vic., xxx., 1918, p. 175); Port Phillip (Mueller, *vide* B.Fl., *l.c.*); near Melbourne (parasitic on small branches of *Eucalyptus rostrata,* in large pendulous bunches; berries large, white, without taste. Found also on *Acacia mollissima* and on *Acacia melanoxylon,* but not common. J. G. Robertson, No. 48); same locality (E. Betche); Langwarrin and Frankston, on a Peppermint, *Eucalyptus* sp. (T. S. Hart, Vict. Nat. xxiv., 1917, p. 32-33); Yarra and Latrobe Rivers (Mueller, *vide* B.Fl., *l.c.*); Watts River (C. Walter); Victorian Alps (Ewart, Vict. Nat., xxvii., 1910, 112); Bairnsdale, on *Eucalyptus eugenioides* (T. S. Hart).

8. Loranthus congener Sieb. (Plate xlvii.)

DC. Prod., iv., 295; Memo. Lor., vi., t. 2; A. Gray, Bot. U.S. Exp. Exped., i., 741, as *L. Cunninghami* A. Gray; G. Don, Gen. Hist. Pl., iii., 419.

Glaber, ramis teretibus, foliis oblongis obtusis basi attentuatis breve petiolatis crasso-coriaceis aveniis, racemis axillaribus foliis brevioribus subcorymbosis, ramülis trifloris, floribus pedicellatis, bractea ovata acuta sub ovario, calycis limbo truncato, alabastro tereti sub clavato, petalis 5 linearibus acutis, antheris linearibus basi insertis. In Novae-Hollandia, Schult. Syst. 7, p. 114 (DC. Coll. Mem., vi., t. 2.) Folia 2 poll. longa, 4-5 lin. lata. Corolla fere pollicem longa. G. Don, *l.c.,* quotes Sieber's No. 243 as the type.

I have not seen the type, but have examined a large series of specimens from Port Jackson, in the vicinity of Sydney, the type locality, and in all, the central flowers are sessile and not pedicellate as stated above. In many cases the central flowers are absent; only the lateral ones are present in old specimens, and they give one the impression that all the flowers are pedicellate. Unless perfect specimens are examined one is apt to regard them as such. It frequently happens that on maturity the central flowers fall off, as they do not set the fruit to the same extent as the lateral flowers. There are only 4 species of this series with pedicellate flowers, namely *L. ferruginiflorus* Fitz., *L. Miquelii* Lehm., *L. bifurcatus* Bth., and *L. sanguineus* F.v.M., and this species cannot possibly be mistaken for any of them, as they are totally different, both in flowers and leaves.

Under *L. pendulus* Sieb., Bentham (B.Fl., iii., 394) refers to *L. congener* Sieb. thus, "Leaves short, central flowers sessile." He probably had access to the type. The leaves are seldom "5 lines broad," unless in depauperate specimens.

The leaves of *L. congener* Sieb. figured by Ettingshausen (Uber die Blatts. der Lor., 1871, Tab. ii., Figs. 22-24) are almost exactly similar to many dried specimens—they measure from 2½-3½ inches long, and 10 lines broad.

The following is a more complete description, from specimens collected in the Port Jackson district. Erect compact plants 1-3 ft. in diameter, with short divaricate branches, with a dark rough bark on the older portions, glabrous, except the flowers and the very young parts, which are more or less covered with a minute hoary or scurfy substance, which disappears with age. Leaves opposite, or occasionally alternate, obtuse, oblong, narrow to broad lanceolate, or falcate, 5-10 cm. (2-4 inches) long, tapering into a short flattish petiole, dark green above, paler beneath, often drying a very dark brown or nearly black, obscurely 3-nerved or the primary nerve alone conspicuous. Cymes axillary, often in pairs, the common peduncle slender, 2-2½ cm. long, bearing an umbel of 2-5 rays, the partial cyme triflorous, the central flowers sessile, the lateral on short, somewhat fleshy pedicels, terminating in an ovate, acute, and slightly gibbose bract, somewhat broader than the bract supporting the central flower. Buds slender, minutely mealy or almost glabrous, acute, sea-green, shaded pink, or sometimes when found in exposed places the same colour as the filaments, 2-3½ cm. long. Calyx cupular to urceolate, the limb very thin and minutely pubescent as well as the base, often splitting into minute irregular lobes. Petals very narrow, carmine inside, at first deflexed, becoming curved and twisted with age, the inner margins ciliate. Filaments carmine, style terete, slightly bent in bud, exceeding the anthers when fully developed; stigma very small, obovate, green. Anthers adnate linear, 3 mm. long. Ripe fruit greenish, minutely pubescent, or pale yellow, barrel-shaped, 10-13 mm. long, on stout pedicels. Disc rather prominent, pentagonal, exceeding the outer rim by about ½ mm. Fruit opening semi-apically. Seeds ovoid, the acute base resting upon a scarcely viscid spongy cushion, from which arise 5 narrow strap-like appendages extending the full length of the endosperm, or sometimes exceeding it, and 5 shorter appendages, about half the length of the endosperm, which give the seed a striped appearance, and are more conspicuous when the viscin that surrounds the seed breaks down or dissolves. Epicarp thick and leathery. Endosperm and embryo dark green. Hypocotyl short, slender, covered with purplish papillae; as it develops it turns pink, as does the endosperm, but to a lesser extent. Embryonic cotyledons spathulate, remaining enclosed in the endosperm. Primary leaves narrow lanceolate. Suctorial disc much enlarged and surrounded by rather long, pink, deflexed suctorial papillae, the surface gelatinous and microscopically rough beneath the viscin before it reaches the host.

Double embryos are very common in this species and, like *P. celastroides* (a plant it is often confused with), it ranges to a very limited extent beyond the tidal waters of the creeks and rivers in New South Wales. As it does not extend inland or thrive at high elevations from the coast, it opens up a very interesting subject as to the cause. The fruits are eaten by the Mistletoe and other birds, and they would very naturally carry it inland, but as it has not yet been found beyond the coastal ranges, it is difficult to account for its non-appearance, especially when the chief agent of distribution is so widespread.

I have pointed out that some of the seeds of this genus need moisture to facilitate germination. Whether the seeds of this species need a greater amount of moisture to enable them to germinate than those of any other species, I cannot say; no doubt this point is worthy of investigation as this may or may not account for the limitation of its range.

Its chief food plant is *Casuarina suberosa* in New South Wales, but, like *P. celastroides* and *P. eucalyptoides,* it is very partial to the exotic genera.

Synonyms.—*L. Cunninghamii* A. Gray, *L. pendulus* Benth. (*non* Sieber), *Dendrophthoe congener* G. Don.

Range.—From Herbarium specimens examined, the species is confined to New South Wales and Queensland. Its most southern limit in the former State is Bermagui, 363 miles south from Port Jackson, the type locality, and it extends northward as far as Townsville, North Queensland. It would not be at all surprising to find this coast-loving species still further south and north of the localities mentioned above.

New South Wales: Bermagui, on *Casuarina suberosa* (W. Dunn, No. 124); Mt. Kembla, on *Casuarina* sp. (A. G. Hamilton, *see* also These Proceedings, xxx., 1905, 490-491, under *L. miraculosus* on the following hosts: *Casuarina stricta, Croton Verreauxii, Synoum glandulosum, Backhousia myrtifolia,* and on the cultivated Peach, Apple, Pear, Orange, Lemon, Willow, Elm and *Nerium Oleander*); Stockout Creek, Coledale Road (J.L.B.); National Park, on *Croton Verreauxii* (J. F. Triscott); Como (E. Betche); Kogarah (J. H. Camfield); Carr's Paddock, Carlton, on *Melaleuca linearifolia, Loranthus vitellinus,* the latter parasitic on *Eucalyptus corymbosa, Casuarina suberosa* (W.F.B.); Sutherland, on *Casuarina suberosa* (J.L.B.); Botanic Gardens, Sydney, on *Gleditschia xylocarpa, Quercus bicolor, Crataegus spathulata, Illicium religiosum, Nerium Oleander, Cupaniopsis serrata* (J. H. Camfield); on *Platanus orientalis* (A. Stanley & R. Rollinson); Outer Domain, on *Ulmus campestris* (J. Madden); Nielsen Park, Vaucluse, on the following hosts: *Eucalyptus obtusiflora, Loranthus vitellinus,* the latter on *Eucalyptus corymbosa, Casuarina suberosa, Melaleuca nodosa* (W.F.B.); The Spit, on *Casuarina suberosa,* and Pear tree (W.F.B. and J.L.B.); Mosman, on Peach tree (Bishop Dwyer); Willoughby, on Plum tree (J. Stack); same locality, on *Acacia decurrens* (A. G. Hamilton, These Proceedings, xxx., 1905, p. 491 as *L. miraculosus*); Ryde (H. Deane); Ermington (H. Bancroft); on *Melaleuca styphelioides* (W.F.B. and D.W.C.S.); Meadow Bank, on *Casuarina suberosa, Melaleuca genistifolia,* and *Acacia decurrens* var. *mollis,* (W.F.B.); Parramatta River, Parramatta, on *Acacia armata, Melaleuca genistifolia, Casuarina suberosa* (W.F.B. and D.W.C.S.); Lane Cove River, Killara, on *Casuarina suberosa,* also double parasitic with *Phrygilanthus eucalyptifolius* (W.F.B.); a little below Lane Cove Bridge, very plentiful on *Casuarina suberosa* (W.F.B.); Gordon, near Station, on Pear tree (W.F.B.); Bobbin Head, Kuring-gai Chase, on *Casuarina suberosa, Loranthus vitellinus,* which in turn was parasitic on *Angophora lanceolata* (W.F.B.); Peat's Ferry Road, Hornsby (H. Deane); Cowan Creek, Cowan, on *Casuarina torulosa, C. suberosa* (W.F.B., D.W.C.S. and H. Bott); Cowan Creek, near Windybank's houseboat, on *Astrotricha floccosa,* a very unusual host (W.F.B., D.W.C.S., and H. Bott); near Cowan Station, on *Loranthus vitellinus,* the latter on *Eucalyptus eximia* (W.F.B. and D.W.C.S.); Berowra Creek, near Punt, on *Loranthus vitellinus,* which was parasitic on *Angophora Bakeri* (W.F.B.); Brooklyn, on the following hosts: *Loranthus vitellinus,* the latter on *Angophora intermedia, Casuarina suberosa,* Lemon tree, *L. vitellinus,* which in turn was parasitic on *Angophora lanceolata,* also double parasitic on the same host, which was parasitic on *Eucalyptus umbra* and *E. eximia,* also on *Leptospermum flavescens* (W.F.B. and D.W.C.S.); Newport, on *Casuarina glauca* (J. H. Maiden and R. H. Cambage); Newcastle, on *Casuarina* sp. (Dr. Leichhardt, labelled *Loranthus maytenifolius* A. Grey in Mueller's handwriting); Cessnock, on White-Cedar, *Melia Azedarach* (A. G. Hamilton); Ash Island, Hastings River, on *Geijera salicifolia* (Dr. Beckler. Bentham refers to Dr. Beckler's specimens, B.Fl., *l.c.,* in reference to the broad leaves. I am of opinion that there are two or three species involved in these specimens, if a suite could be procured); Macleay River, Crescent Head, Trial Bay, on *Casuarina suberosa* (J. Sydenham); Coramba (Dr. Tomlins); Dorrigo (W. Heron); Goat Island, Richmond River (E. Cheel); Coraki (J. H. Maiden and J.L.B.); Casino, on *Melaleuca genistifolia* (L. G. Irby); Ash Island (W. Woolls, Botany of Ash Island); between Bengala and Cassilis (Dr. Leichhardt). If this locality is correct, it is the most distant for this species from the coast.

Queensland: For most of the Queensland specimens I am indebted to Mr. C. T. White, Government Botanist of Queensland, who kindly forwarded them to me for examination. Moreton Bay, on *Excaecaria Agallochia* (R. Elliot, No. 1041); Wellington Point (J. Webb, Oct., 1891. The long lanceolate leaves of this specimen are suggestive of *L. pendulus* Sieber, but the flowers are typical *L. congener* Sieb.); Darra (C. T. White. This is identical with many Port Jackson specimens); Blackall Range, parasitic on *Acacia penninervis* (C. T. White, Aug., 1921); Birkdale, on *Casuarina suberosa* (C. T. White, No. L10); Buderim Mountain, on *Casuarina* sp. (C. T. White, Apr., 1912. The specimen is rather imperfect and destitute of leaves, the flowers are very frail, with almost filiform segments. Perhaps a very slender flowered variety); Nerang River (H. Schneider); Duck Lagoon, South Percy Island (H. Tryon, 5.3.1906); Noosa Head, on "Orange," *Citrus aurantiacum* (C. T. White, No. 12); Bunya Bunya Mountains, "parasitic on *Exocarpus cupressiformis, Acacia Maideni,* and *Acacia decurrens* var. *pauciglandulosa.* (Color notes). Calyx greenish. Base of petals pinkish wine colored upper portion of petals yellow. Stamens red." (C. T. White and Dr. J. B. Cleland, No. 6. Since recorded by C. T. White, Qland. Agric. Journ., xiii., 1920, p. 25); Eidsvold, "Grows on *Geijera parviflora, G. salicifolia, Cassia australis* and *Acacia polybotrya* var. *foliolosa. Geijera* is the commonest host." (Dr. T. L. Bancroft). The latter has smaller leaves and yellowish flowers; Maroochie (F. M. Bailey, Oct., 1874. Leaves broad lanceolate-spathulate to oblong-lanceolate 3- to 4-nerved. This is the broadest leaved form I have seen, but H. Tryon's and H. Schneider's specimens connect it with the normal leaved forms); Townsville. "Flowers dark red at the base, green at the top" (E. Betche, Aug., 1901).

Affinities.—Its nearest affinity is with *L. miraculosus* Miq. from which it differs in the more slender and longer buds, which are usually a sea-green colour, and in the larger sub-cylindrical, or barrel-shaped fruits. The style is also less persistent than that of *L. miraculosus,* and the leaves are decidedly larger and much darker on the upper surface, as against the glaucous leaves of *L. miraculosus,* when well dried. The vestiture of the inflorescence, fruits and nascent parts is also more prominent on *L. congener* Sieb. The union is ball-like in both species, but *L. congener* is invariably a much smaller plant, particularly in the Port Jackson district.

Occasionally very old plants assume a pendulous habit, and are then very like *L. miraculosus.* I have not seen the inflorescence terminal in this species, but in its nearest ally it is sometimes terminal. It is readily separated from *L. pendulus* Sieb., by the more erect and shorter branches and leaves, which are usually much paler on the lower surface, as well as by the different colour of the flowers, and differently shaped fruits. The young seedlings are also different.

Hosts.—*L. congener* Sieb., shows great variation in its choice of food-plants, but as seen from the following list it has only once been found parasitic upon the *Eucalyptus.*

Casuarineae: *Casuarina suberosa* Ott. & Diet., *C. stricta* Ait., *C. torulosa* Ait. Salicaceae: (e) *Salix Babylonica* L. Betulaceae: (e) *Quercus bicolor* L. Platanaceae: (e) *Platanus orientalis* L. Loranthaceae: *Loranthus vitellinus* F.v.M., *Phrygilanthus celastroides* (Sieb.) Eichl., *P. eucalyptifolius* (Sieb.) Engl. Magnoliaceae: (e) *Illicium religiosum* Sieb. Leguminosae: *Acacia decurrens* Willd., and var. *mollis* Benth., var. *pauciglandulosa* Benth., *A. floribunda* Willd., *A. armata* R.Br., *A. penninervis* Sieb., *A. Maideni* F.v.M., (e) *Gelditschia xylocarpa* Hance. Santalaceae: *Exocarpus cupressiformis* Labill. Rosaceae: (e) *Citrus aurantiacum* L. var. "Orange," (e) *C. Limonum* L. var. "Lemon," (e) *Pyrus malus* L. var. "Apple," (e) *P. communis* var. "Pear," (e) *Persica vulgaris* L. var. "Peach," (e) *Prunus domestica* L. var. "Plum," (e) *Crataegus spathula.* Rutaceae: *Geijera salicifolia* Schott., *G. parviflorus* Lindl. Meliaceae: *Melia Azedarach* L. Euphorbiaceae: *Excaecaria Agallocha* L., *Croton Verreauxii* Baill. Sapindaceae: *Cupaniopsis serrata* Radkt. Myrtaceae: *Eucalyptus obtusiflora* DC., *Backhousia myrtifolia* Hook. et Harv., *Leptospermum flavescens* Sm., *Melaleuca genistifolia* Sm., *M. nodosa* Sm., *M. styphelioides* Sm. Araliaceae: *Astrotricha floccosa* DC. Apocynaceae: (e) *Nerium Oleander* L.

(e) Denotes exotic plants.

EXPLANATION OF PLATES XXXIX.—XLVII.

Plate xxxix.

1\. *Loranthus gibberulus* Tate.

1\. Portion of flowering branch (nat. size). 2. Flower (enlarged). 3. Front and back view of anthers (enlarged). 4. Anthers opened out (enlarged).

Plate xl.

2\. *Loranthus bifurcatus* Benth.

1\. Flowering branch (nat. size). 2. Bud. 3. Flower. 4. Lower portion of segment showing the basal spur. 5, 6. Types of fruit. 7. Embryo. 8. Embryo opened out. 9. Seed just commencing to germinate (nat. size). 10. A more advanced seed with the viscin attached.

Plate xli.

3\. A. *Loranthus ferruginiflorus* W. V. Fitz.

1\. Flowering branch (nat. size). 2. Bud (enlarged). 3. Segment (enlarged); with anther attached. 4. Back view of anther. 5. Style. 6. Fruit (nat. size). 7. Seed (nat. size). 8. Embryo.

B. Var. *linearis,* n. var. (nat. size).

Plate xlii.

4\. *Loranthus sanguineus* F. v. M.

1\. Flowering branch (nat. size), Darwin, Professor B. Spencer, No. 649. 2. Bud (nat. size). 3. Three segments remaining united. 4. Anther. 5. Style. 6, 7. Leaf and bud (nat. size), G. F. Hill, No. 319. The leaf is abnormal.

Plate xliii.

4a. *Loranthus sanguineus* F. v. M. var. *pulcher* Ewart.

1. Portion of flowering branch (nat. size). 2. Position of the anthers around the top of the style; (a) Anthers, (b) Style. 3. Natural position of the style forcing its way through the centre of the bud.

Plate xliv.

5. *Loranthus Whiteii,* n.sp

1. Flowering branch (nat. size). 2. Common peduncle with two bracts. 3. A bud. 4. Flower. 5. A bud (nat. size). Mt. Bartle Frere, Bellenden Ker, F. M. Bailey, 1883.

Plate xlv.

6. *Loranthus Miquelii* Lehm.

1. Flowering branch (nat. size). 2. Bud. 3. Fruiting cymule (nat. size). 4. Fruit. 5. Germinating seed (nat. size). 6. Embryo. 7. Disc. 8, 9, 10. Types of fruit galls. 8 shows the bud on the half developed fruit.

B. Var. *minor,* n. var. (nat. size).

Plate xlvi.

7. *Loranthus pendulus* Sieber.

1. Portion of flowering branch (nat. size). 2. A bud (slightly enlarged). 3. A flower (slightly enlarged). 3a. Anther (enlarged). 4. Fruit (nat. size). 5. Fruiting cymule (nat. size). 6. Section of seed showing embryo (enlarged). 7. Germinating seed (nat. size). 8. A young seedling, showing primary leaves (nat. size). 9. Germinating seed (enlarged). 10. Section of host, showing the attachment of the radicle (nat. size). 11. A seedling in its second year (nat. size). 12. Microscopic Fungi which attack the germinating seed (nat. size). 13. The same (enlarged). 14. Type of fruit gall (nat. size).

Plate xlvii.

8. *Loranthus congener* Sieber.

1. Flowering branch (nat. size). 2. Bud. 3. Style and calyx, showing the pubescent base. 4. Fruit (nat. size). 5. Embryo (enlarged). 6. Embryonic cotyledon (enlarged). 7. A young seedling showing the two primary leaves (nat. size). 8. A seedling enlarged; also with the viscin removed from the seed. 9. An enlarged seedling with two radicles. 10. A small leaved form with yellowish flowers, from Eidsvold, Q., Dr. T. L. Bancroft, No. 1192. 11. A large leaf from Harwood Island, Clarence River, Sabina Helms, No. 465. There were normal leaves on the same specimen.

NOTES ON NEMATODES OF THE GENUS PHYSALOPTERA.

PART IV. THE PHYSALOPTERA OF AUSTRALIAN LIZARDS (continued).

By VERA IRWIN-SMITH, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

(Thirty-eight Text-figures.)

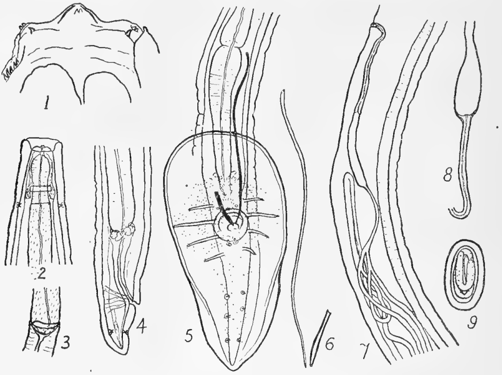
[Read 25th October, 1922.]

From a gecko, *Gymnodactylus platurus* Shaw, three lots of material have been examined, the first taken at Narrabeen, near Sydney, November, 1915, the second from the stomach of a single individual at Quaker's Hat, Middle Harbour, Sydney, October 3, 1921, the third from the stomach of another host of the same species at Narrabeen, April 18, 1922. The first collection was made by Dr. J. B. Cleland, the other two by Miss M. J. Bancroft and Mr. I. M. Mackerras, the three collectors whom I have to thank, also, for the other material dealt with in this paper.

The first collection consists of six larvae under 7 mm. long, and a small 10 mm. male, the second of four females, from 24 to 29.5 mm. long, in which eggs are not developed, evidently unfertilised, the third of the posterior ends of three males and two females. These last specimens, Mr. Mackerras informs me, were found attached to the stomach wall, and were broken when they were being removed. The intestine, with the basal portion of the glandular oesophagus attached, projects from the torn end in two males and one female. Unfortunately, they are the only fully mature specimens available, and the absence of the anterior end makes it difficult to prove their specific identity with the other specimens collected from this host; but a careful comparison of all the specimens indicates that they are the one species, and the following description is based on this assumption. Measurements of examples from each of the three collections are tabulated for comparison.

PHYSALOPTERA BANCROFTI, n.sp.

White, clear, elongated, slender bodied, not enlarged posteriorly, tapering at each extremity. Cuticle very thick, transverse striation very fine, striae about $3\,\mu$ apart. Cephalic collar variable in size, narrow, or cuticle pushed well beyond top of head. Cervical alae well developed to beyond junction of muscular and glandular oesophagus. Lips slightly trilobed; buccal papillae large; external median tooth broad, erect, a small, double-pointed tooth at its base; no inner denticular border, but one small, sharply-pointed denticle visible on each side, below the paired lateral teeth; a row of about five sharply-pointed teeth down the lateral margin of the lip on each side (Text-fig. 1). Nerve-ring behind middle of muscular oesophagus. What appear to be large cervical glands at the sides of nerve-ring, extending back to level of junction of muscular and



Figs. 1-9. *Physaloptera bancrofti*, n.sp.

1. Internal view of lip (x 290); 2. Anterior end of body, showing junction of muscular and glandular oesophagus, nerve-ring, and post-cervical papillae (x 30); 3. Junction of oesophagus and intestine (x 30); 4. Posterior end of female body, showing anus, and caudal pores (x 30); 5. Posterior end of male body, showing ductus ejaculatorius, spicules, and arrangement of papillae on caudal bursa (x 30); 6. Male spicules (x 47.5); 7. Female body in region of vulva, showing terminal portion genital system (x 15); 8. Receptaculum seminis and oviduct (x 47.5); 9. Egg (x 290).

glandular oesophagus. Post-cervical papillae only slightly behind this junction (Text-fig. 2). Oesophagus slender, about one-seventh to one-eighth of total body-length; muscular oesophagus very short, and narrower than the glandular; the base of the latter broad and very bluntly rounded, inserted to only a very shallow depth into the lumen of the intestine, where the entrance is protected by valves (Text-fig. 3). Intestine grooved to receive it, the walls forming two enveloping flaps. Intestine behind junction diminishing to narrower diameter than oesophagus.

Female tail short, sharply-pointed, one-sixtieth to one-sixty-fifth of total body-length, slightly inflected ventrally. Three or four conspicuous dorsoventral muscular bands in region of anus. The two lateral caudal pores on prominent hypodermic elevations opening into large circular depressions in the cuticle behind middle of tail (Text-fig. 4). Vulva at 1/3.8 to 1/4.1 of body length from anterior end in immature whole females, 4.68 mm. behind junction of oesophagus and intestine in broken specimens; vestibule and reservoir of nearly equal length, common trunk slightly shorter, dichotomously divided into four branches, distance between first and second bifurcations 128 to 240 μ; the whole system extending straight back, the division into the four trunks occurring nearly or quite at the maximum length from the vulva, and the uteri not curving forward beyond the level of the reservoir (Text-fig. 7). Reservoir sharply distinct from common trunk. The four branches continuous at a distance of 400 μ with the four uteri, which lie dorsally and ventrally, not intricately coiled, the last coils some distance in front of anus; the four receptacula seminis, behind them, dark brownish bodies, showing distinctly through the body wall, merging gradually into the uteri but sharply constricted from oviducts; ovaries much coiled in region between these and anus. Uteri in unfertilised females poorly developed, slender, 128 μ wide, no formed eggs, terminal portions of system almost entirely devoid of contents; uteri in mature females filling body cavity, 208 μ wide, crowded with eggs containing well developed embryos.

Of the two mature females, in both of which the anterior end is missing, the remaining portion in one extends just to the base of the oesophagus, and is 21.6 mm. long, so that the estimated total length is about 25 mm. In the other, the body is broken off across the middle of the reservoir, and the length of body remaining is 14.16 mm. The eggs are large, and elongated oval in form, measuring 57 x 28 μ (Text-fig. 9).

Larvae (Text-figs. 17-19) 4.2 to 7 mm. long, slender, delicate, semitransparent; tail relatively long, 1/24 to 1/30 of body-length, tapering to a rounded point, generally ventrally inflected at tip. Only two of the six specimens (one 5 mm. and one 7 mm. long) showing rudiments of genitalia; position of vulva not determined, portions of system visible being the rudiments of common trunk, first and second branching, and beginning of uteri, without lumen.

Male. Caudal bursa much like that of *P. antarctica* in shape and arrangement of cuticular processes (Text-fig. 5). The caudal papillae stalked and with corona, but spaced at more equal distances apart than in *P. antarctica*; the first from tip of tail usually nearer to the extremity, and the other two further apart, though the positions vary. The distance of the first from tip varies from 192 to 304 μ, and the distance between second and third from 96 to 208 μ. Cloacal aperture very large and circular, with a prominent rim. Spicules very unequal in length, left slender, reaching from cloaca almost or quite to junction of ductus ejaculatorius and vesicula seminalis, 4.7 to 5.9 times as long as right, which is broader (Text-fig. 6). Ductus ejaculatorius about same length as in *P. antarctica*, 1.14 to 1.44 mm., vesicula seminalis 2.7 to 4.8 mm., vas deferens, separated from it by a distinct constriction, running straight forward to within 2.4 to 3.6 mm. of base of oesophagus before turning back.

The longest remaining portion of a broken male specimen is 17.84 mm., which includes 1.28 mm. of the basal part of the glandular oesophagus. The estimated total length of this specimen is therefore about 19 mm.

Host.—*Gymnodactylus platurus* Shaw.

Location.—Stomach.

Locality.—Narrabeen, Sydney.

Type specimens in the Australian Museum, Sydney.

The notes made by Mr. Mackerras show that of eight or ten specimens of this gecko examined by Miss Bancroft and himself, five harboured nematodes in the gastro-intestinal tract. Two of these were the hosts for the specimens described above. The other three were taken at Mosman, Sydney, in September, 1921, and in each case the nematodes were found in the intestine, and were thought to be Oxyuriidae. Unfortunately, only one of these collections was preserved, and this consists of four females of *Pharyngodon* sp. Dr. Cleland's collection contains only the one lot of nematodes from this host. A second specimen was examined by him, at Sydney, in February, 1916, but it contained no entozoa.

Affinities.—As will be seen from the description, *Physaloptera bancrofti* presents the closest affinities with *P. antarctica.* The most notable differences are found in the smaller size of the body, the much greater disproportion in the length of the spicules, and the size and shape of the eggs, which are longer and narrower than in *P. antarctica.* In *P. antarctica* the left spicule reaches only just beyond the anterior rim of the bursa, and the right is three-fifths of its length, and is relatively broader and of much heavier build than in *P. bancrofti.* Other distinctive features of the new species are the denticular formation on the lips, the slightly more anterior position of the post-cervical papillae, the shallowness of the insertion of the oesophagus into the intestine and its blunt base, and the conspicuous caudal papillae and anal muscular bands.

Of the other species with four uteri, *P. varani* comes nearest to it, both in the lengths of the spicules, the total length of the body, and the position of the vulva, but it differs from *P. bancrofti* in the direct instead of dichotomous division of the common trunk into four uteri, the much longer vestibule, the shorter common trunk, and the slightly longer tail in the female.

Measurements (in mm.) of specimens of *P. bancrofti* taken from three collections.

	Collection. 1 larva	Collection. 2 ♀	Collection. 3 ♀	Collection. 1 ♂	Collection. 3 ♂
Total length	5.0	29.5		10.5	
Maximum thickness	.256	1.0	.544	.480	.400
Tail (anus to tip)	.208	.480	.400	.832	.960
Diameter at anus	.130	.432	.320		
Distance from cephalic extremity of:—Middle of nerve ring .. .	.192	.320		.288	
Post-cervical papillae .. .	.250	.448		.384	
Vulva		7.28			
Buccal cavity	.026	.064		.037	
Muscular oesophagus	.185	.320		.292	
Entire oesophagus	1.34	3.48		2.40	
Proportion of total length to that of oesophagus	3.76	8.47		4.37	
Vestibule		1.28			
Reservoir length		1.28			
width		.128	.144		
Common trunk		.960	.912		
Distance from posterior extremity of:—Caudal pores		.160	.176		
Most posterior loop of uterus		6.28	3.70		
Eggs			.057 x .028		
Spicules left				.776	1.24
right				.185	.256
Length of bursa				1.60	1.72
Lateral width of bursa				.800	.880
Diameter above bursa				.448	.368
Lengths of external bursal papillae				.160, .192, .144, .122	.176, .304, .224, .128

PHYSALOPTERA ANTARCTICA Linstow var. TYPICA.

Of four nematodes found, with two echinorhynchs, in the stomach of *Varanus varius* by Dr. Cleland, three large females appear to belong to this species. They measure respectively 27.5, 36.5, and 40 mm. in length, and all have fully developed genitalia of the typical form, but without developed eggs.

Measurements of the largest example are as follows:—Maximum diameter, 1.0 mm.; diameter at base of collarette, 320 μ; at anus, 400 μ; tail, 512 μ long. Distance of cephalic extremity from nerve ring, 384 μ; post-cervical papillae, 608 μ; excretory pore, 720 μ; vulva, 9.9 mm.; most anterior loop of uterus, 8.0 mm. Distance from posterior extremity of most posterior loop of uterus, 7.6 mm.; of receptacula seminis, 5.3 to 7.6 mm. Maximum width of uterus, 176 μ; width at junction with receptaculum seminis, 80 μ; width of oviduct at junction, 64 μ. Receptaculum seminis, 240 x 192 μ. Vestibule, 1.44 mm. x 112 μ; reservoir, 1.36 mm. x 192 μ; common trunk, 1.28 mm. x 80 μ; length of the two branches, to second bifurcation, 240 and 320 μ. Muscular oesophagus, 400 x 160 μ; total length of oesophagus, 4.36 mm.; width at its base, 384 μ. Proportion of total body length to that of oesophagus, 9.17; to that of portion of body in front of vulva, 4.0.

The reservoir and adjoining ducts, which are devoid of contents in the three examples, show a variability in disposition in the body similar to that already described for this species (Irwin-Smith, These Proceedings, 47, 1922, pp. 237-9), but the general trend of the ducts is backwards from the vulva, and the four slender uteri have an almost straight, parallel course down the body. The structure of the lips is not very clear in these specimens (examined in alcoholic phenol), and no internal denticular border is discernible. In view of the absence of male specimens, and of developed eggs, and the close general resemblance already shown to exist between unripe females of *P. antarctica* and *P. bancrofti*, these specimens have been assigned to the former species chiefly on account of the great length, which corresponds exactly with that recorded for *P. antarctica.*

Physaloptera varani is the only species hitherto recorded from hosts of the genus *Varanus*. The present specimens differ from it in their larger size, the dichotomous instead of direct division of the common trunk, the decided difference in the lengths of ovijector and common trunk in the two forms, and in the tail.

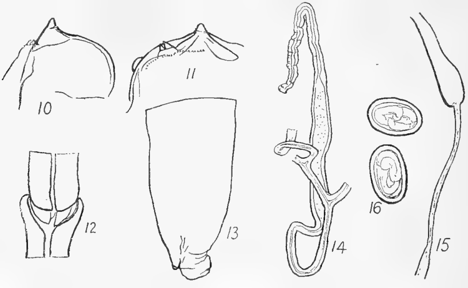
Host.—*Varanus varius.* *Location.*—Stomach. *Locality.*—Bumberry, near Manildra, N.S.W.

Collected by Dr. J. B. Cleland, 8/1/16.

Note.—In the description of *P. antarctica* given in the third paper of this series, the collection described as Lot C. was recorded as containing only 29 specimens. After that paper was in print, a jar containing nearly 900 additional specimens of the same collection, in glycerine alcohol, was discovered. They were all taken from the stomach of a single example of *Tiliqua scincoides* on August 12, 1919. Portion of the stomach wall, with *Physaloptera* still attached, was also preserved. They were deeply embedded, by the anterior end, in the mucosa, and the whole surface of the stomach was closely pitted with the holes made by them. Most of the specimens are small and immature, under 17 mm. long, none more than 30 mm. long and the smallest larvae not more than 4 mm. long.

PHYSALOPTERA CLELANDI, n.sp.

Four broken pieces of a single female specimen very different from those described above occur in the same collection with them, taken from the same host. Although in such a damaged condition, the specimen shows features sufficiently distinctive to enable it to be characterised as a new species. It is remarkable for the stoutness of the body and the great length and width of the oesophagus. The oesophagus is actually longer than in any species hitherto described, and if the four fragments (measuring together 24 mm.) represent the total length of the body, the length of the oesophagus relative to that of the body is also exceptionally great. The worm has been torn or cut across transversely, and the internal structures have been pulled out of position, and project from the ends of each fragment in such a way that it is not possible to determine with certainty how they connect with each other, but as far as can be judged, they represent the full length of the specimen. Uteri filled with eggs containing well-developed embryos extend up parallel with the oesophagus nearly to the head, and far posteriorly. Eggs are found crowded into the tail region behind the anus, but have probably escaped into the body cavity from the ruptured uteri. Four uteri are present, almost emptied of contents through the torn ends. The terminal portion of one, with the receptaculum seminis, oviduct and ovary, is still attached to the body; the same portions of the other three are detached, and lie free in the alcoholic preservative. The vulva is 1 mm. distant from the anterior end of a piece of the body separate from that containing the oesophagus, and a broken uterus projects anteriorly 5.2 mm. from the same end. Assuming that this piece of the body is the one next behind the oesophagus,



Figs. 10-16. *Physaloptera clelandi*, n.sp.

10. Side view of lip, showing external labial tooth, and buccal pad (x 190); 11. Internal view of lip (x 190); 12. Junction of oesophagus and intestine (x 30); 13. Posterior end of female body (x 15); 14. Terminal portion of female genital system (x 27); 15. Receptaculum seminis and oviduct (x 27); 16. Eggs (x 290).

the distance of the vulva from the anterior extremity is 6.7 mm., but if, as is more probable, it is the third piece, the distance is 12.5 mm.

Specific diagnosis.

Male unknown.

Female. Body very robust, opaque, thickset, cuticle very tough and thick (80 μ), covered with a fine transverse striation. Lips large, external labial tooth erect, broad, conical, with blunt tip, which in this specimen appears to be fractured; no internal tooth at its base, paired teeth at sides large, denticular border composed of a single row of very minute denticles, scarcely visible even under high magnifications, sides of lips too damaged to show details of lateral marginal denticles (Text-figs. 10, 11). Post-cervical papillae just behind junction of muscular and glandular oesophagi. Oesophagus very long and thick, muscular oesophagus narrower than glandular oesophagus, and less than one-eleventh of the total length, base of glandular oesophagus broad and rounded, its valves inserted to some depth into the lumen of intestine (Text-fig. 12). Vulva behind termination of oesophagus; vestibule, reservoir, and common trunk all long, division into four branches evidently dichotomous, but the second bifurcation only shows on one side, the other being torn away (Text-fig. 14). Uteri large and distended, with thin, delicate, transparent walls showing elongated cellular structure well. Position of receptacula seminis and ovaries in body not determined. Oviducts sharply delimited from receptacula seminis (Text-fig. 15). Eggs smaller than in the other species, the shell relatively thin, brown coloured (Text-fig. 16). Posterior end of the body thick and blunt, the tail very short, but too distorted for accurate measurement (Text-fig. 13).

Measurements.—Total length, 24 mm. (?); maximum diameter, 1.36 mm.; diameter at base of collarette, 400 μ; at anus, 560 μ. Tail, 400 μ long. Distance from cephalic extremity of post-cervical papillae, 592 μ; excretory pore, 688 μ; most anterior loop of uterus 576 μ (?). Distance from posterior extremity of most posterior loop of uterus, 160 μ (?). Maximum width of uterus, 480 μ; width at junction with receptaculum seminis, 112 μ; width of oviduct at junction, 64 μ. Receptaculum seminis, 432 x 192 μ. Vestibule, 1.68 mm. x 96 μ; reservoir, 1.44 mm. x 192 μ; common trunk, 1.52 mm. x 85 μ. Distance between first and second bifurcation, 400 μ. Lengths of oviducts, 1.87 and 1.52 mm. Muscular oesophagus, 480 x 176 μ, total length of oesophagus, 5.56 mm.; width at its base, 480 μ. Proportion of total body-length to that of oesophagus, 4.3 (?). Eggs, 44 x 29 μ.

Host.—*Varanus varius.* *Location.*—Stomach. *Locality.*—Bumberry, near Manildra, N.S.W.

Collected by Dr. J. B. Cleland, 8/1/16.

The dimensions of the eggs agree with the figures given by Parona for *P. varani,* but differ from those given by Seurat for the same species. Parona's description is insufficient otherwise, for comparison, but *P. clelandi* differs from the specimens described by Seurat as *P. varani,* in the much greater length of the oesophagus and common trunk, the dichotomous instead of direct division of the latter, and the shorter ovijector and tail.

In addition to the host from which this and the preceding specimens were taken, two other examples of *Varanus varius* were searched by Dr. Cleland for internal parasites. Neither of them contained *Physaloptera.* In one, taken at Dubbo, October, 1911, the only helminth present was a cestode in the intestines. The other taken at Eidsvold, Queensland, September, 1912, contained only some examples of a *Filaria* sp. in the pleuroperitoneal cavity.

PHYSALOPTERA SP., from *Lialis burtonii* Gray.

The material available is inadequate for specific determination, consisting of two small larvae, 6.6 and 6.7 mm. long, in which the genital system is not developed.

The body is relatively stout (Text-fig. 20); cephalic collarette and lateral alae fairly well developed. Cuticle fairly thick, finely striate transversely. External median tooth large, erect, sharply-pointed, a small tooth, apparently double-pointed, at its base internally; the pair of lateral teeth on each side well developed, sharply-pointed; no internal denticular border discernible; the pair of papillae on the external cuticular pad on each lip large, prominent (Text-fig. 22). Oesophagus one-fifth of body length, muscular oesophagus narrower than glandular, and sharply distinct from it, the muscular part light in colour, the glandular part very dark, its base broadly rounded. Nerve-ring just in front of junction of muscular and glandular portions; the post-cervical papillae just behind the junction (Text-fig. 23). What appear to be cervical glands extending back nearly to the level of the papillae. Tail sharply pointed, 1/32 to 1/35 of the total body-length; narrow transverse muscular bands across body in region of anus; rectal glands large (Text-fig. 24).

Measurements.—Total length, 6.7 mm.; maximum diameter, 336 μ; diameter at base of collarette, 128 μ; at anus, 128 μ. Tail, 190 μ long. Distance from cephalic extremity of nerve-ring, 185 μ; post-cervical papillae, 256 μ; excretory pore, 296 μ. Buccal cavity, 33 μ; muscular oesophagus, 176 x 59 μ; total length of oesophagus, 1.34 mm.; width at its base, 103 μ.

Host.—Lialis burtonii Gray. *Location.*—Intestine. *Locality.*—Helensburg, New South Wales.

In Dr. J. B. Cleland's collection. Collected by Dr. Cox, 2/1/15.

These larvae differ from those of *P. antarctica*, and from those found in *Gymnodactylus platurus* and assigned to *P. bancrofti*, in having a much thicker and more opaque body. They are of heavier build altogether; the oesophagus is relatively a little shorter and broader, and the nerve-ring is nearer to the junction of muscular and glandular oesophagi (Text-figs. 17-19, and 20-23).

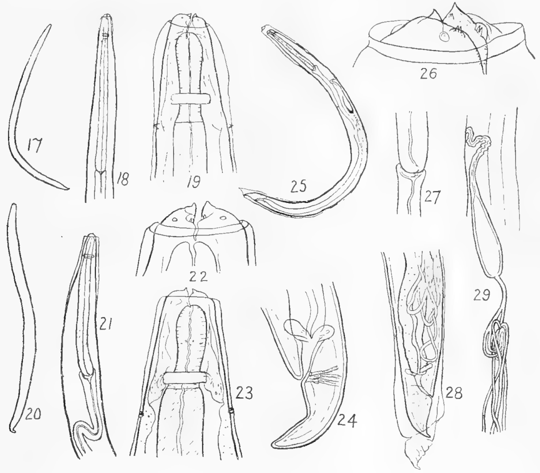
According to Dr. Cleland's notes, another lot of Nematodes was obtained from this host, collected by Miss Wearne at Manly, Sydney, in June, 1915, and described as "a bunch of Nematodes attached to the small intestine, and a free Nematode, apparently of another species." These were probably *Physaloptera*, but, unfortunately, the specimens are not available for examination.

PHYSALOPTERA SP., from *Lygosoma entrecasteauxii.*

A single, small, immature female, taken from the same host which harboured an *Oxyuris* sp., and the *Rictularia disparilis* already described in a separate paper (Irwin-Smith, These Proceedings, 47, 1922, p. 311), cannot at present be placed more definitely than *Physaloptera* sp. In this specimen, preserved in alcohol, the body is withdrawn about .2 mm. from the cuticle at each extremity.

The body is robust, heavy, rather opaque, of uniform diameter, not much attenuated towards the extremities (Text-fig. 25). Cephalic collarette well developed. Labial papillae large. External median tooth large, erect, sharply-pointed; a double-pointed tooth at its base; broad, paired, lateral denticles; possibly a single continuous row of very minute internal denticles, but this rather indefinite; a row of small lateral marginal denticles (Text-fig. 26). Oesophagus about one-fifth of body-length, relatively broad, muscular oesophagus very short, its junction with glandular oesophagus not very clear; nerve-ring apparently just at junction. Base of glandular oesophagus broad and rounded, not deeply inserted into lumen of intestine (Text-fig. 27). Tail one-thirty-third of body-length, sharply pointed, ventrally inflected at tip (Text-fig. 28). Four uteri. Vulva .5 mm. behind base of oesophagus, at 1/3.8 of the body-length from cephalic extremity. Vestibule and reservoir both long, and reservoir broad and very well developed, pear-shaped, sharply delimited from common trunk (Text-fig.

29). Common trunk very short, dividing dichotomously into four branches, the two branches from the first division as long as the common trunk; the whole system extending straight back, branches looped and coiled in region of second bifurcation; no uteri in front of this, all four intertwined and coiled in posterior



Figs. 17-19. Larval *Physaloptera bancrofti,* from *Gymnodactylus platurus.*

17. Whole worm (x 7.5); 18. Anterior end of body, showing oesophagus (x 27); 19. Anterior end, showing junction of muscular and glandular oesophagi, nerve-ring, and post-cervical papillae (x 100).

Figs. 20-24. *Physaloptera* sp. (larva), from *Lialis burtonii.*

20. Whole worm (x 7.5); 21. Anterior end of body (x 27); 22. The two lateral lips (x 190); 23. Anterior extremity (x 100); 24. Posterior end of body (x 100).

Figs. 25-29. *Physaloptera* sp. (♀), from *Hinulia* sp.

25. Whole worm (x 7.5); 26. The two lateral lips (x 290); 27. Junction of oesophagus and intestine (x 30); 28. Posterior end of body (x 30); 29. Terminal portion of female genital system (x 27).

region of body, extending back nearly to anus; uteri very narrow, poorly developed. Receptacula seminis not observed. No developed eggs.

Measurements.—Total length, 8.56 mm.; maximum diameter, 480 μ; diameter at base of collarette, 176 μ; at posterior third of body, 480 μ; at anus, 208 μ. Tail, 256 μ long. Distance from cephalic extremity of nerve-ring, 176 μ; post-cervical papillae, 256 μ, vulva, 2.24 mm.; most anterior loop of uterus, 4.50 mm.

Distance from posterior extremity of most posterior loop of uterus, 780 μ; of ovaries, 416 μ. Maximum width of uterus, 33 μ. Vestibule, 960 x 52 μ; reservoir, 800 x 208 μ; common trunk, 256 x 48 μ. Distance between first and second bifurcation, 256 μ. Muscular oesophagus, 176 (?) x 112 μ; total length of oesophagus, 1.70 mm.; width at its base, 176 μ.

Host.—*Lygosoma* (*Liolepisma*) *entrecasteauxii.* *Location.*—Alimentary canal. *Locality.*—Flinders Island, Bass Straits.

Collected by Dr. J. B. Cleland, 25/11/12.

Two specimens of this host species were examined. The second specimen contained only Oxyuriidae.

Except for the larger size and the development of genitalia, there is little, in the general conformation and proportions of this specimen, to distinguish it from the larval *Physaloptera* found in *Lialis burtonii* and described above. They may all belong to the one species, but this can not be determined, nor the species clearly characterised, until more specimens are available for examination. It is apparently a young specimen, not fully grown.

From an examination of numerous examples of *P. antarctica,* it has been shown (Irwin-Smith, These Proc., 47, 1922, p. 237) that measurements taken from a single specimen are, alone, of little specific value, since considerable variations, both in the proportions and conformation of organs, are found to occur within a single species. In view of this, and of the immaturity of the single female specimen found, and of the absence of males, it is not desirable, at present, to propose a new species for this specimen, though it is evidently distinct from any of the species with four uteri hitherto described.

In none of the other species is the female genital system well developed in specimens of such a small size. The dichotomous division of the very short common trunk into four uteri, with the first two branches equal in length to the common trunk is also distinctive, if it is a constant feature. It is of heavier build than examples of *P. antarctica* and *P. bancrofti* of the same size, and the denticular formation is different.

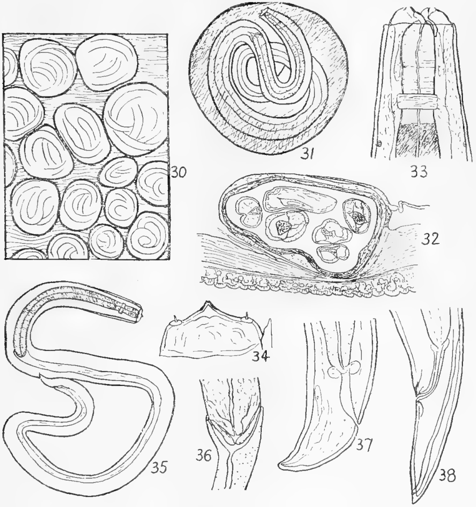
Although so much smaller in size, its heavy build recalls that of *P. clelandi*; but the tail is relatively longer and more slender and sharply pointed, and the oesophagus is shorter in proportion to the length of the body. Marked differences from *P. pallaryi, P. varani,* and *P. abbreviata,* in addition to the size and relative proportions of the body, are the situation of the vulva behind the termination of the oesophagus instead of in front of it, where it is found in *P. pallaryi,* the dichotomous instead of direct division of the common trunk, as in *P. varani,* and the denticular formation with a large inner double-pointed tooth, unlike *P. abbreviata* and the other two species.

Encysted *Physaloptera* larvae in *Hinulia taeniolatum.*

From Mr. Mackerras I have received, recently, a portion of the stomach-wall of an *Hinulia taeniolatum* infested with nematode cysts, with the information that similar cysts were numerous in the mesentery and behind the peritoneum on the posterior body wall.

The cysts contain larvae which are undoubtedly *Physaloptera,* and the evidence they supply of migratory and cyst-forming habits in this genus of nematodes is of great interest and significance.

The portion of the stomach-wall preserved was entirely covered with them, forty-two occupying an area one centimetre square (Text-fig. 30). Beyond this area they were more scattered, but were fairly thick all over the stomach. It was not possible to determine, from a macroscopic examination of the fragment of the stomach preserved, whether they were on the outer or inner side of the wall. But microtome sections, made by Dr. J. R. Dixon, show that they are all quite external, being situated between the muscle-coat and a thin, transparent membrane, which is evidently the peritoneum. They are not embedded in the muscle, but lie loosely on its surface, in depressions which are sometimes deep enough to displace the muscle fibres (Text-fig. 32). When the peritoneum is stripped off, they are easily detached intact, each enclosed in a tough, but very thin, smooth, and semitransparent membrane, within which the coiled nematodes



Figs. 30-38. Encysted *Physaloptera* larvae on stomach of *Hinulia taeniolatum.*

30. Portion of stomach-wall of host, with *Physaloptera* cysts (x 7.5); 31. A single cyst (x 27); 32. Transverse section through cyst, and stomach-wall (x 30); 33. Anterior end of nematode, showing junction of muscular and glandular oesophagi, nerve-ring, and post-cervical papillae (x 100); 34. Internal view of lip (x 190); 35. *Physaloptera* sp. Whole worm uncoiled (x 27); 36. Junction of oesophagus and intestine (x 100); 37. Female tail (x 100); 38. Male tail (x 100).

lie free in a watery medium (Text-fig. 31). The cyst-wall, apparently, has no connection with the host-tissues. It consists of a thin outer layer of loose cellular tissue, strengthened, internally, by a thicker, denser layer of fibrous material.

The cysts vary in diameter from 1 to 2.34 mm., and contain from one to seven worms, which can be removed without difficulty by cutting round the circumference, and turning the wall back. When more than one is present, the worms are closely intertwined, in a ball-like mass, but, with a little care, they can be separated whole and extended in good condition for microscopic examination (Text-fig. 35).

Their large size is somewhat remarkable. The largest of them attain a length of nearly 12 mm. and a maximum diameter of .4 mm., but none of them show any trace of genitalia. Of fifteen larvae, taken from four cysts, the average length is 7.4 mm., four in one cyst measuring from 6.4 to 7.6 mm., and seven in another from 6.0 to 8.0 mm. A difference in the length and shape of the tail evidently distinguishes the two sexes, the female tail being short, fairly thick and blunt, the male tail longer, thinner, and sharply pointed. Two of each form were found in one cyst containing four larvae.

Examination and measurements of the larvae were made both in glycerine and alcoholic phenol.

Description.—*Physaloptera* larvae. Genitalia not developed. Fairly stout bodied, tapering posteriorly, but not greatly attenuated anteriorly; anterior half of body broader than posterior half; tail one-fortieth to one-thirtieth of body-length, longer, narrower and more sharply pointed in the male than in the female, the average lengths in the two sexes being 240 and 176 μ (Text-figs. 37, 38). Cuticle clear and delicate, body very transparent, oesophagus very heavy and dark in contrast; transverse striation very fine. Cephalic collarette and alae well developed. Labial papillae large; external median tooth truncated at tip, and slightly notched; only one lateral tooth on each side, slender, needle-like; no internal denticular border (Text-fig. 34). Muscular oesophagus about one-seventh to one-eighth of total length of oesophagus, narrower and clearer than glandular oesophagus, a well marked line dividing the two. The anterior part of muscular oesophagus distinctly different in structure from the posterior part. Nerve-ring surrounding it very close to the junction with glandular oesophagus. Post-cervical papillae about 80 μ behind the junction (Text-fig. 33). Short, dark, granular bodies on each side of the oesophagus, anteriorly, not reaching to the level of the nerve-ring, apparently cervical glands. Total length of oesophagus one-fourth to one-fifth of body-length in the smaller larvae, slightly less in the larger specimens. Base of oesophagus inserted well into lumen of intestine (Text-fig. 36). Intestine narrow, thin-walled, delicate.

Measurements of one example.—Total length, 7.6 mm.; maximum diameter, 256 μ; diameter at base of collarette, 148 μ; at anus, 112 μ. Tail, 240 μ. Distance from cephalic extremity of nerve-ring, 203 μ; post-cervical papillae, 333 μ. Length of buccal cavity, 37 μ; of muscular oesophagus 208 μ; total length of oesophagus, 1.63 mm. Width of muscular oesophagus, 62 μ; of glandular oesophagus, 129 μ.

Host.—Lygosoma (*Hinulia*) *taeniolatum* White. *Location*.—Body cavity. *Locality*.—"Castle Rock," Middle Harbour, Sydney.

Collected by Miss Bancroft and Mr. Mackerras, 14/9/21.

The host formed one of three examples of this species examined at the same time, by Miss Bancroft and Mr. Mackerras for internal parasites. No nematodes were found in the others.

These encysted larvae are clearly distinct from the *Physaloptera* sp., described above, from *Lygosoma entrecasteauxii*. The absence of genitalia in encysted specimens much larger than that specimen, in which the female genital system is well developed, shows that they belong to a much larger species. In addition, the shape of the body is different. In the specimen from *L. entrecasteauxii* it is not attenuated in the posterior half, as it is in the encysted larvae, and it is altogether stouter and more opaque. The oesophagus is also somewhat thicker and the denticular formation is quite different.

Only one other record exists of a *Physaloptera* from any species of *Lygosoma*. This was listed by Dr. T. H. Johnston as *Physaloptera* sp., from *Lygosoma* (*Hinulia*) *tenue*, duodenum, Millfield, N.S.W. The record is not accompanied by a description, so that it is impossible to compare Dr. Johnston's specimen with these encysted larvae.

Collections of internal parasites were made by Dr. Cleland from three species, *Lygosoma* (*Liolepisma*) *entrecasteauxii*, *Lygosoma* (*Hinulia*) *taeniolatum*, and *Lygosoma* (*Hemiergis*) *descresiense*, and Dr. Johnston's lists contain single records from three species, but, with the exception of the specimens already noted, none of these relate to *Physaloptera*.

There is no indication that nematode cysts have ever before been observed in this or any other Australian lizard genus, but, apparently, very few examples have been searched, and it is possible that when lizards are examined in much greater numbers, *Physaloptera* larvae in an encysted condition will be found to be not uncommon.

Note (*added 30th September, 1922*).—Since the above was written, Mr. Mackerras has found a solitary cyst of the same character, embedded subperitoneally on the stomach-wall of another example of *Lygosoma* (*Hinulia*) *taeniolatum*. The cyst contained a single specimen of a *Physaloptera* larva exactly similar to those described here. It was removed from the cyst while still alive, and fixed in hot 70% alcohol in well extended condition. It is a large, well-preserved specimen, a little over 12 mm. long. No other cysts, nor any free nematodes were found in this host-specimen, although a thorough search was made.

List of lizard-hosts referred to in Parts 3 and 4 of Physaloptera *notes, with the helminth parasites recorded from them.*

Gymnodactylus platurus Shaw	*Physaloptera bancrofti* Irwin-Smith, *Pharyngodon* sp.
Lialis burtonii Gray	*Physaloptera* sp. (larvae).
Lygosoma (*Hinulia*) *taeniolatum* White	*Physaloptera* sp. (encysted larvae).
Lygosoma (*Liolepisma*) *entrecasteauxii*	*Oxyuris* sp., *Physaloptera* sp., *Rictularia disparilis* Irwin-Smith.
Tiliqua occipitalis Gray	*Physaloptera antarctica* Linstow.
Tiliqua scincoides White	*Physaloptera antarctica* var. *typica* Linstow, and var. *lata* Irwin-Smith.
Varanus varius	*Physaloptera antarctica* var. *typica* Linstow, *Physaloptera clelandi* Irwin-Smith, *Filaria* sp., *Echinorhynchus* sp., *P. tidswelli* (Cestode).

In conclusion, I wish to make grateful acknowledgment of the assistance received in the preparation of this series of *Physaloptera* studies: to Miss Chase and students of the Zoology Dept. of the University of Sydney, Professor J. B. Cleland, Miss M. J. Bancroft, and Mr. I. M. Mackerras for providing the material, to Dr. J. R. Dixon for the preparation of sections, and to Mr. J. R. Kinghorn, of the Australian Museum, for supplying me with information relating to the hosts and for the selection of the proper host-names.

THE OCCURRENCE OF OIL-GLANDS IN THE BARKS OF CERTAIN EUCALYPTS.

By M. B. Welch, B.Sc., A.I.C., Economic Botanist, Technological Museum.

(Plates xlviii.-xlix.)

[Read 27th September, 1922.]

The occurrence of secretory glands containing an essential oil in the leaves of plants is typical of a number of Natural Orders, particularly in the Myrtaceae and Rutaceae. In the case of the barks, however, oil glands are comparatively rare and Solereder (1908) records them in his generalisation only in the Samydaceae and Myrtaceae. Under the Myrtaceae, however, Solereder states, "The improbable statement of Möller's (Rindenanatomie, pp. 344-347) as to the occurrence of resin spaces in the secondary bast in *Eucalyptus viminalis* and *E. Stuartiana,* F.v.M. requires re-examination. According to Möller spherical (0.12 mm. diameter) apparently lysigenous resin spaces occur in the first named species." Unfortunately a copy of Möller's work is not available for reference, but under *E. viminalis,* Mueller (1879-84) gives "an abridged translation" from it, which reads as follows:—"The periderm contains rows of almost cubic partially unilateral-sclerotic cork-cellules, and reaches quite to the bast; the latter is scalariform-laminated through isolated or not far extending plates of fibre-bundles; the fibres of the bast are about 0.03 mm. broad, and accompanied by chambered fibres (Kammer-Fasern), which contain prismatic crystals, similar to those occurring in the bast of elms, and such crystals are scattered also through the soft bast; the latter consists of small cellules, is thin-walled and beset with roundish Kino-spots; the sieve-tubules (Sieb-Röhren) have the narrow perforated plates numerously ladder-like arranged (Stein-Zellen); the medullary rays are one- or two-rowed, are never sclerotic and contain no crystals."

It will be noticed that in this translation no mention is made of "resin-spaces" and the nearest approach to them is found in the words "roundish Kino-spots." Mueller makes no mention of the bark anatomy under *E. Stuartiana,* as apparently that portion of the Eucalyptographia was completed before 1882, the date when Möller's Rindenanatomie was published. In spite of Solereder's doubts as to the correctness of Möller's work, the presence of an essential oil in the barks of certain Eucalypts can no longer be disputed.

In 1898 Baker (1898, p. 166) obtained an essential oil from a steam distillation of the bark of *E. Bridgesiana* and later H. G. Smith (1916, p. 177) gave an analysis of the oil obtained in a similar manner from the bark of *E. Macarthuri.* In Eucalyptographia, under *E. pulverulenta,* Mueller mentions that this tree is sometimes known as "Turpentine" on account of the "peculiar somewhat terebinthine odour" in the bark. This reference is evidently in connection with *E. cinerea,* which was then synonymised under the small slender bush *E. pulverulenta.* J. H. Maiden (1921, p. 101) mentions the fact that "the inner bark of *E. acaciaeformis* has a distinct odour of turpentine" and that "the bark of old trees of *E. aggregata* contains essential oil."

Frequent references have also been made by many botanical workers to the fact that both *E. Bridgesiana* and *E. Macarthuri* possess a bark containing oil but, apart from Möller, no record has so far been met with as to a similar occurrence in *E. viminalis* and *E. Stuartiana.* It was at first thought that Möller may have been working on material of *E. Bridgesiana* and *E. Macarthuri,* as between these four species there has been a certain amount of confusion in the past. For example, *E. Stuartiana* has had a particularly chequered career and its botanical history is somewhat complex. Numerous attempts have been made to prove that *E. Bridgesiana* R. T. Baker, a Woollybutt with a soft fibrous bark, is synonymous with *E. Stuartiana* F.v.M., "Apple" of Victoria, a tree with a reddish "Stringybark." There is, in fact, little in common between the barks and timbers of the two species. Again Bentham (1866) places Woolls's specimens labelled Camden Woollybutt, now *E. Macarthuri,* under *E. viminalis,* though the barks of the two trees are also dissimilar. According to Deane and Maiden (1899) in their original description of *E. Macarthuri,* the Camden Woollybutt of Bentham is identical with their species.

It was therefore thought probable that in view of the relationship, in nomenclature at any rate, of the present day *E. Bridgesiana* and *E. Macarthuri,* with the older *E. viminalis* and *E. Stuartiana,* that the former species were the ones which Möller had used, particularly since no subsequent Australian writer has confirmed his work. An examination was therefore made of a number of Eucalyptus barks and, not only are there definite oil-glands in the secondary bast of certain species, but they occur also in the two species on which Möller worked.

This investigation shows that oil-glands occur in the following species:—*E. acaciaeformis* Deane & Maiden, *E. aggregata* Deane & Maiden, *E. angophoroides* Baker, *E. Bridgesiana* Baker, *E. cinerea* F.v.M., *E. elaeophora* F.v.M., *E. Gullicki* Baker, *E. Macarthuri* Deane & Maiden, *E. maculosa* Baker, *E. nova-anglica* Deane & Maiden, *E. pulverulenta* Sims., *E. rubida* Deane & Maiden, *E. Smithii* Baker, *E. Stuartiana* F.v.M., and *E. viminalis* Labill.

A large number of the species have been examined with negative results, and it is evident that Eucalypts with bark oil-glands are the exception rather than the rule.

Bark specimens of the following Eucalyptus species showed no evidence of oil-glands:—*E. acmenioides* Schau., *E. albens* Miq., *E. Behriana* F.v.M., *E. bicolor* Cunn., *E. Boormani* Deane & Maiden, *E. Bosistoana* F.v.M., *E. botryoides* Sm., *E. calycogona* Turcz., *E. camphora* Baker, *E. Cannoni* Baker, *E. corymbosa* Sm., *E. crebra* F.v.M., *E. Dawsoni* Baker, *E. dealbata* Cunn., *E. dives* Schau., *E. fasciculosa* F.v.M., *E. fastigata* Deane & Maiden, *E. Fletcheri* Baker, *E. fraxinoides* Deane & Maiden, *E. globulus* Labill., *E. haemastoma* Sm., *E. haemastoma* Sm. var. *micrantha* Benth., *E. hemilampra* F.v.M., *E. hemiphloia* F.v.M., *E. longifolia* Link et Otto, *E. Maideni* F.v.M., *E. melliodora* Cunn., *E. microtheca* F.v.M., *E. Nepeanensis* Baker & Smith, *E. oreades* Baker, *E. ovalifolia* Baker, *E. paludosa* Baker, *E. paniculata* Sm., *E. patentinervis* Baker, *E. pilularis* Sm., *E. piperita* Sm., *E. polyanthemos* Schau., *E. populifolia* Hook., *E. punctata* De C., *E. radiata* Sieb., *E. regnans* F.v.M., *E. resinifera* Sm., *E. Rossii* Baker & Smith, *E. rostrata* Schlecht., *E. saligna* Sm., *E. Sieberiana* F.v.M., *E. squamosa* Deane & Maiden, *E. tesselaris* F.v.M., *E. vitrea* Baker, and *E. Woollsiana* Baker.

Although these glands are only of specific importance, yet they are valuable taxonomically in the particular species in which they occur and, since the secondary development can usually be recognised in small stems such as are commonly found among herbarium material, their presence may be used as an aid to identification.

Most of the detailed investigation of the bark oil-glands was carried out on *E. Macarthuri,* as their arrangement and distribution in this case is apparently typical of the other species.

In almost all Eucalypts which have been examined in this work, oil-glands are a common feature in the cortical tissues of the young stems, especially before the development of the periderm. In the young stems the glands are close to the epidermis, but, although they are often numerous, there is apparently no increase in their number and, even in the more mature stems, they still form a ring in the cortex. There is also no sign of glands in the secondary phloem and they may be regarded as purely cortical in their origin and distribution. In the barks of older trees there is also no trace of glands and naturally the original cortical glands have long since ceased to function.

In *E. Macarthuri,* however, an examination of the "bark" of a twig an inch in diameter, or of the bark of a tree several feet in diameter, shows an enormous increase in the number of glands, and it is evident that their development must be of a secondary character. In tracing this secondary increase, an examination was first made of the young twigs of *E. Macarthuri* about 1.0 mm. in diameter. In many cases no oil-glands were found at all, in a few sections (Pl. xlviii., fig. 1) glands 0.10 mm. to 0.15 mm. in diameter were present in the cortex, flattened with the longer axis tangentially directed, and close to the epidermal layer. The phellogen was not continuous, but along portion of the stem showed the early cells of the periderm, though the epidermal layer had not yet broken away.

The two oil-glands seen in the figure correspond in mode of occurrence and position with those commonly found in the cortical tissues of young Eucalyptus stems, as already pointed out. The outer limit of the primary phloem is limited by a broken ring of small groups of mechanical fibres, as pointed out by Solereder (1908) as a characteristic of the Myrtaceae. Slightly thicker stems, about 2.0 mm. in diameter, showed no oil-glands in the cortex in the particular sections examined, though it is evident that some must occur. At this stage, however, there is apparently no increase in their number, although the epidermis had commenced to strip off—a result of the outward pressure of the periderm. The phloem was about 0.25 mm. in thickness. In stems 6.0 mm. in diameter, several glands were found measuring .09 mm. x 0.45 mm., almost on the border-line between the phloem and the cortex. They were few in number and in many cases were found to occupy a position in the medullary rays. A few are evidently secondary in character. The periderm was about 0.075 mm. in thickness, the secondary phloem 0.70 mm., the cortex 0.10 mm.

A section of a 6 mm. stem (Pl. xlviii., fig. 2) is shown in which there is almost an entire absence of oil-glands, though two are seen in the top corners of the illustration. It is apparent that very little secondary development has yet occurred, since these glands are probably of a primary character and correspond in origin with those in Plate xlviii., fig. 1. Slightly older stems, with a thickness of almost 10 mm., showed numerous oil-glands in section. These were flattened, with the longer axis tangentially directed, the larger ones being within 0.3 mm. of the outer periderm layers, the latter being quite thin (0.075 mm.), and showing signs of flaking off. The glands were often 0.22 mm. x 0.10 mm. in size. Numerous somewhat smaller glands were also found towards the periphery, averaging about 0.12 mm. in length, and all showing the characteristic tangential flattening. The total thickness from cambium and phellogen averaged 1.5 mm. The glands are distributed usually along the broader medullary rays, the smaller cavities being nearer the cambium. Glands measuring up to 0.12 mm. in diameter were found within 0.45 mm. of the cambium, and at a distance of 2 mm. from the latter averaged 0.015 mm. in size.

Towards the cortex the smaller medullary rays become irregular and bent, losing their characteristic straightness. The medullary rays usually consist of a single row of cells, in transverse section, and seldom broaden out until at least half way to the cortex. Wherever the oil-glands occur the parenchymatous cells of the ray have their longer axes directed tangentially, and the gland is situated in the fan-like area formed by the widening at that point. In many cases the ray is again contracted to a single row of cells. Plate xlviii., fig. 3, shows a transverse section of a 10 mm. stem in which the distribution of the oil-glands in the medullary rays is apparent. There are numerous rhombohedral crystals (presumably calcium oxalate) distributed throughout the phloem, sometimes arranged in concentric rings, and numerous small areas of immature bast-fibres are developing. The oil-glands are always surrounded with several rows of parenchymatous cells and, in the more mature cavities, are found the remains of what are apparently disintegrated epithelial layers.

In a transverse section of the bark which, even in very young stems, flakes off in thin layers, it is evident that the meristematic cells are cutting off, on the outside, absciss-layers of usually a single row of thin-walled unsuberised cells separating the zones of one, two or three layers of normal cork-cells. The thickness of the persistent corky tissue is surprisingly small, usually only a few cells in thickness even in the smaller branches. It is, however, a common occurrence to find evidence of the development of a new phellogen nearer the cambium and by the development of the periderm the outer tissues, including oil-glands, are cut off from the inner portion and eventually thrown off.

A transverse section of a 16 mm. stem (Pl. xlviii., fig. 4), as would be expected, shows a much greater development of the secondary oil-glands.

These are often in contact and are, as usual, flattened so that their tangential and vertical axes are greatest.

A portion of the phloem and cortical tissues of a 45 mm. stem is shown in transverse section in Plate xlviii., fig. 5. The enormous development of the oil-glands in the secondary bast is apparent, and they are distributed chiefly in the broader fan-shaped rays though glands are seen to occur also in the smaller rays. Glands measuring 0.23 mm. and 0.11 mm. are common. The total width of the secondary phloem is 3.5 mm. It is evident that the glands are not developed, except at some distance from the cambium, and by far the greater development and number occur in the outer half of the secondary tissues.

In radial section (Pl. xlviii., fig. 6), the glands are found to be approximately circular in section and it is evident that there is no trace of elongation into anything resembling a duct. The glands occur in irregular groupings, often two or more in contact. The loose parenchymatous tissue in which they occur is irregularly divided by bast-fibres and parenchyma-elements of the secondary phloem, since, as has been pointed out, the medullary rays are bent from their usual radial direction in this region.

It will be seen from the section that towards the phellogen the glands are comparatively small, reaching their maximum size nearer the cambium. The great increase in the number of glands in the cortical tissues, as well as in the fan-shaped medullary rays, indicates that they are developed in any position, evidently by the repeated division of certain meristematic cells and the subsequent enlarging of the cavity, forming several rows of narrow cells round the periphery.

The development of the gland is probably the same as occurs in the leaf oil-ducts, where the early stages are schizogenous, subsequently becoming lysigenous, the mature cavity being therefore schizo-lysigenous. No very definite examples of the very early stages in development were found, however, though the subsequent disintegration of the innermost cell-layers may be observed in older glands.

The bark of the mature tree *E. Macarthuri* is typically that of a Woollybutt, i.e., the outer portion is fairly compact, short-fibred and grey in colour, with numerous interlacing ridges, in fact close in texture to the "Boxes" The outer fibrous portion consists of dead tissue, but a short distance from the exterior the periderm cells are living and the odour of geranyl acetate is very distinct as soon as the bark is cut. On a tree about two feet in diameter the bark examined was 1½ inches in thickness. Oil-glands were found right up to the dry outer surface, the contents being bright yellow to brown in colour; towards the cambium the oil-glands were lighter in colour. Plate xlix., fig. 7 shows a transverse section of the bark near the exterior, the tissue consisting entirely of secondary phloem. The oil-glands are numerous, usually 0.10—0.15 mm. in diameter, and occur in areas of thin-walled tissue, either isolated or in groups. The medullary rays, usually only a single row of cells in width, are often forced to one side by the glands. The cells immediately surrounding the cavity are narrow and similar to those found surrounding the leaf oil-glands. In *E. Macarthuri* the zones of bast-fibres are irregular in size and distribution, and numerous single fibres are found. Plate xlix., fig. 8 shows a section of a portion of the bark about 10 mm. from the cambium. It is evident that there are no glands whatever in this part, the larger cells seen in section being the sieve tubes. A section taken about 15 mm. from the cambium shows the first stages in the development of the glands in a position in close proximity to the medullary rays.

In Plate xlix., fig. 9, a tangential section near the outer portion of the bark (4—10 mm. from the exterior), it is seen that the glands are largely distributed throughout broad bands of thin-walled parenchymatous tissue, corresponding in position to a broad medullary ray, which is crossed by interlacing bast-fibres. Although in this species there is a tendency for the oil-glands to be arranged in this radial manner, in some Eucalypts the distribution is more even throughout the secondary phloem tissues, whilst in *E. Smithii,* as pointed out later on, the glands are arranged in zones which have the broader axes directed tangentially. In radial section (Pl. xlix., fig. 10) the relationship between the smaller cells of the numerous medullary rays and the loose thin-walled tissue in which the glands are usually found, is evident.

Nature of Oil-Gland Contents.

In small twigs of *E. Macarthuri* the contents of the oil-glands are soluble in 80—90% alcohol, are granular and light yellow in colour, or almost colourless. In a stem of about 45 mm. in diameter the contents of the innermost glands are soluble in 90% alcohol; towards the outer portion of the bark, however, the contents are darker in colour and more insoluble, even 100% alcohol having no effect in many cases. In the mature bark about 40 mm. in thickness, a similar state of affairs is found. Within a distance of 10 mm. from the outside, the gland contents are as a rule quite insoluble in 100% alcohol and are dark yellow in colour. In the next section (from 10 mm.—20 mm.) the contents are partly insoluble, becoming less so towards the cambium, with a gradual lightening in colour. From 20 mm. to 30 mm. there are comparatively few glands and the contents are readily soluble, whilst in the inner portion (30—40 mm.) glands are practically non-existent. The odour of geranyl acetate, though pronounced in the outer portion, cannot be detected in the inner section. The outer yellow contents are insoluble in glacial acetic acid, ether, chloroform, etc. On leaving sections in glacial acetic acid for 48 hours there was a lightening in colour, but the contents were otherwise apparently quite unaffected. It is apparent, therefore, that there is a decided alteration in the contents of the oil-glands in the outer portion of the bark, even in those of comparatively small branches. This is evidently due to alteration of the oil to bodies of a resinous nature. Alkannin in 50% alcohol gave a definite colouration for oil in the interior glands. There was no indication of tannin in the glands, though ferric chloride gave a definite reaction in the neighbouring cells. An examination of the leaf oil-glands showed the contents to be somewhat sparse, often only a fringe bordering the edge of the cavity, granular, almost colourless and soluble in 80—90% alcohol, though leaving a film-like insoluble residue.

The following descriptions deal briefly with the individual species in which bark oil-glands have been found.

E. acaciaeformis Deane & Maiden. "Black Peppermint."

A tree with a fibrous bark, sometimes rough and furrowed. Oil-glands are not numerous, large, measuring up 0.23 mm. in diameter, contents yellow in colour, less soluble and darker towards the outside. Fibre zones numerous thus forming the rough persistent outer bark.

E. aggregata Deane & Maiden. "Black Gum," "Peppermint."

Bark "Box-like or rather more flaky; between that of a Box and a Stringybark or Woollybutt. . . . . In old trees very thick and containing essential oil" (original description). Oil-glands fairly numerous, distributed evenly through the outer portion of secondary phloem, contents almost soluble in 95% alcohol, darker yellow in colour towards the outside—measuring up to 0.18 mm. in diameter. Fibre zones arranged in concentric rings.

E. angophoroides Baker. "Apple Tree Box."

A "tree with a white Box-bark, persistent to the ultimate branches" (orig. description). Oil-glands large, up to 0.23 mm. in diameter in the material examined. Contents dark, granular, partially filling cavity, soluble slowly in 100% alcohol. They are arranged between the groups of fibres, often 3—4 glands occurring in a row. Alkannin gave a very definite reaction. In twigs a few millimetres in diameter the development of secondary glands was evident.

E. Bridgesiana Baker. "Woollybutt" or "Butt Butt."

"Bark whitish-grey, wrinkled or tessellated, short and brittle in the grain, not fibrous, almost exactly identical with the Box, *E. hemiphloia,* when freshly cut giving out an aroma similar to the ordinary oil obtained from Eucalyptus leaves" (original description). An examination of the mature bark sections shows glands measuring up to 0.18 mm., elliptical in cross-section, with the longer axis directed tangentially. Section near the cambium showed no trace of glands. Small twigs also showed marked development near the outer portion. The glands were large, measuring up to .23 mm. in diameter. There is less development of the regular fibre zones, these being replaced by more or less isolated pitted stone-cells.

E. cinerea F.v.M. "Argyle Apple."

Possesses a thick fibrous stringybark, reddish-brown on trunk and longer limbs almost to the branchlets. This tree was, by later botanists, confused with *E. pulverulenta* Sims. The inner portion of the bark contains numerous oil-glands, the contents being yellow in colour and almost soluble in 100% alcohol. Average size 0.12 mm. x 0.075 mm. In some cases the glands were not circular or elliptical in section but rather triangular, rhomboidal or pentagonal, up to 0.20 mm. in diameter. In small twigs oil-glands were also prominent in the secondary bast.

E. elaeophora F.v.M. "Bundy or Half Box."

Has a fibrous bark similar to that of the "Boxes," more furrowed in old trees. Oil-glands numerous, small, up to 0.18 mm., averaging about 0.12 mm. Contents bright yellow, soluble slowly in 100% alcohol. The fibre zones are arranged irregularly and are somewhat elliptical in cross-section, thus giving rise to the fibrous character towards the outside.

E. Gullicki Baker & Smith. "Blue Mountain Gum."

Bark usually smooth, mottled grey, resembling *E. haemastoma* var. *micrantha,* but sometimes rough on the lower portion of the trunk. On cutting the bark the odour of the essential oil is very noticeable, and provides an easy method in the field of distinguishing this species from the "Scribbly Gum" (*E. haemastoma* var. *micrantha*), the two species often growing together. In section, oil-glands are very numerous, the contents being light yellow in colour, usually darker towards the outside, and are soluble in 90 to 95% alcohol, leaving a small residue. The fibre groups are not regularly arranged but, nevertheless, are more concentrated into concentric bands (visible macroscopically) from 2—3 mm. apart. The glands, though numerous, are rather small, measuring up to 0.12 mm. in diameter.

E. maculosa Baker. "Spotted Gum" or "Brittle Gum."

A tree with a smooth bark, sometimes rough at the base. Oil-glands distributed in outer portion of the bark, fibre zones in distinct concentric rings which are separated by broad zones of thin-walled tissue in which irregular stone-cells occur. The glands are not particularly numerous, and are small, averaging about 0.10 mm. in diameter. Contents soluble in 100% alcohol, except those darker in colour towards the outside.

E. Smithii Baker. "White Top" or "Gully Ash."

Bark on young trees smooth, but later becoming deeply furrowed as in *E. Sieberiana,* and resembling in appearance that of an Ironbark. Oil-glands are particularly numerous and large in this species and are as a rule grouped in large areas of thin-walled parenchymatous tissue, more or less spindle-shaped in radial section and each area separated from the others by large groups of bast-fibres. The glands are quite visible with the naked eye and measure up to 0.3 mm. in diameter. The distribution in this species is rather exceptional as the outer bark is divided into two distinct interlacing tissue zones, with and without glands. In a portion of the bark of *E. Smithii* 3 inches (75 mm.) in thickness, glands were scarcely evident within a distance of 8 mm. from the cambium. Towards the outside the loose thin-walled areas become disintegrated, leaving the more persistent fibre zones and hence producing the decided bark corrugations. Plate xlix., fig. 11 shows a transverse section of the mature bark of *E. Smithii*, about 15 mm. from the cambium. The oil-glands are characteristically prominent. Crossing the field obliquely are seen numerous narrow medullary rays and usually at right angles to these are the bands of thin-walled, loosely-arranged parenchymatous tissue in which the oil-glands occur. The fibre groups are irregularly arranged and, although to some extent intermingled with the gland-bearing tissue, the great majority form distinct areas, readily visible with the naked eye, in which glands do not occur. Tangentially it is possible to obtain large sections in which there is no trace of the usual elements of the phloem, the entire field being composed of the loose parenchyma and numerous oil-glands. In radial section (Pl. xlix., fig. 12) two narrow fibre zones have been cut, between which is a broad gland-bearing area typical of the species. The contents of the oil-glands in the outer portion are dark in colour and practically insoluble, whereas towards the cambium the contents are light yellow and soluble in 90—95% alcohol.

E. nova-anglica Deane & Maiden. "Black Peppermint."

Bark straight, semi-persistent on the trunk, ribbony on the branches. Oil-glands were not numerous in the material examined, e.g., in one area of 32 sq. mm. only one oil-gland was found. The contents were bright yellow and as a rule slowly soluble in 100% alcohol. Distinct secondary glands were found in a twig of herbarium material.

E. pulverulenta Sims.

A shrub with thin weak stems, possessing a smooth bark, tending to flake off. In section the arrangement of the fibres is very regular. Oil-glands of a secondary nature were found in stems 7 mm. in diameter, but are not numerous in this species; sections often failed to show very definite evidence of their presence.

E. rubida Deane & Maiden. "Candle Bark."

A tree with a smooth white bark, falling off in ribbons. Oil-glands very few in the material examined and small (averaging about 0.06 mm. in diameter). Contents ranging from bright yellow and pale lemon-yellow in colour, almost soluble in 100% alcohol. The bast fibre zones are very regularly arranged in rows parallel to the cambium, evidently accounting for the regular clean stripping of the shed bark and the smoothness of that left behind.

E. Stuartiana F.v.M. "Apple of Victoria."

Possesses a fibrous bark, which "would allow this species to pass almost as a Stringybark" (Mueller, 1879-84). Oil-glands are comparatively few in number, measuring up to 0.15 mm. x 0.10 mm. The bark was not fresh and the contents of the inner glands were represented by a dark cellular fringe. This became lighter in colour and went into solution readily in 100% alcohol, leaving only a small insoluble residue. Small twigs of herbarium material showed undoubted secondary glands, contents partially filling the cavity. Fresh material also showed glands with light-coloured contents. There is a tendency to form stone-cells, irregular in outline.

E. viminalis Labill. "Manna" or "White Gum."

Possesses a bark which is typically smooth, decorticating in long strips and therefore known sometimes as "Ribbony Gum." At other times it is rough and persistent on the lower portion of the tree. The oil-glands are, in the older bark, comparatively small, about 0.11 mm. x 0.09 mm. The bark was not fresh and the contents had become dark and granular. In 100% alcohol, however, they went into solution with the exception of a small dark cellular mass.

Alkannin showed numerous small oil droplets but the larger ones were too dark in colour to stain definitely. In smaller twigs the glands were not numerous in some of the sections examined. The glands were typically compressed radially and approach the cambium more closely in the broader medullary rays. The phellogen evidently develops at a considerable distance below the epidermis, and subsequently develops at some distance below the abscission layers, thus giving rise to the process of decortication. The bark thus removed is more or less persistent on the trunk. Fibre zones are arranged comparatively regularly throughout the secondary bast.

A seedling of *E. Macarthuri*, 2 feet 6 inches in height, was examined and oil-glands were found in the outer portion of the stem nodule which was about 1 inch in diameter. The glands were small, and not numerous, averaging 0.07 mm. in diameter, with pale yellow contents. Definite oil-glands were also found in the phloem of roots 4 mm. in diameter. They were usually small, but measured up to 0.12 mm. in diameter, and were evidently of a secondary character, as they were quite numerous and were distributed from the outer limits of the phloem to the periderm. In roots of only 1 mm. diameter, oil-glands were also prominent but were not found in roots smaller than this. The odour of geranyl-acetate was very pronounced when the roots were cut.

A seedling of *E. globulus*, a species in which oil-glands do not occur in the bark, was also examined. Small oil-glands were found in the cortical tissue of young stems and several, measuring up to 0.15 mm., occurred in the stem nodule. No glands were found in the roots.

A seedling of *E. piperita* showed the usual cortical oil-glands in the stem but none were found in the swollen stem base, though they probably occur there, or in the roots.

The occurrence of oil-glands in the bark, roots, leaves, etc., seems to indicate that the function is one of protection against insect or fungus attack rather than as food storage organs or for the reduction of transpiration, as suggested by Tyndall. Although Eucalypts are by no means immune from insect attack, particularly the leaves in some species, yet this does not rule out the protective nature of the oil, the bactericidal value of which is well known. If the glands were used as a storage tissue, then it is evident that by the shedding of the bark and leaves the plant would lose a considerable amount of valuable reserve material. In the majority of Eucalypts there is an entire absence of what might be termed a discharge mechanism in connection with the leaf oil-glands and it is obvious that there can be nothing of this nature in the deep-seated oil-glands of the secondary phloem of stem and root. For this reason it does not seem possible that Tyndall's reduction of transpiration theory can apply in this case, though he has shown that a medium of an essential oil does absorb radiant heat.

Oil-glands occur in the great majority of species of *Eucalyptus* in the cortical tissues of the very young stems before the development of the periderm, and well developed oil-glands are also found in leaves while less than 1 mm. in diameter and still in bud. These facts seem to indicate that the presence of the essential oil is primarily for protective reasons.

Although affinities do exist between certain species of *Eucalyptus* in which bark oil-glands occur, there is no general feature which is common to all. There is a considerable variation in bark, timber, fruits, leaf-venation and constituents of the essential oil from the leaves, throughout the series.

They cannot be regarded as primitive types and none of them fall into the Corymbosae group.

Summary.

Oil-glands are typical of the cortical tissues in the young stems of the majority of species of *Eucalyptus,* but usually there is no subsequent development and they soon cease to function.

Oil-glands, however, of a secondary nature are developed to a greater or less extent in the secondary phloem of stems and roots of certain species of *Eucalyptus*, reaching an enormous development in the barks in some types.

The glands are distributed almost uniformly throughout the outer portion of the secondary phloem in some species; in others they are confined to definite zones separated by broad bands of phloem elements.

They are never developed in close proximity to the cambium, and in the bark of mature trees seldom approach within 10 mm. of this inner meristem; thus, in stripping bark for oil distillation, it would be unnecessary to remove the innermost layers.

Their development is evidently schizo-lysigenous and the glands are always found surrounded by loose thin-walled parenchymatous tissue, either in a broad zone or formed by the spreading out of the medullary ray at that point.

The contents of the glands in twigs and those furthest from the outside in mature bark are readily soluble in alcohol; towards the outside, however, the contents become darker in colour and apparently resinous, but are not wholly soluble in any of the ordinary solvents.

The barks of the various species dealt with show a great variation, from the smooth-barked "Gums," through the loose, short-fibred "Peppermints" and "Boxes," the long-fibred "Stringybarks," to the rough, deeply-furrowed types approaching the "Ironbarks."

The occurrence of oil-glands in the roots and bark seems to indicate that they are of a protective nature in the Eucalypts rather than a means of reducing transpiration or as food-storage organs.

In conclusion I should like to express my indebtedness to Mr. J. H. Maiden, I.S.O., F.R.S., for his courtesy in allowing me to obtain material of many of the Eucalypts from the Botanic Gardens. I am also indebted to Mr. R. T. Baker, Professor Lawson and Dr. McLuckie for kindly advice and criticism throughout the work.

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EXPLANATION OF PLATES XLVIII.—XLIX.

Plate xlviii.

Eucalyptus Macarthuri.

Fig. 1. Transverse section of 1 mm. stem showing two primary oil-glands in the uppermost cortical region. The epidermis has not yet been removed.

Fig. 2. Transverse section of 6 mm. stem showing the phloem and cortex above and portion of the xylem below. Two oil-glands are seen at the top, right and left hand corners, also corresponding in position and size with the primary oil-glands common in the majority of young Eucalyptus stems. Although there is a marked increase in the thickness of the secondary phloem, oil-glands are not yet prominent. The epidermis has been replaced by a narrow periderm layer.

Fig. 3. Transverse section of the phloem and cortical tissues of a 10 mm. stem, showing an increase in the number of secondary oil-glands. These are scattered throughout the phloem, but occur always in conjunction with the medullary rays.

Fig. 4. Transverse section of the outer portion of a 16 mm. stem. The great increase in number and size of the secondary oil-glands is prominent, particularly towards the outer limit of the phloem fibres. Towards the cambium, smaller glands are seen in course of development and the widening of the medullary ray where the gland is incorporated is evident.

Fig. 5. Transverse section of the outer portion of a 45 mm. stem. The maximum development in size is evidently at some distance below the periderm, which shows practically no increase in thickness. Towards the cambium, numerous small glands are seen in stages of development.

Fig. 6. Radial longitudinal section of the outer portion of a 45 mm. stem. The distribution of the glands in relation to the bast fibres is shown. It is evident that the glands are not elongated but are circular or elliptical in cross section.

Plate xlix.

Figs. 7-10. *Eucalyptus Macarthuri.*

Fig. 7. Transverse section of bark or secondary phloem of a mature tree near the exterior. The oil-glands measuring up to 0.15 mm. in diameter are found in the loose thin-walled parenchymatous tissue. Parallel to the numerous medullary rays crossing the field from left to right are bast fibre zones. Stone cells are rare in this species.

Fig. 8. Transverse section of the bark of a mature tree within 10 mm. of the cambium. There are no oil-glands in this region, the larger cells in section being the sieve-tubes.

Fig. 9. Longitudinal tangential section of the bark of a mature tree within 10 mm. of the exterior. Two oil-gland zones are seen, crossed by interlacing bands of one or more bast fibres.

Fig. 10. Radial longitudinal section of the mature bark within 10 mm. of the exterior. Crossing the field from left to right are the numerous thin-walled medullary ray cells, the oil-glands showing a comparatively even distribution in this section.

Figs. 11-12. *Eucalyptus Smithii.*

Fig. 11. Transverse section of the mature bark passing through an oil-gland zone. The zones in this species have the broader axis at right angles to the medullary rays. The glands are especially numerous and large, measuring up to 0.3 mm. in diameter.

Fig. 12. Radial longitudinal section of the mature bark. This shows a large gland-bearing zone with two smaller bast-fibre zones, giving the appearance of a typical tangential section. The disintegration of the large area of thin-walled parenchyma in which the glands occur, helps to give rise to the extremely rough outer bark found in the species.

SOME AUSTRALIAN MOTHS FROM LORD HOWE ISLAND.

By A. Jefferis Turner, M.D., F.E.S.

[Read 25th October, 1922.]

I have received from the Australian Museum a small parcel of moths taken by Mr. A. Musgrave on Lord Howe Island in December, 1921. They are:—

Arctiadae.

1. *Utetheisa pulchella* Lin. One ♀. This cannot be distinguished from *pulchelloides* Hmps., which differs only in secondary sexual characters of the ♂.

Noctuidae.

2. *Plusia chalcytes* Esp. ♀.
3. *Sericea spectans* Gn.
4. *Eumenas salaminia* Cram.
5. *Dichromia quinqualis* Wlk. ♀.
6. *Hypena masurialis* Gn.
7. *Hypena* sp. unidentified, near *subvittalis* Wlk. One unset example.

Hypsidae.

8. *Nyctemera amica* Wlk. 2 ♂ examples.

Geometridae.

9. *Xanthorhoe subidaria* Gn. ♂.
10. *Scardamia chrysolina* Meyr.

Pyralidae.

11. *Macalla concisella* Wlk. (*phoenopasta* Turn.) 6 ♂. 2 ♀.
12. *Hymenia fascialis* Cram.
13. *Nansinoe pueritia* Cram.

Psychidae.

14. *Oeceticus elongatus* Lewin.

As I have demonstrated (Trans. Roy. Soc. S.A., 1917, p. 53, and 1918, p. 276) Lord Howe Island possesses a truly endemic lepidopterous fauna, but the endemic species are mostly small and inconspicuous, and probably do not occur abundantly in the immediate neighbourhood of the settlement. The present instalment consists exclusively of Australian species. Numbers 1, 3, 4, 5, and 6 have been previously recorded from the island. The series of *Macalla concisella* shows considerable variability and approaches so closely to Australian examples, which are also variable, that I can no longer regard it as a distinct species. *M. phoenopasta* Turn. is only a local race of *concisella*, distinguished in the ♂ sex by a greater development of coloured scales in the forewing. As a local race it is truly endemic. The example of *Dichromia quinqualis* differs from my examples in the dark colour of the large triangular mark on the forewings being developed only at its apex. This may be only an individual aberration, but it may point to the existence of an endemic race. In the two examples previously seen I made no note on this point, but they may have been in poor condition.

Omitting No. 7, there remain eleven species exactly similar to examples from the Australian mainland, and the question that interests us is how they got to the island. Nos. 1, 2, 4, 6, 12, and 13 are very widely distributed and appear to be well able to cross the seas. Of them *Hymenia fascialis* is common in gardens on cucurbitaceous plants, and may have been introduced. Nos. 3, 8, 9, 10, and 14 are purely Australian. One of them, *Scardamia chrysolina*, is uncommon, recorded only from Brisbane and Newcastle. The others are abundant. *Sericea spectans* takes shelter, sometimes in large numbers, in caves, hollow trees, and houses. It may well have travelled in the hold or cabins of a ship. *Oeceticus elongatus* is a most unexpected find on an oceanic island. Like all Psychidae, the ♀ is a wingless grub, which never leaves its case. It is conceivable that a ♂ might be blown overseas, but most unlikely, for it is short-lived, and uses its powers of flight only for mating. This species must have been artificially introduced in the larval or pupal stage. Their cases are often seen in gardens, and the transportation of a few young fruit-trees might easily have conveyed them.

I have a strong suspicion that steamer and ship traffic plays an important part in the introduction of Australian species of lepidoptera into Lord Howe I., Norfolk I., and New Zealand.

CHEMICAL NOTES.—GENERAL.

By Thos. Steel.

(Plate l.)

[Read 27th September, 1922.]

1. Some Ferruginous Concretions.

Concretionary accumulations, siliceous and calcareous, are of common occurrence and have been frequently described, but similar deposits of a ferruginous nature are not so frequently met with and I do not recall having noticed any references to the chemical examination of such. Two somewhat interesting examples of this class of concretion have come under my notice.

Ferruginous stalagmites.—In a small grotto at Wentworth Falls, N.S. Wales, near the railway station, known as Fairy Dell, water impregnated with ferrous carbonate exudes from the sandstone roof and, meeting with atmospheric oxygen, the ferrous salt is oxidised with liberation of carbon dioxide and deposition of hydrated ferric oxide. The deposited oxide, together with silica and a little lime and magnesia as silicates, takes the form of stalactites and stalagmitic masses. The analysis below gives the composition of the latter. Plate l., fig. 1, represents a piece of stalagmite with its smooth outer surface, and fig. 2 the fractured end exposing the numerous thin layers of which the mass is built up.

Ferruginous Concretions.—At the foot of Cranky's Creek Falls, a small waterfall near Fitzroy Falls, N.S. Wales, at a spot where a fairly liberal outflow of similar chalybite water occurs, the water forms a shallow pool in which twigs and other objects, kept in motion by the running water, have become evenly coated with ferric oxide. Some of the twigs (Pl. l., fig. 3) look like pieces of surgical bougies, being smooth and rounded at the ends, while others have irregular outlines due to the shape of the twigs. Fig. 4 represents a twig with a very uniform thick coating. Outwardly it bears a striking resemblance to a piece of stick liquorice. The wooden core is hard and stained deep brown and looks just like a piece of wire. The pieces in fig. 5 are of a similar character to the last. Fig. 6 is a fruit of *Hakea dactyloides.* There is also (fig. 7) a piece of deposit showing a well preserved leaf of another species of *Hakea* which Mr. H. Deane considers may be *H. saligna.* I have to thank Mr. Deane for his kindness in going to a good deal of trouble to identify these specimens for me. Owing to the thickness of the deposit on the fruit as figured it was quite impossible to state its identity. It was only when Mr. Deane removed the coating that he was able to make out its true nature. These Cranky's Creek specimens were collected and given to me by Mr. J. Turnbull, formerly of Avoca, near the falls.

Epsomite.—A small cave near the foot of the falls has its floor coated with a beautiful velvet-like deposit of epsomite ($MgSO_4 + 7H_2O$).

"Devil's Dice."—From my brother, Mr. F. W. Steel, I have received some interesting pseudomorphs of iron pyrites. These come from the Talga River, W. Australia, where they are locally known as "Devil's Dice." I have no information regarding their origin or mode of occurrence other than that they are found loose amongst gravel in the bed of the stream. In size they vary from 2 to 8 mm. faces. Analysis is given below. I have deposited all the above described specimens in the Australian Museum, Sydney.

Siderite.—Point Danger, where the dividing line between Queensland and New South Wales strikes the coast, consists of a bold mass of porphyritic dolerite capped by a bed of volcanic ash and resting on the upturned edges of (?) Ordovician schist which lies at a high angle, being almost on edge, dipping to the west and striking almost north and south. The schist is burnt and altered by contact with the dolerite. Scattered through the dolerite are numerous masses of a spathic mineral which externally bear a strong resemblance to kidney iron ore and which on analysis proved to be siderite.

The analyses of the specimens described above are as under.

	Stalagmite, Fairy Dell.	Incrustation, Cranky's Creek Falls.	"Devil's Dice," W. Australia.
Ferric oxide (Fe_2O_3)	75.45	78.10	81.60
Lime (CaO)	0.15	—	—
Magnesia (MgO)	0.37	—	—
Silica (SiO_2)	8.51	4.25	8.00
Water at 150°C.	7.30	9.75	1.07
Water +	8.15	7.25	9.24
	99.93	99.35	99.91

	Siderite, Point Danger.
Ferrous carbonate ($FeCO_3$)	88.22
Ferric oxide (Fe_2O_3)	6.53
Calcic carbonate ($CaCO_3$)	2.40
Magnesia carbonate ($MgCO_3$)	2.50
Silica (SiO_2)	0.40
	100.05

II. Coral lime, Fiji.

The natives of Fiji make use of a paste of coral lime and water which they smear through their hair for the purpose of cleansing and bleaching it. The paste is rubbed well into the hair which is then plastered onto the top of the head, the native going about for a day or so and then washing the lime out, the hair being then plentifully anointed with coco-nut oil. The hair which is naturally dark in colour becomes by this treatment of a tawny-brown tint.

The lime is prepared by burning coral in wood fires.

The analysis shows decarbonation to have been very imperfect, but if the burning were more perfect the product would have a destructive effect on the hair and skin.

Lime (CaO)	12.07
Carbonate of lime ($CaCO_3$)	71.08
Sulphate of lime ($CaSO_4$)	1.05
Carbonate of magnesia ($MgCO_3$)	Trace
Alumina and iron oxide (Al_2O_3 and Fe_2O_3)	0.80
Sodium chloride (NaCl)	2.06
Phosphoric oxide (P_2O_5)	Trace
Silica (SiO_2)	0.35
Sand	0.24
Water	12.35
	100.00

III. Shell of Helix aspera.

In Australia the shells of this common introduced European garden snail are notably smaller and thinner than is the case under the more rigorous conditions of their native habitat. So far as I have observed in various parts of Australia and about Auckland, New Zealand, the prevailing type of shell agrees precisely with the form described as *H. aspera* var. *tenuior* Shuttl. (J. W. Taylor, Monog. Land and Fresh Water Mollusca of British Isles. Part xxiii., Helicidae).

Not having seen any account of the composition of the shell, I made an examination of examples collected near Sydney. Incidentally it was noticed that when pulverised in the mortar the shells were exceedingly hard and tough and difficult to reduce to a fine powder. Incineration in the course of the analysis had to be conducted very slowly and cautiously owing to the persistent decrepitation, even when finely powdered. Before grinding, the shells were well washed and thoroughly air-dried.

The figures obtained by analysis were:—

Lime (CaO)	54.00	Calcic carbonate ($CaCO_3$)	91.45
Phosphoric oxide (P_2O_5)	0.04	Calcic phosphate ($Ca_3P_2O_8$)	0.09
Carbon dioxide (CO_2)	40.24	Lime in organic combination	2.74
Silica (SiO_2)	0.10	Silica	0.10
Conchiolin *	5.00	Conchiolin	5.00
Water	0.62	Water	0.62
	100.00		100.00

*Containing nitrogen .. 0.45

The organic constituent consists of conchiolin, a substance allied to chitin (Watts' Dict. Chem., i., 1879, p. 1107; also J. A. Thomson. Outlines of Zoology, 1892, p. 301).

Examination of the results in the first column shows that part of the lime is in organic combination, the calculated figures being given in the second column.

It was a matter of surprise to me to find that the shell contained so small a proportion of the organic constituent.

Analyses of the shells of some marine mollusca, *Crania, Terebratulina* and *Waldheimia* by F. Kunckell (Jour. Chem. Soc. Abs., ii., 1899, p. 313) show results of a similar general character as regards calcic carbonate and organic matter, but differing in the presence of magnesia and calcic sulphate which were absent from the shells of *H. aspera.*

IV. Urinary Secretion of Birds and Reptiles.

Most people have noticed the white calcareous-looking deposit on the excreta of fowls. Popularly this is commonly supposed to consist of excess lime not required for shell-making purposes. As a matter of fact it contains no lime, but consists almost entirely of minute crystalline spheroids of a mixture of ammonium urate and uric acid, constituting the urinary secretion of the fowl. The same applies to the similar secretion of other birds and is particularly noticeable in predatory species, such as hawks and eagles, and in marine birds. The white splashes dropped by birds and commonly seen on the ground, on fences, leaves, etc., are the same. In many birds and most reptiles the undigested residues of the food are regurgitated, the excrement consisting of white urinary secretion mixed with small amounts of other substances. This is particularly noticeable in the excreta of snakes, which have for many years been recognised as consisting practically entirely of uric acid or ammonium urate. The pellets of fur, bones and debris of insects so frequently noticed on stumps, fences, etc., in the country, are ejected by birds of different sorts, notably the "laughing jackass," while the similar ejectamenta of frogs and lizards are common in the haunts of these animals.

The kidneys of birds and reptiles consist of dark brown irregular lobulated structures closely pressed into the space on either side of the vertebral column at the rump. They can be easily examined in the common fowl. The ureters enter the cloaca near the vent, the urinary secretion being a white pasty or semi-liquid mass. As the secretion from the kidneys is continuous, the deposit accumulates in the cloaca until pushed out in front of the mass of ordinary excrement in the case of the fowl, and forms the white cap so prominent on the excreta of brooding fowls which only make occasional evacuations.

The analysis of the urinary secretion of the fowl, below, was made on carefully selected material pure white in colour.

Through the courtesy of Mr. A. S. le Souef, I was enabled to examine the excreta of the ostrich and a number of reptiles living in the Zoological Gardens, Sydney. In all cases the sand is an accidental admixture derived from that passing through the digestive tract.

Urinary Secretions. (Calculated to dryness.)

	Common Fowl. 1	Common Fowl. 2	Ostrich.	*Python variegata.*	*Moloch horridus.*	*Varanus varius.*
Ammonium urate * ..	36.1	38.1	—	15.2	—	—
Uric acid	51.1	51.3	46.8	77.0	96.5	18.4
Other organic matter	2.5	1.1	9.4	1.7	—	9.7
Ash	10.0	9.1	2.4	5.5	—	19.0
Sand	0.3	0.4	41.4	0.6	—	52.9
	100.0	100.0	100.0	100.0	—	100.0
Water in air dried material	7.8	8.0	6.8	9.0	—	9.2
*Containing Ammonia	3.32	3.50	—	1.40	—	—
Total Uric acid . ..	83.9	85.9	46.8	90.8	96.5	18.4

The secretion from *Moloch horridus* was in the form of beautiful glistening white crystals; only a very small sample was available. In three of the samples the quantity available was insufficient for determination of ammonia.

I am indebted to Mr. W. M. Doherty for kindly confirming the ammonia determinations for me.

V. Fruit of Banana.

I am only aware of two published analyses of the fruit of the banana or plantain. In Fiji, November, 1885, I examined the husked ripe fruit, ripened on the tree.

H. Prinsen-Geerligs (Jour. Soc. Chem. Ind., 16, 1897, p. 939) gives an analysis made in Java of a plantain. E. Leuscher (Jour. Chem. Soc., 1902, Abs. ii., p. 421) that of a ripe banana, husks removed. The abstract does not give locality. The results are as under:—

	T. Steel. Fiji.	Prinsen-Geerligs. Java.	Leuscher. —
Cane Sugar	5.65	13.68	15.83
Dextrose	18.64	4.72	9.70
Levulose		3.61	
Total Sugar	24.29	22.01	25.53
Water	71.64	—	67.10

I found considerably more fruit sugar and less cane sugar than is reported in the other analyses, so that evidently this fruit varies considerably in composition; the degree of ripeness may have to do with this. In addition to the other sugars, Leuscher records the presence of 0.95% dextrin; I did not find any of this substance present in my sample.

VI. "Milk" of Unripe Cocoa-nuts.

In December, 1885, when resident in Fiji, I made a chemical examination of several samples of the "milk" of green cocoa-nuts at the stage when used for drinking. The native name of this stage is "bu" (pronounced "mbu") though they are commonly referred to as "niu" which is really the name of the tree. The Fijians recognise by different names eight stages in ripeness of the nuts.

Van Slyde (Amer. Chem. Journ., 13, 1891, p. 130) gives analyses of six unripe samples, the average of which is stated below along with my Fiji analyses.

	Van Slyde.	T. Steel.		
	Average.	1.	2.	3.
Cane sugar	Trace		0.61	0.53
Fruit sugar	3.97	3.47	4.82	4.58
Protein and fat	0.25		0.32	0.86
Ash	0.62		0.59	0.48
Water	95.01		93.66	93.55
	99.85		100.00	100.00
Sp. Gr.	1.0227	1.0249	1.0250	1.0255

It will be noticed that Van Slyde only records traces of cane sugar as being present. In an analysis of "milk" of a ripe cocoa-nut in the same paper, he shows traces only of fruit sugar and 4.42 of cane sugar. In my analysis the cane sugar was determined by Clerget double reading on the saccharometer and checked by copper titre after inversion. The water in my samples was ascertained by drying by the paper roll method and is in extremely close agreement with that corresponding to the Sp. Gr. for solutions of sugar. In Van Slyde's analyses the water is in each case too high for the Sp. Gr., by this standard, being 0.76 per cent. high on the average. This perhaps indicates that there may have been over-estimation of water and that about the same amount of cane sugar as I found may have been really present.

VII. Oxalic Acid in Plants.

Since the publication of my paper, "The Occurrence of Calcium oxalate in *Acacia Cambagei*" (Proc. Linn. Soc. N.S. Wales, xlvi., 1921, p. 256), I have noticed a very interesting early paper on the presence of this acid in a fungus. In 1804, Dr. Robert Scott of Dublin contributed (Trans. Linn. Soc. London, 1804, p. 262) a paper describing the crystallization of oxalic acid on the surface of a dried specimen of *Boletus sulphureus.* He describes the efflorescence as consisting of needle-like crystals of the free acid mixed with a small proportion combined with "vegetable fixed alkali." This would be potash.

EXPLANATION OF PLATE L.

Fig. 1. Stalagmitic ferruginous deposit. Fairy Dell.

Fig. 2. The same, end view.

Fig. 3. Twigs with ferruginous coating. Cranky's Creek Falls.

Fig. 4. Thickly coated twig, broken to show core and structure. Cranky's Creek Falls.

Fig. 5. Similarly coated twigs. Cranky's Creek Falls.

Fig. 6. Fruit of *Hakea dactyloides*, thickly coated. Partly stripped. Cranky's Creek Falls.

Fig. 7. Leaf, probably *H. saligna.* Cranky's Creek Falls.

(All figures x 4/5.)

MESOZOIC INSECTS OF QUEENSLAND.

No. 9. Orthoptera, and Additions to the Protorthoptera, Odonata, Hemiptera and Planipennia.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), C.M.Z.S., F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Plates li.-liii.; Text-figs. 72-89.)

[Read 25th October, 1922.]

The present paper completes the study of the Ipswich Upper Triassic fossils sent to me by Mr. B. Dunstan, Chief Government Geologist of Queensland, with the sole exception of the Coleoptera, which Mr. Dunstan himself is dealing with. In it no less than twenty species are dealt with, of which sixteen are described as new, while ten new genera are proposed for their reception. The species dealt with belong to the Orders Protorthoptera, Orthoptera, Odonata, Hemiptera (both Homoptera and Heteroptera) and Neuroptera Planipennia. A number of the fossils are shown enlarged on Plates li.-liii., which have been reproduced from photographs taken by Mr. W. C. Davies, Curator of the Cawthron Institute, to whom my best thanks are due. I also desire to thank Mr. F. Muir, the well known Homopterist of Honolulu, for valuable criticisms of my former publications on fossil Homoptera, as a result of which I have attempted some regrouping of the families represented in the Upper Trias.

Order **PROTORTHOPTERA.**

Family MESORTHOPTERIDAE.

Mesorthopteron locustoides, Tillyard, Mesozoic and Tertiary Insects of Queensland and N.S.W., Queensland Geol. Survey, Publ. No. 253, 1916, p. 14, Plate 2, figs. 3—6.

The types of this species are Specimens No. 5*a* and 5*b* in the Queensland Geol. Survey Collection at Brisbane. The fragment 5*c*, though originally figured (*l.c.,* Plate 1, fig. 4) as belonging to this species, can now be proved not to belong to it at all. The wing shown on Plate 1, fig. 5 of the same paper (Specimen No. 4), which was originally indicated as doubtfully belonging to this species, has now been shown, by further study and comparison with other fossils, to be the somewhat badly preserved tegmen of a Homopteron, *Mesocixiodes* ***brachyclada,*** n.sp., described in this paper.

Since the type was described, a number of fragments of this species have been discovered at Ipswich, together with one more complete specimen showing a large portion of the wing. Taken together, they enable us to complete the restoration of the wing, the only parts not found upon one or other of the fragments being a portion of the distal area below the apex, together with the apical border itself, part of the distal branching of the cubitus, and the actual outline of the anal border. A study of all the specimens discovered shows that the original interpretation of the venation given by me was incorrect. A new definition of the family and genus is here given:—

Family *Mesorthopteridae*: Large Protorthopterous insects having rather long wings, well rounded at the apex, and carrying numerous main veins separated everywhere by a complete archedictyon or original meshwork of irregular polygonal cellules, as shown in Plate li., fig. 26. Costal space with many oblique veinlets. Sc a strongly formed vein. R strongly formed, with the origin of Rs placed far from base. M a weak vein fused with R basally and diverging only slightly from it. Cu_1 a very strongly formed vein, giving off a series of numerous anterior branches. Anal area rather narrow.

Genus MESORTHOPTERON Till. (Plate li., fig. 26; Text-fig. 72.)

Large insects having the forewing somewhat longer and narrower than the hind. Sc long, reaching to about one-fifth from apex, and with the subcostal veinlets evenly spaced and mostly unbranched. R_1 branching apically so as to fill the space between end of Sc and apex of wing. Rs with few branches, all running to margin around apex. M_{1+2} with few branches, M_{3+4} a weak furrow vein without any branches at all. Main stem of Cu_1 giving off anteriorly a series of about six anterior branches, very regularly arranged, most of which fork dichotomically before reaching the margin; the branches of this vein supply a space reaching from just below the apex right round to half-way along the posterior margin. Cu_2 a weak, straight, furrow vein, ending up somewhat before half-way along the posterior margin. Apparently only two anal veins, the first running parallel to Cu_2 just below it, and probably branched distally, the second somewhat curved, with a number of descending branchlets. In the costal and anal areas the archedictyon is much denser than on the rest of the wing, being formed of a very large number of very irregular cellules; in the rest of the wing, it consists chiefly of two rows of polygonal cells lying between each consecutive pair of longitudinal veins.

Genotype, *Mesorthopteron locustoides* Till.

The genus remains monotypic, and can be recognised at once by the extraordinary manner of branching of Cu_1, which, as far as I know, is unique within the Class Insecta. Small fragments of the wings of this insect are frequently met with at Ipswich, and can always be recognised by the very characteristic archedictyon.

MESORTHOPTERON LOCUSTOIDES Till. (Plate li., fig. 26; Text-fig. 72.)

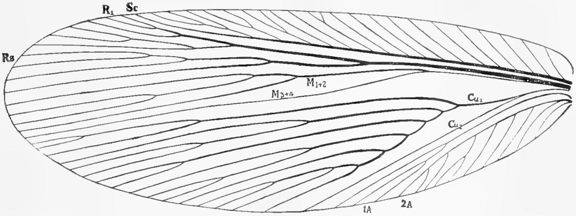
The restoration of this fine wing, given in Text-fig. 72, is based chiefly upon Specimen No. 258*b*, a large fragment of a forewing, showing almost the whole of the costal margin (except the apical and basal portions), and portions of all the veins down to within a short distance of the posterior margin; the latter, together with the anal area, is absent. *Total length* of fragment, 22.5 mm., from which the measurements of the complete forewing may be estimated to be about 35 mm. long by 15 mm. wide.

The other fragments studied in making the restoration were the following:—

Specimen No. 72 *a-b*: a small piece, showing portion of the anal veins and Cu_2.

Specimen No. 75: a fragment showing basal portions of Cu_1, Cu_2 and nearly all the anal veins.

Specimen No. 78*a-b*: portions of Cu_1 and Cu_2, showing branches of the former.



Text-fig. 72.—*Mesorthopteron locustoides* Till. Restoration of forewing, with archedictyon omitted (*see* Plate li., fig. 26.) (x 4).

Specimen No. 123: anal veins, basal part of Cu_2 and portion of branches of Cu_1.

Specimen No. 224: two fragments on one small piece of rock; one shows a piece of Sc with costal area, the other portions of the branches of Cu_1.

Specimen No. 234: ends of Sc and R, with branches around apex.

Specimen No. 241*b*: Sc and the costal area practically complete from base to near apex, also distal portion of R.

Type, Specimens No. 5*a*, 5*b*, in Coll. Queensland Geol. Survey, Brisbane. Heautotypes used in restoring the wing are the specimens mentioned above.

This insect is clearly an archaic type persisting from the Upper Carboniferous Protorthoptera, and appears to have its nearest relatives in the Prototettigidae of the Middle Upper Carboniferous of Saarbrücken.

Specimens No. 100 and 162*a* are fragments of Protorthopterous wings not belonging to the genus *Mesorthopteron*, and distinguished from it by the fainter and more regular archedictyon and the very strong veins. They probably belong to the genus *Notoblattites* Till., but there is not enough of the wing preserved to allow of a definite placing and naming of the specimens.

Order **ORTHOPTERA**.

Family TRIASSOMANTIDAE, n.fam.

Insects of rather small size, in which the forewing is of the general plan shown in recent Mantidae, but with the venation of a more archaic type. Sc short, ending up little beyond half-way along the costa, and thus leaving a long pterostigmatic area between itself and R_1. Rs arising nearer to base than in any known Mantoid types, and dividing dichotomically into two parallel branches. M a single vein to beyond middle of wing, dividing into two main branches beyond the level of the end of Sc. (Clavus and most of Cu missing).

This family appears to come fairly close to the Liassic Geinitziidae of Europe, but is more archaic in possessing a much longer Rs, which is dichotomically forked. The small bark-haunting Perlamantinae, well represented in Australia to-day, are perhaps the direct descendants of this family.

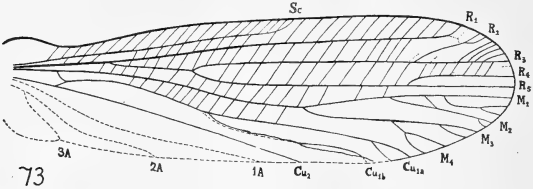
Genus TRIASSOMANTIS, n.g. (Plate li., fig. 27; Text-fig. 73.)

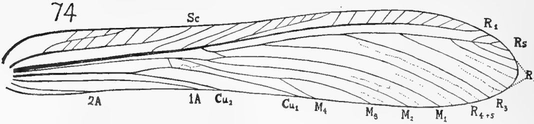
Characters as given for the family, with the following additions:—Costal and pterostigmatic veinlets, and all series of cross-veins, fairly abundant, oblique and parallel to one another. Sc and R_1 both turn fairly sharply upwards to end on the costal margin. R_{2+3} runs quite straight to a point a little above the apex, and gives off a strong anterior distal branch (R_2) below the end of R_1, together with a set of shorter distal branchlets anteriorly at the end of R_3. R_{4+5} also runs quite straight below and parallel to R_{2+3}, and gives off R_4 as a close parallel branch above R_5; the latter continues the line of R_{4+5} and ends up at the apex of the wing, which is well rounded. M slightly curved downwards near middle of wing; both its main branches give off somewhat irregular posterior branches with small terminal forks. Part of Cu_1 preserved distally as a straight vein having a small terminal fork.

Genotype, *Triassomantis pygmaeus*, n.sp. (Upper Triassic, Ipswich, Q.).

TRIASSOMANTIS PYGMAEUS, n.sp. (Plate li., fig. 27; Text-fig. 73.)

This species is represented by a rather faint impression of a left forewing, complete except for the loss of the clavus and most of the cubitus. *Total length,*





Text-fig. 73.—*Triassomantis pygmaeus*, n.g. et sp. Restoration of forewing with apex to right (*see* Plate li., fig. 27.) (x 11).

Text-fig. 74.—*Triassolocusta leptoptera*, n.g. et sp. Restoration of forewing (*see* Plate li., fig. 28.) (x 5.4).

10 mm. *Greatest breadth,* 2.8 mm. The costal veinlets are numerous and more closely spaced than the cross-veins in the rest of the wing. The elongated pterostigma carries eleven veinlets spaced about the same distance apart as the cross-

veins in the radial and median areas below them. The number and position of the terminal branches of Rs and M may also be considered as specific characters; R_3 has four closely placed anterior branchlets, while M_{1+2} and M_{3+4} both run straight to the wing margin, giving off only posterior branches as shown in Text-fig. 73. M_{1+2} converges towards R_5 from below.

T y p e, Specimen No. 86*a*, in Coll. Geol. Survey, Brisbane.

H o r i z o n, Upper Triassic, Ipswich, Q.

The size of this wing appears to indicate a small insect, not unlike the present day Perlamantinae, and possibly of somewhat similar habits. The restoration of the missing parts of the wing, in Text-fig. 73, is made on the supposition that the missing portion of the venation was on the Perlamantine plan.

Family LOCUSTOPSIDAE.

This family was formed by Handlirsch to include a number of Liassic and Upper Jurassic Locustoid insects allied to the Elcanidae, but differing from them in having M branched instead of simple, Sc much longer, and Cu not fused basally with M. The fossil from the Upper Trias of Ipswich, which I here place under this family, agrees with the Locustopsidae in all characters except only the short Sc, a character which I do not consider of sufficient importance to justify the making of a new family to contain it. The definition of the family Locustopsidae will therefore need emending as regards the length of Sc, which may be either short or long. These insects appear to have been slender, voiceless Locustoids, having very long and slender antennae, and with the long, slender hind-legs not armed with spines.

Genus T R I A S S O L O C U S T A, n.g. (Plate li., fig. 28; Text-fig. 74.)

Insects of moderate size, with forewing very long and narrow. Sc ending up before half-way along costal margin, and provided with a shorter anterior branch. Rs arising somewhat before half-way along the wing, with four distinct and well-spaced branches arranged in pectinate series. M branching into three near level of origin of Rs; the most posterior of these three branches, M_{3+4}, forks again distally. First fork of Cu placed well away from base, at about one-fourth of the wing-length. Cu_1 arching somewhat flatly upwards, connected with M above by an oblique vein (M_5), and forked distally. Cu_2 short, straight, ending up very close to Cu_{1b}. (Clavus missing).

G e n o t y p e, *Triassolocusta leptoptera*, n.sp. (Upper Triassic, Ipswich).

TRIASSOLOCUSTA LEPTOPTERA, n.sp. (Plate li., fig. 28; Text-fig. 74.)

Total length, 21 mm., *greatest breadth* (at about one-fifth from apex), 4 mm. The specimen is a very clear impression of a right forewing, complete except for the loss of the very narrow clavus and slight damage to the basal portion of the costal margin. Veinlets and cross-veins are only faintly preserved, and are mostly omitted from Text-fig. 74. Sc gives off an anterior branch Sc_1, quite close to the base; this branch has about four faint oblique cross-veins below it, and is separated from the end of the main stem of Sc by two oblique veinlets. From a little before the level of the end of Sc, R begins to give off anterior veinlets running very obliquely to the costal margin. There are three of these, the last being at the level of the origin of Rs. Next comes a fairly long anterior branch, running at a very slight angle to R_1 itself, and carrying on it four or five shorter anterior veinlets. Beyond this branch lies a series of pterostigmatic veinlets, eight in number, less obliquely placed. R_1 itself ends up not much before the apex of the wing. Rs has, besides the series of four pectinate branches already mentioned in the generic definition, a set of four terminal twigs arranged as shown in Text-fig. 74; the branch next below these ends exactly at the apex of the wing. The cross-venation in the spaces between the branches of Rs and M distally is a fine polygonal meshwork, two cells thick within each successive space, the borders of the cells making a slightly irregular line, dividing each space longitudinally about midway. Portions of these are indicated by dotted lines in Text-fig. 74.

Type, Specimen No. 99, in Coll. Queensland Geol. Survey.

Horizon, Upper Triassic, Ipswich, Q.

In Text-fig. 74, the clavus has been restored on the lines shown in the genus *Locustopsis* Handl., with only two anal veins.

Order **ODONATA**.

Suborder **Archizygoptera**.

Family MESOPHLEBIIDAE.

Further study of the genus *Mesophlebia* (Tillyard, 1916, p. 24) has convinced me that it does not belong to the Anisoptera, but to Handlirsch's Suborder Anisozygoptera, to which also most of the known Liassic Dragonflies belong. It seems best to treat it for the present as representative of a new family Mesophlebiidae, which shows some affinity with the Liassic Heterophlebiidae. The exact relationships of the new family cannot be accurately determined until the basal half of the wing is discovered.

MESOPHLEBIA ANTINODALIS Till. (Plate lii., fig. 30; Text-fig. 75.)

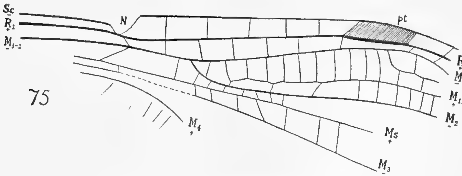
Tillyard, Mesozoic and Tertiary Insects of Queensland and New South Wales, Qld. Geol. Survey, Publ. No. 253, 1916, p. 24.

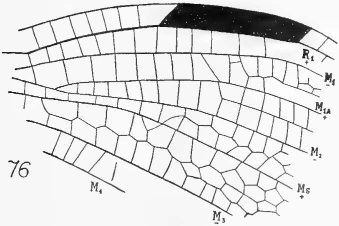
Specimen 127*a* represents a fairly well preserved portion of a right forewing of this species, comprising the whole of the costal margin from somewhat before the nodus to a little beyond the pterostigma, and including the subnodus and all branches of M except M_4, of which only a very small portion is preserved. The nodus is incomplete basally by the loss of the costal margin, though Sc is complete. The pterostigma is complete and remarkably well preserved.

Total length of fragment, 28 mm. *Distance from nodus to beginning of pterostigma,* 12 mm. *Length of pterostigma,* 3.6 mm. The approximate total length of the wing must have been about 40 mm. By comparison with the type specimen, the present wing is found to be somewhat narrower in comparison with its length, and may therefore be considered as a forewing, the type specimen representing a hindwing. The pterostigma, however, is longer than in the type (3.6 mm. as against 2.8 mm.) which is a somewhat anomalous condition. *Number of postnodals* five, as in type. *Pterostigma* slightly wider basally than distally, slightly shorter along costa than along R, and strongly thickened along R. No brace-vein below pterostigma. A strong, oblique subnodus between R and M_{1+2}, strutted below, between M_{1+2} and Ms, by a much longer oblique cross-vein running in the opposite direction, at right angles to subnodus. M_1 curving upwards so as to come to lie close under pterostigma, as in the type. Structure of M_{1A} and M_2 very closely similar to type, but the broadened space between M_1 and M_{1A} below distal half of pterostigma carried definitely two rows of cellules. A weak oblique vein indicated between M_2 and Ms, far from level of nodus, and a similar but longer oblique vein below it, between Ms and M_3.

Distad from level of nodus, M_4 arches rather sharply downwards away from M_3, as also in type.

The differences to be noted between the new specimen and the type consist in the presence of a definite subnodus normally placed, the absence of the weak pterostigmatic brace-vein shown in the type, the longer pterostigma, and the double row of cellules distally below the pterostigma. As the type was not very well preserved in places, it is possible that these differences may not really have been as great as they appear, e.g., the apparent brace-vein in the type may be only very slightly different from the normal cross-vein of the present specimen,





Text-fig. 75.—*Mesophlebia antinodalis* Till. Heautotype. (*see* Plate lii., fig. 30.) (x 3.5). Convex veins marked +, concave veins —.

Text-fig. 76.—*Triassophlebia stigmatica*, n.g. et sp. Fragment of wing. (x 5). Convex veins marked +, concave veins —.

while the subnodus may be present in the type, but indistinct, and the same may be true of the double row of cellules below the pterostigma. I have therefore decided not to give the new fossil a separate specific name, but to include it in the species *M. antinodalis* Till., allowing a certain amount of variability in the length of the pterostigma in this species, and in one or two other characters. It is a great pity that this second fossil shows practically the same portions of the wing preserved as in the type, while the important region of arculus and discoidal cell still remains undiscovered.

Type, Specimen No. 3*a*, and Type-Counterpart Spec. No. 3*b*. Heautotype, Specimen No. 127*a*. All in Coll. Queensland Geol. Survey, Brisbane.

Genus TRIASSOPHLEBIA, n.g. (Text-fig. 76.)

Pterostigma elongated, about twice as long as in *Mesophlebia*. *Postnodals* numerous and close together. M_1 only slightly converging towards R beneath distal end of pterostigma. M_{1A} and M_2 very much as in *Mesophlebia*, but M_{1A} definitely arising from M_2. Supplementary sectors present distally between M_1 and M_{1A}, also between M_{1A} and M_2. Ms running very close below M_2 at level of origin of M_{1A}, as in *Mesophlebia*, but no oblique vein visible between M_2 and Ms. Two rows of cellules present distally between M_2 and Ms. M_3 lies further away from Ms than in *Mesophlebia*, with two rows of cellules between them at the level of the origin of M_{1A}, increasing to three and then to four rows distally. M_4 not arching strongly downwards away from M_3. (Rest of wing not preserved).

Genotype, *Triassophlebia stigmatica*, n.sp. (Upper Triassic, Ipswich, Q.).

This new genus may be placed provisionally within the Mesophlebiidae, pending the discovery of more complete material.

TRIASSOPHLEBIA STIGMATICA, n.sp. (Text-fig. 76.)

Total length of fragment, about 14 mm., probably representing a total wing-length of at least 40 mm. *Number of postnodals* preserved or partially preserved, eight, indicating a total of about twelve. *Pterostigma* covering about nine or ten cellules. R somewhat thickened below pterostigma, but not so strongly as in *Mesophlebia antinodalis*. M_{1A} arises from M_2 as a well defined vein, strongly convex, well before the level of the pterostigma, and continues strongly to below the middle of the latter, when it becomes slightly kinked in one or two places, as shown in Text-fig. 76. Supplementary sector above M_{1A} preceded by three irregularly divided cellules; that below M_{1A} is a straight sector from its very beginning, preceded by a single row of cellules. M_2 arising from M as a strongly diverging vein which almost at once approaches Ms very closely, being separated from it only by a single row of very narrow cellules; further distad, below the level of the pterostigma, these two veins diverge somewhat, and are separated by two rows of cellules. The portion of M_3 preserved runs sub-parallel to Ms, and is separated from it mostly by two rows of cellules, increasing to three or four rows of smaller cellules distally. Only a small portion of M_4 is preserved, diverging slightly from M_3, and separated from it by a single row of cellules.

Type, Specimen No. 82*a* in Coll. Queensland Geological Survey, Brisbane.
Horizon, Upper Triassic, Ipswich, Q.

Suborder **Anisozygoptera.**

Family TRIASSAGRIONIDAE, n.fam.

Sc greatly shortened, ending up at less than one-fourth of the wing-length. Probably only two antenodals present. No definite nodus formed. Postnodals numerous. A true pterostigma present. Base of wing petiolate, very narrow. M fused with R basally, diverging very gently from it at the arculus, which is incomplete posteriorly. No true discoidal cell present. At the arculus M divides into M_{1-3} and M_4; the former is a strong concave vein, running below and sub-parallel to R_1, and giving off (*a*) the common stem of M_3 and Ms, and (*b*) at about twice as far from the arculus, the stem of M_2. M_2 arises from M_1 a little before half-way along the wing, arching strongly downwards, and soon dividing into two strong branches, which diverge at a sharp angle; the upper branch, M_{2a}, runs straight along the wing to end up just below the apex, close to M_{1A}, which is a long sector formed between M_1 and M_2; the lower branch, M_{2b}, runs obliquely just above Ms. The common stem of Ms and M_3 soon divides at a very acute angle into Ms, which runs straight on, obliquely across the wing, and M_3, which arches so as to end up about half-way along the posterior border, far from Ms, but very close to M_4. M_4 is a slightly arched, unbranched, convex vein, rather weakly formed distally. The cubitus is a simple, concave vein, corresponding with Cu_1 of recent Odonata, slightly curved below the arculus, and then running almost straight on to end up at about the middle of the posterior border, a little before M_4. Anal crossing present as a weak cubito-anal veinlet, situated at the end of the petiole, and marking the origin of 1A from Cu; 1A itself runs between Cu and the posterior border, and ends up not far from Cu. Both Cu and 1A become weak and somewhat zig-zagged distally.

Handlirsch formed the new Suborder Archizygoptera to include the single peculiar and highly problematical genus *Protomyrmeleon* Geinitz, represented by a single species, *P. brunonis* Geinitz, from the Upper Lias of Dobbertin in Mecklenburg. This fossil was placed by him in the family Protomyrmeleontidae, the only family of the Suborder. The present fossil agrees with *Protomyrmeleon* in the very striking characters of the shortened Sc, unformed nodus, peculiar development of M_{1A}, two-branched M_2 and simple cubitus, but appears to differ in the base not being petiolate, M arising separate from R, so that no arculus is formed, separation of the base of Ms from M_3, and entire absence of 1A. (It should be noted that Handlirsch's naming of all the veins after M_1 is incorrect, his M_2 being actually M_{1A}; his Rs, M_{2a}; his M_3, M_{2b}; his M_4, Ms; and his Cu_1, Cu_2 and 1A being M_3, M_4 and Cu respectively). It would appear highly probable that the true base of *Protomyrmeleon* has not been preserved, including the petiole (if present), the portion of M fused with R, and the true arculus. This misled Handlirsch in naming the veins. As drawn by him in Plate xlii., fig. 14 of his Atlas to "Die Fossilen Insekten," there is, in any case, no true 1A in this genus.

Genus Triassagrion, n.g. (Plate lii., fig. 31; Text-fig. 77.)

To the characters given for the family we may add the following for the genus:—*Postnodals* about twenty-four, the basal ones mostly continuous with the cross-veins below them, the distal ones not so. *Pterostigma* short, about twice as long as wide. R_1, M_1, M_{1A} and M_{2a} all ending up close together at or near apex of wing. M_{1A} arises as a weak zig-zag vein from near base of M_2, and runs very close above M_2 at first, but gradually diverges until, below the pterostigma, it runs as a straight vein about half-way between M_1 and M_{2a}. The wide triangular spaces between the two branches of M_2 and also between Ms and M_3 are filled with irregular cellules, without any supplements. Only one row of cellules between 1A and the posterior border of the wing.

Genotype, *Triassagrion australiense*, n.sp. (Upper Triassic, Ipswich, Q.).

It is useless to try to compare this genus closely with any existing Zygoptera, owing to the great difference in the structure of the arculus, the entire absence of the discoidal cell, the primitive condition of Cu and 1A, and the branched condition of M_2. I would, however, call attention to certain resemblances which it bears to the forewing of the genus *Chorismagrion* Morton. This latter genus, found in North Queensland at the present day, has the arculus open basally in the forewing; Sc is very short; M_{1-3} gives off the common stem of M_3 and Ms at the subnodus, and M_2 far beyond it, with M_{1A} forming a well developed vein between M_1 and M_2; Cu, except for current usage, might well be interpreted as a simple vein, 1A arising separately out of the posterior margin just beyond the end of the petiole, and connected with Cu above it by the anal crossing. Again, if we look at the genus *Hemiphlebia,* which also has the arculus incomplete basally in the forewing, we see that the same interpretation of Cu and 1A is the obvious one, and that 1A actually arises from the cubito-anal veinlet as it does in *Triassagrion,* with a small cross-vein connecting it with the end of the petiole as in that genus. This latter character, being unique in present-day Zygoptera, is a very significant one. I therefore suggest the *probability* of our modern Zygoptera having arisen from some such form as *Triassagrion* by the following changes:—

(1) Formation of a complete nodus by strengthening of the subnodal cross-veins between end of Sc and R, and between R and M_{1-3}.

(2) Formation of the strong distal side of the still open discoidal cell, by change of direction of the first cross-vein between M_4 and Cu.

(3) A further bending of Cu below arculus, correlated with (2).

(4) Cross-vein situated below distal angle of discoidal cell becomes strong and oblique, and, in the nymphal wing, carries a trachea which captures 1A and attaches it to Cu.

(5) Shortening and simplification of M_{1A}.

(6) Reduction of M_2 to a simple vein.

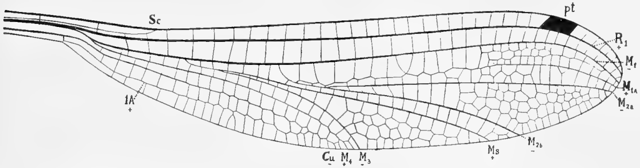
(7) Approximation of M_3 towards Ms.

Definite proof of the origin of modern Zygoptera from such a type as *Triassagrion* cannot be given with the present state of our knowledge. It is more probable that a considerable number of archaic types ancestral to various groups of the true Zygoptera were already in existence in the Upper Trias. One, indeed, we already know in the genus *Triassolestes,* related to *Epiophlebia.* We can only add that the recent studies of Professor C. H. Kennedy on the penes of Zygoptera strongly indicate the probability of forms such as *Hemiphlebia* and the Megapodagrionidae being the oldest existing Zygoptera, and that this result, startling as it appears to be, would be quite in harmony with the evidence of our Upper Triassic fossils.

TRIASSAGRION AUSTRALIENSE, n.sp. (Plate lii., fig. 31; Text-fig. 77.)

An almost complete wing, probably a forewing. *Total length,* 21 mm; *Greatest breadth,* 4.5 mm. The wing is the reverse of a left wing, as is shown by R_1 being concave and M_1 convex in the impression.

The wing is complete except for the following missing parts:—Portions of the costal area broken away (*a*) before the end of Sc, (*b*) in two places between Sc and pterostigma, the second of these being a deep triangular break reaching across R_1, as shown in Plate lii., fig. 31, and (*c*) from pterostigma to near apex; in this last case, the two posterior angles of the pterostigma are visible, and also the whole of the straight and slightly thickened base along R_1, so that the stigma itself can easily be restored in its entirety. The basal piece of Cu up to beginning of arculus is very faintly preserved, and has been restored backwards to base, in Text-fig. 77, along the line faintly indicated in the fossil. The posterior margin of the petiole is absent, but a clear indication of the cubito-anal crossing and the beginning of 1A below it can be seen; most of the course of 1A is very faint indeed. Between the origins of M_3 and M_2, the wing has become slightly buckled by lying above a hard, convex object, probably a fruit or cone of some plant, and this has also caused the transverse tear, which can be seen across veins M_4 and Cu_1 in Plate lii., fig. 31, somewhat anterior to this point, and is indicated by the dark shadow. The distal halves of M_4 and Cu_1 are thus shifted upwards out of their proper levels, and at the same time



Text-fig. 77.—*Triassagrion australiense*, n.g. et sp.. Restoration of wing. (*see* Plate lii., fig. 31.) (x 6.3). Convex veins marked +, concave veins —.

it is probable that, by slight longitudinal rucking, the veins M_3, Ms and M_2 have got pushed together more closely, near their origins, than would be the case if the wing were lying flat. The correct positions of these last three veins cannot be exactly restored; but, in the case of M_4 and Cu, the former being convex and the latter concave, it is easy to pick up their broken courses, and to restore them as in Text-fig. 77.

Plate lii., fig. 31 shows this fossil wing with the light so arranged that the main veins are well shown up; consequently, the cross-veins are not well shown, being mostly at right angles to the main veins. Under a moderate power, however, every single cross-vein of this wing can be seen, though they are all of very fine calibre. The only parts which cannot be restored with absolute certainty are those where there has been a break or rucking. In this connection, I desire to emphasize the following points:—

(1) In the restoration, the origins and basal portions of M_3, Ms and M_2 are probably crowded a little too closely together, owing to the rucking already mentioned.

(2) It is not absolutely certain that there are only two antenodals; there may be another one closer to the distal end of Sc.

(3) Cu, being a concave vein, is raised up in this reverse impression, and its basal piece, within the petiole, has the actual impression of the vein removed, as often along a ridge; its course, however, seems fairly well indicated, and it is restored in its normal position for Zygoptera.

(4) The posterior border of the petiole is also missing. But the anal crossing, Ac, can be seen, with faint indications of the origin of 1A below it. The restoration is given in the only possible way in which these remnants can be made to fit into the wing-scheme, but must not be taken as being absolutely accurate.

(5) The breaks along the costa have been filled in by completing the series of postnodals, and by continuing the oblique sides of the pterostigma upwards from the preserved posterior portion along R_1. As this vein can be seen to be strongly thickened below the pterostigma, the assumption that the latter was well chitinised is, I think, justified.

The importance of this wing in the study of Odonate phylogeny seems to me to be so great that it is essential that all doubtful points in the restoration of the wing should be fully emphasized.

Type, Specimen 290*a* (reverse), in Coll. Queensland Geol. Survey, Brisbane.

Horizon, Upper Triassic, Ipswich, Q.

Order **HEMIPTERA.**

Suborder **Homoptera.**

Since the publication of Nos. 7 and 8 of this series of papers, a considerable number of tegmina have been sent to me from the Ipswich fossil beds. It is now apparent that, next to the Coleoptera, the Homoptera were the dominant Order in the Upper Trias of Ipswich. We now know enough to attempt a review of the whole position of the Suborder at that period; the difficulty is not so much lack of knowledge of the Triassic forms, as the still fluctuating and uncertain schemes of classification of recent Auchenorrhyncha, particularly in the Superfamily Fulgoroidea. Mr. F. Muir, the well-known authority on these insects, has recently taken considerable interest in the fossil discoveries at Belmont and Ipswich; and he writes to me that, in his opinion, the Suborder Palaeohemiptera of Handlirsch does not exist, as the two genera still included in it (*Prosbole* Handl. and *Mitchelloneura* Till.) may reasonably be considered as archaic Fulgoroids of the family Tropiduchidae, the connection being furnished by the evidence of the venation of the South American genus *Alcestis.* Accepting this view, it becomes evident at once that the tegmina placed in this paper under the genus *Mesodiphthera* are even more typically Tropiduchid than those already mentioned. I therefore have no hesitation in removing them from the Scytinopteridae and placing them in the Tropiduchidae. Mr. Muir is also of opinion that the forms placed by me in the subfamily Mesocixiinae of the Scytinopteridae are true Cixiidae, a conclusion which seems reasonable when we consider that this family stands morphologically at the very root of the Fulgoroidea. I shall therefore remove the genera *Mesocixius* Till., *Triassocixius* Till. and *Mesocixiodes,* n.g. to the family Cixiidae. The Ipsviciidae may also be considered to be a specialised family of Fulgoroidea, and are almost the only Triassic forms in which the evolution of the anal Y-vein on the clavus can be seen to have begun.

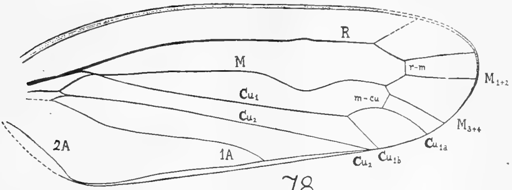
This leaves in the Scytinopteridae the Upper Triassic genera *Mesoscytina* Till., *Triassoscarta* Till. and *Chiliocycla* Till. To these will be here added the two new genera *Apheloscyta* and *Polycytella,* the former allied to *Scytinoptera* Handl. and the latter to *Chiliocycla.* It is possible that the two genera *Chiliocycla* and *Polycytella* may prove to be Membracids of a primitive type; but until we can discover the clavus of *Chiliocycla,* so as to determine the course of 1A, it will be best to leave them in the Scytinopteridae.

The other families of Auchenorrhyncha represented in the Upper Triassic of Ipswich are the Mesogereonidae, ancestral to the Cicadidae, and the Cicadellidae or Jassidae. No further examples of these are dealt with in this paper.

Family SCYTINOPTERIDAE.

Genus APHELOSCYTA, n.g. (Plate liii., fig. 33; Text-fig. 78.)

Allied to *Scytinoptera* Handl. from the Upper Permian of Russia, but differing from it in having Rs coming off from R quite close to the apex of the wing, whereas Rs arises about half-way along R in *Scytinoptera.* Vein M, which is quite straight in *Scytinoptera,* is bent sharply into a very noticeable bay or hollow, concave to the costal margin, a little beyond the middle of the wing, in the new genus. Terminal branchings of M and Cu_1 two each, connected by a single cross-vein much as in *Scytinoptera,* but M_{3+4} and Cu_{1a} lie closer together. Clavus (missing in *Scytinoptera*) of fairly typical Scytinopterid type, but 2A



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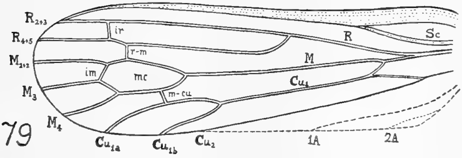

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Text-fig. 78.—*Apheloscyta mesocampta*, n.g. et sp. Tegmen. (*see* Plate liii., fig. 33.) (x 10.3).

Text-fig. 79.—*Chiliocycla scolopoides* Till. Restoration of tegmen from type and heautotype, with tuberculation omitted. (x 11.7). (*see* Plate liii., fig. 37.)

lies very close to the basal posterior margin, and appears also to run close alongside the distal posterior margin of the clavus, thus showing a very early stage in the evolution of the true claval Y-vein found in the Fulgoroidea. Shape of wing somewhat different from that of *Scytinoptera,* the costal area being about equally wide throughout, and the apex much less broadly rounded.

G e n o t y p e, *Apheloscyta mesocampta,* n.sp. (Upper Triassic, Ipswich).

APHELOSCYTA MESOCAMPTA, n.sp. (Plate liii., fig. 33; Text-fig. 78.)

Total length, 10 mm.; *greatest breadth,* 3.5 mm.

A complete tegmen, except for slight damage at the base of the clavus and also at end of R_1; of tough consistency, strongly granulated all over. All the main veins clearly marked, but the distal branchings somewhat fainter. The impression is that of a left tegmen, of which both obverse and reverse are preserved; the latter is the better impression of the two.

Type, Specimen No. 98*a* (reverse) in Coll. Queensland Geol. Survey, Brisbane.

Horizon, Upper Triassic, Ipswich, Q.

Genus CHILIOCYCLA Till.

Tillyard, Proc. Linn. Soc. N.S.W., xliv., pt. 4, 1919 (1920), p. 868.

Genotype, *Chiliocycla scolopoides* Till. (*l.c.*, p. 869).

CHILIOCYCLA SCOLOPOIDES Till. (Plate liii., fig. 37; Text-fig. 79.)

Specimen No. 327*a* is a second example of this interesting tegmen, more complete basally than the type, but with the clavus missing, and the sculpture much more poorly preserved. Combining the two tegmina, it is possible to offer a reconstruction of the tegmen as shown in Text-fig. 79, the very strong sculpture of flat circular tubercles, covering all except the distal end of the tegmen, being omitted. The new specimen shows very clearly the excessively strongly built costal border basally, and the short Sc connecting with it. The restoration of the clavus is purely provisional.

Types: Holotype, Specimen No. 158*a*; heautotype, Spec. No. 327*a*, in Coll. Queensland Geol. Survey, Brisbane.

Horizon, Upper Triassic, Ipswich, Q.

Genus POLYCYTELLA, n.g. (Plate liii., fig. 36.)

Tegmen of rather long, narrow shape, strongly sculptured all over with a meshwork of raised polygonal cellules, somewhat resembling the flattened tubercles of *Chiliocycla*, but placed more closely together. Only four main veins between the costa and the vena dividens, viz., Sc, R, M and Cu_1. These radiate out from near the base of the wing, and run almost straight to the wing-margin, without any branches. Sc very short; R ends up about half-way along the curved costal margin, M near apex, and Cu_1 well below apex. Cu_2 (vena dividens) runs straight to a little beyond half-way along posterior margin of wing. Clavus (partially missing) apparently rather narrow, the courses of the anal veins not preserved.

Genotype, *Polycytella triassica*, n.sp. (Upper Triassic, Ipswich).

POLYCYTELLA TRIASSICA, n.sp. (Plate liii., fig. 36.)

Total length of fragment, 7.5 mm., representing a tegmen of about 8.5 mm. in length. The costal margin is not very well preserved, except at the extreme base, where there may also be seen a short, slender vein, probably a much shortened Sc, separated from the costa by a single row of cellules. Between Sc and R there are three rows of cellules, somewhat irregularly arranged. The number of rows of cellules between R, M, Cu_1 and Cu_2, respectively, increases in each case from the base outwards from one or two up to six or seven rows, and the individual cellules become somewhat larger distally. The distal two-fifths of the costa and the whole of the apical margin to a little below the end of Cu_1 are missing, as is also most of the clavus.

Type, Specimen No. 81*a*, and paratype No. 154 (poorly preserved), in Coll. Queensland Geol. Survey, Brisbane.

Horizon, Upper Triassic, Ipswich, Q.

Family TROPIDUCHIDAE.

Genus MESODIPHTHERA Till. (Text-figs. 80, 81.)

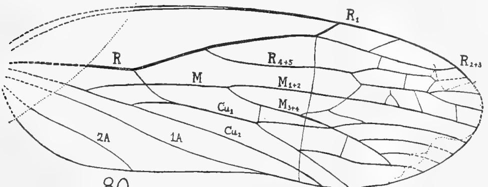
Tillyard, Proc. Linn. Soc. N.S.W., xliv., pt. 4, 1919 (1920), p. 873.

The type of this genus is *M. grandis* Till., represented by the basal half only of a large tegmen about 20 mm. long. Two more specimens referable to this genus are now to hand, and enable us to add to the definition of the genus the following characters:—Branches of R and M irregularly branched distally; a slightly impressed dividing line crossing the wing transversely from near end of R_1 to near end of clavus.

MESODIPHTHERA PROSBOLOIDES, n.sp. (Text-fig. 80.)

Greatest length of fragment, 14.4 mm; *greatest breadth,* 5 mm. The complete tegmen was probably about 15 mm. long.

This species is represented by the greater portion of a fairly large tegmen, evidently of stout build, but not very well preserved. The membrane is creased and cracked in places, making it very difficult to follow out the details of the venation, in which there are some very unexpected fusions of branch veins. The



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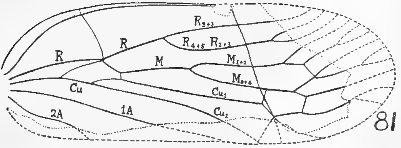


Text-fig. 80.—*Mesodiphthera prosboloides*, n. sp. Tegmen restored. (x 7.5).
Text-fig. 81.—*Mesodiphthera dunstani*, n. sp. Tegmen restored. (x 11.6).

structure of the basal half of the tegmen resembles that of *M. grandis* Till., except that there is an oblique connecting vein between M and Cu_1, absent in the genotype, and Cu_1 is weakly formed and somewhat irregular. The costal area is broad basally, and shaped as in the genotype. R_1 appears as a short free vein distally, arising obliquely from R_{2+3}, which is not well preserved. R_{4+5} is considerably branched. M_{1+2} is a strong, straight vein running to near apex, and having no branches. M_{3+4} gives off three anterior branches distally, and also meets two very oblique branches from Cu_1, the main stem of which is short, and ends up not far beyond the end of the clavus. Cu_2 is a straight furrow-vein. Most of the clavus is preserved, with 1A and 2A separate, and shaped much as in the genotype, though 2A is longer. The border of the clavus seems to be somewhat irregular in shape, but is not well preserved, and may have undergone some distortion.

Type, Specimen No. 89*a*, in Coll. Queensland Geol. Survey, Brisbane.

Horizon, Upper Triassic, Ipswich, Q.

MESODIPHTHERA DUNSTANI, n.sp. (Text-fig. 81.)

Greatest length of fragment, 10.8 mm.; *greatest breadth,* 3.8 mm. The complete tegmen was probably about 12 mm. long.

This species is complete basally, except for a small portion of the border of the clavus; the apical portion of the tegmen is broken off obliquely, but all the main branchings of the veins are well shown, though a considerable amount of transverse crumpling undergone by the tegmen makes them difficult to follow in places. The species is easily distinguished by the basal bending of M, which arches up so as to touch R, and then bends downwards again until it nearly touches Cu. Also all the distal branchings of R and M tend to turn upwards, and both branches of M are forked. Cu_1 is weakly formed, as in the previous species, but its manner of branching is different.

Family CIXIIDAE.

Genus MESOCIXIODES, n.g. (Plate liii., fig. 34; Text-figs. 82-84.)

Allied to *Mesocixius* Till., and also to *Triassocixius* Till., but differing from both in having R_1 unbranched, while R_{2+3} sends a series of veinlets to the costa distally. Costal area very broad. Median cell (*mc*) complete, small, and placed far distally, as in *Mesocixius*. Cu_1 with a small distal fork.

Genotype, *Mesocixiodes termioneura,* n.sp. (Upper Triassic, Ipswich, Q.).

MESOCIXIODES TERMIONEURA, n.sp. (Plate liii., fig. 34; Text-fig. 82.)

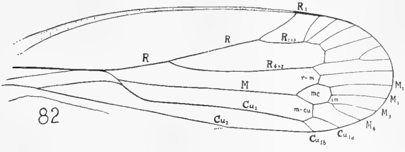
Total length, 12.5 mm.; width at end of clavus, 3.5 mm. The tegmen is complete except for the absence of the clavus and a slight break near the apex of the wing; it is finely granulated all over, and is stained a bright orange-brown. R_1 is a short vein, slightly curved, and somewhat similar to the terminal branches of R_{2+3}, though more strongly formed. R_{2+3} gives off altogether four terminal branches, the first two of which arise close together. R_{2+3} and R_{4+5} are connected distally by a strong cross-vein, and a similar R_{4+5} branches into two distally, the upper branch having a short terminal fork. cross-vein, *r-m,* connects R_{4+5} with the closed median cell below it. M_1 and M_2 are sessile upon the median cell (*mc*), M_3 and M_4 shortly stalked from it. A strong cross-vein, *m-cu,* connects the median cell with the short Cu_{1a} below it. There are no cross-veins present in the broad costal area, nor in the spaces between the main veins, except the three distal ones already mentioned, together with *im,* which closes the median cell.

Type, Specimen 88*a*, in Coll. Queensland Geol. Survey, Brisbane.

Horizon, Upper Triassic, Ipswich, Q.

MESOCIXIODES ORTHOCLADA, n.sp. (Text-fig. 83.)

Total length, 9 mm.; *greatest breadth,* 3.2 mm. This specimen is complete, except for partial obliteration of the distal portion. The costal area is broad, as in the genotype, but R_1 is a much longer vein, running straight out from the main stem of R in an oblique direction to a point about three-fifths of the way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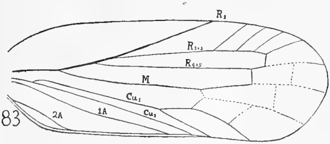
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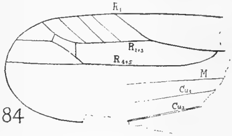
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Text-fig. 82.—*Mesocixiodes termioneura*, n.g. et sp. Tegmen. (*see* Plate liii., fig. 34.) (x 6.7).

Text-fig. 83.—*Mesocixiodes orthoclada*, n.g. et sp. Tegmen. (x 8).

Text-fig. 84.—*Mesocixiodes brachyclada*, n.g. et sp. Fragment of tegmen. (x 5).

along the costa, and thus making the costal area very pointed distally. Four evenly-spaced branches of R_{2+3} are present, and this vein leaves the main stem of R very close to R_{4+5}. M does not appear to be connected with Cu_1 basally, and its distal branches are very indistinct, though the median cell appears to be an elongated cell enclosed between only two main branches. The distal forking of Cu_1 is much longer than in the genotype. Clavus complete, with 1A running below and close to Cu_2 and very slightly waved; 2A a small loop across the anal angle.

T y p e, Specimen No. 318*a*, in Coll. Queensland Geol. Survey, Brisbane.

H o r i z o n, Upper Triassic, Ipswich, Q.

In the absence of any definite evidence as to the true form of the median cell, it seems best to keep this species in the genus *Mesocixiodes*, with which it agrees in its other characters. The species is easily distinguished by the striking form of R_1, which has suggested the specific name *orthoclada*.

MESOCIXIODES BRACHYCLADA, n.sp. (Text-fig. 84.)

This species is represented only by the distal half of a left tegmen of about the same size as that of the previous species, having the four distal branches of

R_{2+3} similarly situated, but the first of them much closer to R_1, which is a short vein like that in the genotype, but quite straight. The end branch of R_{2+3} is gently curved, and is joined to an anterior branch of R_{4+5} by two short cross-veins. R_{2+3} and R_{4+5} come off far apart, as in the genotype. Branches of M and Cu_1 obliterated; Cu_2 apparently a rather stout vein. Length of fragment, 9.5 mm.

T y p e, Specimen No. 325*a* in Coll. Queensland Geol. Survey, Brisbane. Specimen No. 4, figured by me in 1916 (*l.c.*, Plate 1, fig. 5) as doubtfully belonging to *Mesorthopteron locustoides* Till., belongs to this species also, but the venation is very poorly preserved.

H o r i z o n, Upper Triassic, Ipswich, Q.

Family IPSVICIIDAE.

Genus IPSVICIOPSIS, n.g. (Plate liii., fig. 35; Text-figs. 85, 86.)

Closely allied to *Ipsvicia* Till. from the same horizon, but differing from it in having an anterior branch of R present, which I have labelled R_1 in the figures, though it may perhaps represent R_{2+3} with R_1 suppressed. The tegmen is also of more normal shape, with a less acute apex and much less prominent anal angle of the clavus. Distally R and M are irregularly branched. Cu_1 is curved as in *Ipsvicia*, but runs much closer to Cu_2. The claval Y-vein is present, but its stem and the distal portion of its posterior arm (2A) are scarcely removed at all from the border of the wing. There are no patches of raised tubercles present, but the tegmen is finely and evenly granulated all over.

G e n o t y p e, *Ipsviciopsis elegans*, n.sp. (Upper Triassic, Ipswich, Q.).

IPSVICIOPSIS ELEGANS, n.sp. (Plate liii., fig. 35; Text-fig. 85.)

Total length, 12.5 mm.; *greatest breadth*, 3.8 mm. The specimen is a practically complete left tegmen, obverse impression, which has been turned round in Text-fig. 85, so as to bring the apex to the right. A small piece at the base of the costa has become somewhat detached from the rest of the wing, as may be seen in Plate liii., fig. 35, but has been replaced in Text-fig. 85. There is also some slight abrasion of the angle of the clavus. Rs and M are connected distally by three cross-veins, enclosing between them two elongated polygonal cells; above these is another cell formed by the branching of Rs distally, and closed by another cross-vein. Small branches from Rs and M form a series of irregular and mostly very small cells along the apical margin. M_{3+4} unites with Cu_1, which is unbranched, thus leaving a large open space below M_{1+2}. The whole tegmen is stained a rich orange-brown.

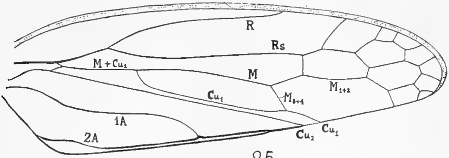
The above description applies to Specimen No. 178*a*, which is the type. Specimen No. 278*a* is another practically complete tegmen of this same species. It is the obverse of a right tegmen, complete except for an oblique depression in the rock, which runs across the distal portion of the wing, and has caused some abrasion in the depressed portion. The venation is almost exactly the same as in the type, there being only some slight differences in the size and position of the distal cells.

T y p e s, Holotype, Specimen No. 178*a*; paratype, Specimen No. 278*a*. Both in Coll. Queensland Geol. Survey, Brisbane.

H o r i z o n, Upper Triassic, Ipswich, Q.

Ipsviciopsis magna, n.sp. (Text-fig. 86.)

This species is represented by a fragment of a right tegmen, reverse impression, measuring 10 mm. in length, and obviously belonging to a large tegmen, probably about 26 mm. in total length. It is very much cracked and



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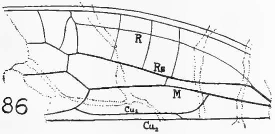

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Text-fig. 85.—*Ipsviciopsis elegans*, n.g. et sp. Type tegmen restored, with apex to right. (*see* Plate liii., fig. 35.) (x 7.9).

Text-fig. 86.—*Ipsviciopsis magna*, n.g. et sp. Fragment of tegmen. (x 6).

broken transversely, possibly owing to its toughness and may have been cracked under pressure. It differs markedly from the previous species in possessing a series of transverse veinlets running from Rs across R_1 to the costa. R_1 ends up on the fourth of these, which is joined near the costa by the fifth, these two arising one on each side of the strong cross-vein connecting Rs with M. A sixth veinlet is shown distally from Rs to the costal margin. R is also connected more basally with M by a short cross-vein, absent in the previous species; and a small cross-vein, obliquely placed, connects Cu_1 with Cu_2 at about the same level. Clavus and distal portion of the wing missing, as well as the extreme base.

Type, Specimen No. 93*a*, in Coll. Queensland Geol. Survey, Brisbane.

Horizon, Upper Triassic, Ipswich, Q.

Suborder **Heteroptera.**

Division *GYMNOCERATA.*

Family DUNSTANIIDAE.

Specimen 119*a* is a hemelytron belonging to this family, probably to *Dunstaniopsis triassica* Till., but not well enough preserved for accurate determination. The greater portion of the corium is visible, with the stems and branches of M and Cu, but all the margins are destroyed. The clavus and membrane are mostly obliterated.

Division *CRYPTOCERATA.*

Family TRIASSOCORIDAE, n.fam.

Insects resembling the Naucoridae and Galgulidae in the form of the hemelytron, which is broad, with a strongly projecting clavus reaching half-way or less along the posterior margin, and strongly angulated. Tegmen smooth, dark and shiny, as in Naucoridae, and not tough or marked with paler patches as in Galgulidae; the main veins R, M and Cu_1 are still visible on the corium, which extends over the greater portion of the hemelytron and is separated from the narrow distal membrane by a definitely impressed line, more or less concentric with the wing-border. In the region of the membrane above the apex, R and M give off a series of radiating branches which cross the membrane at close and regular intervals; most of these are only faintly outlined. These characters agree with those of the Belostomatidae of the present day, from which the fossil family is distinguished by its much smaller size and different shape. It would appear to be ancestral to the three families Galgulidae, Naucoridae and Belostomatidae, and perhaps to all the rest of the Cryptocerata also.

Genus Triassocoris, n.g. (Text-figs. 87, 88.)

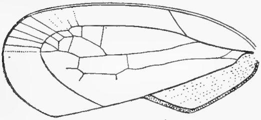
Hemelytron short, broad, quite smooth in texture, shiny and also very darkly coloured. Venation mostly very faintly marked, only three main veins apparent on the corium, viz., R, M and Cu_1. R and M are fused basally for some distance. R runs about parallel with the costal margin, a considerable distance from it; about one-third from base, it gives off a faint oblique veinlet, which is probably the first of the series of radiating veinlets continued around the apex, but mostly too weakly formed to be made out with certainty. M and Cu_1 both very faint, becoming irregular distally, and breaking up into small branchlets, most of which are too faint to be indicated accurately in the figure. Below Cu_1 there is an appearance of a very faint, irregular, polygonal meshwork; this is more clearly marked in specimen 167*b* than it is in specimen 140. The division between corium and membrane distally is indicated by a curved line running round from the end of R concentrically with the rounded apical margin. In the region of the apex, especially above it, a series of radiating veinlets can be seen crossing the membrane; they are clearly branches of R and M which cross the concentric line above mentioned. Clavus short and broad, strongly angulated, and ending up about half-way along the posterior margin of the wing, with which it makes a very marked angle. The position of the two hemelytra on the back of the insect when at rest is shown in Text-fig. 88, the shaded portions being the two clavi.

Genotype, *Triassocoris myersi*, n.sp. (Upper Triassic, Ipswich).

Triassocoris myersi, n.sp. (Text-figs. 87, 88.)

Total length, 5.8 mm.; *greatest breadth,* 2.5 mm. Hemelytron broad and well rounded apically; the corium and membrane quite smooth, apparently shiny in life, and probably of a very dark colour, since specimen 140 is very much darker than the rock on which it lies, but is clearly not carbonised. The venation of the corium is very faint, but the courses of M and Cu_1 upon it can just be made out in a strong oblique light, as well as a small portion of the polygonal meshwork, in specimen 140; in specimen 167*b*, this meshwork is more clearly marked, and very irregular in form.

This species is dedicated to my friend Mr. J. G. Myers, F.E.S., Assistant Entomologist, Biological Laboratory, Wellington, N.Z., who is doing excellent work on New Zealand Hemiptera.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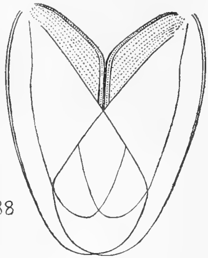
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Text-fig. 87.—*Triassocoris myersi*, n.g. et sp. Tegmen. (x 9.6).
Text-fig. 88.—*Triassocoris myersi*, n.g. et sp. The two tegmina placed in the position of rest. (x 9.6).

T y p e s, Specimen 140*a* (corium and membrane) and 167*b* (clavus), in Coll. Queensland Geol. Survey, Brisbane.

H o r i z o n, Upper Triassic, Ipswich, Q.

TRIASSOCORIS SCUTULUM, n.sp.

Specimen No. 134 contains two impressions of different insects, one being a portion of the tegmen of a Cockroach belonging to the genus *Samaroblatta* Till., not sufficiently well preserved to merit a name, and the other the two hemelytra of a species of *Triassocoris* folded over in the position of rest, as shown in Text-fig. 88, which was reconstructed from the previous species. The present species differs from the genotype in having the hemelytra much less rounded apically; so that, when folded in the position of rest, their appearance is more pointed apically, the figure being shield-shaped. Besides this, it can be seen that the course of R and the dividing vein which continues it between corium and membrane does not run concentrically with the margin but begins at the base comparatively close to the costa, and gradually diverges from it towards the apex. The hemelytra are irregularly broken off basally, but most of the two clavi can be seen *in situ*; the venation is practically obliterated.

T y p e, Specimen No. 134 in Coll. Queensland Geol. Survey, Brisbane.

H o r i z o n, Upper Triassic, Ipswich, Q.

Specimen No. 184*b* also appears to belong to this genus, but is too poorly preserved for description.

Order **NEUROPTERA**.

Suborder **Planipennia**.

Family PSYCHOPSIDAE.

Genus T R I A S S O P S Y C H O P S, n.g. (Plate lii., fig. 32; Text-fig. 89.)

Forewing very broad, the apex rounded, but less so than in most recent Psychopsidae, the tornus broadly rounded. Sc, R_1 and Rs very strongly built from base to a little beyond half-way, forming a true *vena triplica*, characteristic of this family, and joined distally by two strong cross-veins; beyond this point, these three veins continue a short distance, when they are again connected by two cross-veins; at this point, Sc divides into terminal veinlets; R_1 and Rs continue a little further, when they are again connected by a cross-vein, after which Rs divides into terminal veinlets; R_1 divides into such between the second and third cross-veins. Of the three veins forming the vena triplica, Sc is much the strongest, R_1 the weakest. Costal area broad, a little broader than the area covered by Cu and the anal veins, but not so broad as in recent forms; a recurrent veinlet present at its base, sending a number of branches to the margin; the succeeding costal veinlets lie close together, mostly arising from Sc at an angle of about 45°, mostly branched, and connected here and there by small cross-veins, which show no tendency to become arranged into a costal series of gradate cross-veins, such as occurs in many recent forms. Apical area missing in the fossil, but its extent can be inferred from the length of the pectinate branches of Rs, some of which are preserved right to the margin of the wing; the actual shape of the apex can also be inferred from the comparative width of the costal margin and slant of the costal veinlets. Rs with about fourteen branches descending from the vena triplica, some branched and some simple within the area of the disc, but all branching closely towards the distal margin of the wing. M apparently with five branches within the area of the disc, and connected with the lowest branch of Rs by a strong oblique cross-vein. No fusion of M with Cu_1 distally. Cu_1 strongly formed, remaining unbranched for about three-fifths of its length, and then giving off numerous branches to the area of the tornus. Cu_2 a weakly-formed vein lying closely parallel below Cu_1, giving off a series of branches from about half-way, and bending strongly down distally below the point where Cu_1 gives off its first branch. 1A and 2A slightly arched veins branching longitudinally; 3A not present as a vein distinct from 2A basally. Posterior margin of the wing not strongly arched outwards at base. Cross-veins present in the vena triplica, strongly formed, spaced irregularly at fairly wide intervals. Numerous weak cross-veins present in the disc, especially in the basal half and between the branches of M almost to the distal margin; there are also weak cross-veins present between most of the outer branches of Rs at about two-thirds of the wing-length from the base; these show a tendency to arrangement as a true gradate series separating the disc from the marginal area; the latter is practically devoid of cross-veins, the cubito-anal area completely so.

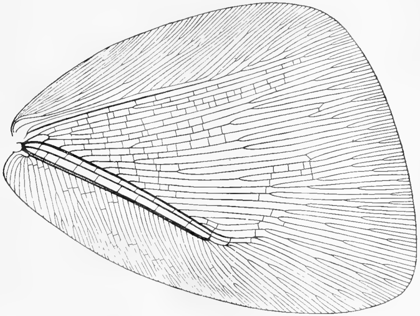
Genotype, *Triassopsychops superba*, n.sp. (Upper Triassic, Ipswich, Q.).

This genus differs from *Archepsychops* Till. in its less expanded costal area, in having R_1 and Rs separate right from the base, and not curved downwards markedly away from Sc, and also in having Cu_1 straight at the base, not arching sharply downwards, and making a smaller angle of divergence with Sc than in *Archepsychops*. This latter genus was placed by me, with *Protopsychopsis*, in the family Prohemerobiidae; but it seems probable, on the evidence offered by the new fossil, that it too would possess a true vena triplica of the Psychopsid type, and should therefore be placed within the family Psychopsidae. *Protopsychopsis* on the other hand must remain in the Prohemerobiidae, since the form of its apical area shows that a true vena triplica was not present.

The discovery of this magnificent fossil, complete in all the more important details of venation, enables us to state definitely that true Psychopsidae were present in the Upper Triassic fauna of Ipswich. The more primitive condition of the fossil wing, compared with recent forms, and especially noticeable in the less rounded apex, less expanded costal area, and absence of any definite or complete gradate series of cross-veins, makes it necessary to place *Triassopsychops* by itself in a new subfamily Triassopsychopinae, which may possibly also include the genus *Archepsychops,* when more of the venation of that genus is made known.

TRIASSOPSYCHOPS SUPERBA, n.sp. (Plate lii., fig. 32; Text-fig. 89.)

Greatest length of fragment (obliquely along lower branches of Rs), 29 mm., representing a total length of 32 mm. *Greatest breadth of fragment,* 22 mm., representing a true greatest breadth of the complete wing, near tornus, of about 23.5 mm. The fossil is beautifully preserved, but the apical portion of the wing



Text-fig. 89 —*Triassopsychops superba*, n.g. et sp. Restoration of forewing. (*see* Plate lii., fig. 32.) (x 3).

is missing, and there are also irregular breaks along the costal and posterior margins. The more important details of venation have been included in the generic definition; the lesser details of the branching of the veins may be gathered from Plate lii., fig. 32. Text-fig. 89 shows a restoration of the complete wing, based on the photograph shown in the Plate.

T y p e, Specimen No. 284*a,* in Coll. Queensland Geol. Survey, Brisbane.

H o r i z o n, Upper Triassic, Ipswich, Q.

Order **COLEOPTERA**.

The numerous specimens belonging to this Order, chiefly separate elytra, but some few showing the body of the insect with the wings *in situ,* are being worked up by Mr. Dunstan, and will be dealt with in a separate part. There is, however, one specimen of great interest which may be dealt with here, since it does not require a name. It is Specimen No. 170, which shows the stem of a plant in which there can be plainly seen the mine or burrow of an insect larva. The type of burrow is clearly Coleopterous, and the larva probably belonged to one of the obscure families of very small beetles, the burrow being far too small to be that of a Cerambycid. It is shown in Plate li., fig. 29.

EXPLANATION OF PLATES LI.-LIII.

Plate li.

Fig. 26.—*Mesorthopteron locustoides* Till. Forewing, specimen No. 258*b*. (x 5).
Fig. 27 —*Triassomantis pygmaeus*, n.g. et sp. Forewing. (x 10.5).
Fig. 28.—*Triassolocusta leptoptera*, n.g. et sp. Forewing. (x 5.1).
Fig. 29.—Burrow of Coleopterous larva in stem of plant. (x 6.2).

Plate lii.

Fig. 30.—*Mesophlebia antinodalis* Till. Heautotype. (x 4).
Fig. 31.—*Triassagrion australiense*, n.g. et sp. (x 4).
Fig. 32.—*Triassopsychops superba*, n.g et sp. (x 4.2).

Plate liii.

Fig. 33.—*Apheloscyta mesocampta*, n.g. et sp. Tegmen. (x 8.85).
Fig. 34.—*Mesocixiodes termioneura*, n.g. et sp. Tegmen. (x 7.6).
Fig. 35.—*Ipsviciopsis elegans*, n.g. et sp. Tegmen. (x 7.5).
Fig. 36.—*Polycytella triassica*, n.g. et sp. Tegmen. (x 11).
Fig. 37.—*Chiliocycla scolopoides* Till. Tegmen. Type. (x 10).

(N.B.—The numbers of the figures run concurrently with those of the previous Part).

ON AUSTRALIAN ANTHICIDAE (COLEOPTERA).

By Arthur M. Lea, F.E.S.

[Read 29th November, 1922.]

Since the publication of Masters' Catalogue, the Australian species referred to this family of small and graceful beetles have been more than doubled, some generic transfers made, synonymy noted, and the known range of many species greatly extended; it has been considered desirable, therefore, to give a list of the known species, with their range, before dealing with some new ones. Of species previously referred to the family *Anthicus aberrans* Macl., has been transferred to *Macratria* (Pedilidae) and *A. abnormis* King to *Xylophilus* (Xylophilidae). *A. melancholicus* Lea, as a record of locality only, (Trans. Roy. Soc. S. Aust., 1916, p. 582) was used in error for *A. inglorius* Lea.

List of known species of Anthicidae and their range in Australia.

Anthicus Payk.

adelaidae Champ. (N.W. Aust.)
albifasciatus Pic. (*Ischyropalpus*). (Australia)*
albanyensis Pic. (W.A.)
(= inflatus Champ.)
apicalis King. (Qld.)
australis King, *non* Champ. (*Formicomus*). (Qld., N.S.W., Vic., Tas., S.A., W.A.)
(= walkeri Champ.)
baudinensis Champ. (Baudin I.)
brevicollis King. (Qld., N.S.W., Vic.)
bryanti Pic. (Qld., N.S.W., Vic.)
cancellatus Lea. (N.S.W.)
cavifrons Champ. (W.A.)
clarki King (*Formicomus*). (W.A.)
(= charon King, var.)
comptus Laf. (N.S.W., S.A.)
confertus Lea. (N.S.W.)
constrictus Macl. (Qld.)
crassipes Laf. (Qld., N.S.W., Vic., Tas., King I.)
crassus King. (N.S.W., Vic., Tas., S.A., W.A.)
(= tasmanicus Champ.)
demissus Lea. (N.S.W.)
denisoni King. (Qld., N.S.W.)
discoideus Champ. (N.W. Aust.)
dubius King. (N.S.W.)
elegans Lea (*Formicomus*). (N.W. Aust.)
exsanguis Pic. (Qld., N.S.W.)
(= pallidus Macl.)
floralis Payk. (Qld., N.S.W., Vic., Tas., S.A., W.A., Cent. Aust.)
gawleri King. (N.S.W., S.A., W.A.)
geminatus Lea. (Vic., Tas., S.A., W.A.)
glaber King. (N.S.W., Vic., Tas., S.A.)

* Possibly not really Australian as named originally from South America.

hackeri Pic. (Australia.)
hesperi King. (Qld., N.S.W., Vic., Tas., S.A., W.A.)
(= mastersi Macl., similis Lea.)
inglorius Lea. (Qld., N.S.W., S.A., Cent. Aust.)
immaculatus King (Vic., S.A.)
inornatus Lea. (N.W. Aust.)
intricatus King. (W.A.)
(= ovipennis Lea.)
kingi Macl. (Qld.)
kreusleri King. (N.S.W., S.A.)
laticollis Macl. (Qld., W.A., N.W. Aust., N.T., Magnetic, Garden, Rottnest and Moa Islands.)
(= excavatus Champ., triangularis Lea, var.)
leae Pic. (Qld., N.S.W.)
(= exiguus Lea, rubriceps Lea.)
lemodioides Lea. (N.S.W.)
luridus King. (Qld.)
macleayi King. (N.S.W., Tas.)
monilis King. (N.S.W., S.A., Cent. Aust.)
monostigma Champ. (Baudin I.)
myrteus King. (Qld., N.S.W., Vic., S.A., Cent. Aust.)
(= glabricollis King.)
nigricollis King. (S.A.)
nitidissimus King. (N.S.W., S.A., W.A.)
obliquifasciatus King (*Formicomus*). (N.S.W., Vic.)
pallipes Lea (Qld., N.S.W., N.T., Melville I.)
paululus Champ. (S.A., W.A., N.W. Aust., N.T.)
(= delicatulus Lea.)
permutatus Pic. (N.S.W.)
(= latus Lea.)
pignerator Lea. (N.S.W.)
politulus Lea. (N.S.W.)
posticalis Lea (*Formicomus*). (N.S.W.)
pulcher King. (N.S.W., S.A.)
(= Micranthicus brachypterus Champ.
rarus King. (Qld., N.S.W., Vic., Tas.)
(= australis Champ. *non* King, glabriceps Lea, var.; krefftii Macl., var.; propinquus Macl., pulchrior Lea, var.)
rectifasciatus Lea. (Qld., Fitzroy I.)
scabricollis Champ. (Troughton I.)
scydmaenoides King. (N.S.W.)
scutellatus Lea. (N.W. Aust.)
segregatus Champ. (E. Wallaby I.)
semipunctatus Lea. (Qld., S.A., W.A., N.W. Aust., Cent. Aust.)
stenomorphus Champ. (Troughton and Pelsart Islands.)
strictus Er. (N.S.W., Vic., Tas., S.A., W.A.)
(= bellus King, bembidioides Laf., simulator Lea.)
tridentatus Champ. (N.W. Aust.)
unicinctus Champ. (Troughton and Baudin Islands.)
unifasciatus King. (Vic., S.A., W.A., Cent. Aust.)
villosipennis Lea (*Formicomus*). (N.S.W., Vic., Tas., W.A.)
wollastoni King. (N.S.W., Vic., S.A., Cent. Aust., King I.)
xerophilus Lea. (Qld., N.S.W., S.A., W.A., Cent. Aust.)

Cribroanthicus Pic.

frenchi Pic. (Australia.)

Eurygeniomorphus Pic.

rugosus Pic. (Australia.)

Formicomus Laf.

agilis King. (Qld., N.S.W.)
(= humeralis Macl.)
cyaneus Hope (*Anthelephilus*). (Australia.)
denisoni King. (Qld., N.T., N.W. Aust.)
(= nigripennis Champ.)
mastersi King. (Qld., N.S.W., S.A.)
(= kingi Macl.)
niger Pic. (Australia.)
quadrimaculatus King. (Qld., N.S.W., Vic., S.A., W.A., Cent. Aust.)
rufithorax Pic. (Qld.)
senex Laf. (Australia.)
speciosus King. (S.A., W.A.)

LEMODES Boh.

atricollis Oberth. (Vic.)
caeruleiventris Blair. (Qld.)
coccinea Boh. (Qld., N.S.W., Vic.)
elongata Lea. (Qld., N.S.W.)
mastersi Macl. (Qld., N.S.W.)
splendens Lea. (N.S.W.)

LEMODINUS Blair.

tumidipennis Blair (*Lemodes*). (Qld., N.S.W.)

MECYNOTARSUS Laf.

albellus Pasc. (S.A., W.A.)
amabilis Lea. (N.S.W., S.A.)
apicipennis Lea. (S.A.)
concolor King (S.A.)
kingi Macl. (Qld.)
kreusleri King. (Qld. N.S.W., S.A.)
mastersi Macl. (Qld.)
ziczac King. (N.S.W., Vic., S.A., W.A.)

NOTOXUS Geoff.

australasiae Laf. (S.A.)
decemnotatus Pic. (Australia.)

TOMODERUS Laf.

denticollis Champ. (N.W. Aust.)
vinctus Er. (Tas.)
leae Pic. (N.S.W., Vic., S.A.)
(= brevicornis Lea.)

TRICHANANCA Blackb.

concolor King (*Anthicus*). (N.S.W.)
nigripennis Lea. (N.T.)
pisoniae Lea. (Qld.)
victoriensis Blackb. (N.S.W., Vic.)
(= Lemodes corticalis Lea.)

WALESIUS Pic.

theresae Pic. (N.S.W.)

ANTHICUS.

The number of described Australian species of this genus probably represents but a comparatively small proportion of the total to be obtained; although most are of graceful form and many are widely distributed and abundant, occurring in countless thousands on flowers and frequently coming to lights, occurring on sea-beaches, and frequently washed out by floods, yet their very abundance causes many to be passed over by collectors, on account of their diminutive size rendering certain identification in the field difficult. Some of the more interesting apterous, or at least flightless species, are of very local occurrence, and usually to be obtained only by the use of sieves. Several species have been seen in the nests of ants, but apparently only as casual visitors. King commented on the great variation that occurs in many species of the family, and especially in *Anthicus,* but did not make sufficient allowance for it, so that when dealing with specimens from widely separated localities, that differed in colour and markings, he sometimes presumed them to be distinct, and hence made several synonyms. In my first two papers, in which members of the family were dealt with, I also regarded and named some varietal forms as distinct species, although, with the exception of a few which had perished, I had examined the whole of King's and Macleay's types. Champion, who had not this advantage when describing the Anthicidae taken by Walker, also made several synonyms. In identifying species from descriptions, unless there are very strong structural features, colour and markings must be relied upon, and hence it is easily possible for an author to fail to identify a species from its description. King, however, added to the difficulty by occasionally referring the same species, under different names, to different groups; he also sometimes referred closely allied species to widely separated groups, but it is not always easy to follow Laferte's divisions. Whilst many of the species are very variable in colour and need close comparison to be certain of the range of variation, several species strongly resemble each other and yet may be distinguished by profound differences in sculpture. Most species are shining, but a few have the whole or parts of the upper surface opaque or subopaque (in *A. crassus* only in the male), and when it is certain that the opacity is natural, and not due to age, grease, gum, etc., the character is a very useful one. Most, if not all, of the species of the *A. brevicollis* group are extremely variable in their markings, and somewhat in size; they all have the head short, with large eyes, and the prothorax short, with a narrow sub-basal impression, connected on each flank with a deep groove; a few have characters by which the males only may be identified with certainty, but most of them will be found difficult to deal with, and specimens taken *in cop.* will be found very useful. Many of the group have densely crowded punctures on the pronotum, and on some they are sparser, usually larger and asperate; the differences may be used in roughly dividing both males and females into two sections of the group, but are not sufficient to isolate closely allied species. Some synonymy has already been noted in the group, and as I am doubtful as to the range and forms of several species many specimens of the group have not been dealt with. The sexes may usually be readily distinguished by the males having dilated front tarsi, hind tibiae thickened, curved or notched, and apical segment of abdomen notched or impressed. On many of the Australian species the intercoxal process of abdomen is acutely triangular, but on some of them the tip is feebly or even moderately rounded.

Anthicus strictus Er.

Syn.—*A. bellus* King, *A. bembidioides* Laf., *A. simulator* Lea.

A small, widely distributed species, with elytral spots varying in size and intensity, head and prothorax varying in colour, and punctures of prothorax and elytra more sharply defined on some specimens than on others; *A. bembidioides* has already been referred to the species, and I have now to refer *A. bellus* and *A. simulator* to it. On some specimens the postmedian spots are extremely faint and small, being scarcely paler than the surrounding parts, and clearly connecting the species with the following variety.

Var. flavohumeralis, n. var.

On numerous specimens from South and Western Australia the humeral spots are flavous and sharply defined, and are the only spots on the elytra. The head varies from the same shade of red as the prothorax to almost black.

Anthicus crassipes Laf.

Two males from Cairns, that appear to belong to this species have the elytra of a dingy red, with three large black spots (two median and one apical), and the base slightly infuscated; the hind tibiae are wider than usual, with the notch deeper and shorter, and its beginning and end marked by dentiform processes, although these are quite concealed from some directions.

Anthicus rarus King.

Syn.—*A. australis* Champ. (not King), *A. glabriceps* Lea, *A. Kreffti* Macl., *A. propinquus* Macl., *A. pulchrior* Lea.

Long series of specimens now convince me that *A. glabriceps* and *A. pulchrior* should be regarded as varieties of this variable and widely distributed species; the other synonymy has been previously recorded. Two specimens from the Victorian Alps, and one from Townsville, have the upper surface (except for the two elytral fasciae) black; two from Gayndah are paler than usual, with the elytra pale except for a median fascia and the apex, which are moderately infuscated.

Anthicus luridus King.

This species, one of the allies of *A. brevicollis,* is common in the Cairns district, and occurs also at Port Denison, Stewart River, Townsville and Cunnamulla. Two females were compared with the type and are entirely pale (the eyes, of course, excepted), seventeen other females are similarly pale; but three males have the abdomen (only) deeply infuscated, especially at the sides, its tip is notched and the hind tibiae are curved (rather strongly so as seen from some directions), the elytra are also less shining than on the female, but are not opaque as on the males of *A. crassus,* from the pale forms of which it also differs in the less crowded prothoracic punctures. The disproportion between the sexes is so great that it seems probable the males vary in colour, and this appears to be the case, as four males, agreeing perfectly otherwise with the three previously mentioned, each have a moderately infuscated spot on each elytron on the middle of the side. It is almost certain that males with more strongly defined markings (two or three elytral spots) have been described under different names, but as there are no specimens before me marked as having been taken *in cop.,* the names suspected to be varietal are not mentioned. Some specimens from the Northern Territory and North-western Australia appear to be varieties.

Anthicus crassus King.

Syn.—*A. tasmanicus* Champ.

This is a widely distributed, abundant, and very variable species, with the short prothorax and general appearance of some specimens of *A. brevicollis* and of *A. crassipes,* but with the hind tibiae of the male not notched, although somewhat curved and thicker than on its female. It may, however, be distinguished from those species and from all the allied ones by the elytra of the male, these being distinctly sub-opaque, instead of shining as on other species, and on its own females; its elytral punctures are also less sharply defined than on its own females; the appearance is as if the derm was slightly obscured by gum or grease, but is alike on all the males before me, some of which are taken quite recently. The type of *A. crassus* was from South Australia, and is a rare form (Form 1) of the male in that State, but the common one in Tasmania; King's second specimen was probably like Form 3, with the prothorax entirely pale; only one specimen was known to Champion, the type of *A. tasmanicus.* In general, the males are darker than the females, but numerous dark females are darker than some pale males, but, in addition to the elytra and hind tibiae, the sexes may be distinguished by the apical segment of the abdomen, that of the male having a conspicuous curved impression and with coarse punctures in parts, that of the female being even throughout and with small punctures. The under surface and legs vary considerably in colour, the abdomen usually being black, but often (especially, but not solely, in the female) pale, the metasternum is nearly always black. Disregarding the under surface, antennae and legs, some forms of the male occurring in South Australia are as follows:—

1. Dark, sometimes black, prothorax usually reddish at base, elytra with a large flavous spot on each shoulder (the typical form).

2. Like 1, but elytra with basal third flavous, bounded posteriorly by a dark fascia (often ill-defined), beyond which the derm is again pale, although not as pale as the basal portion.

3. Like 1, but dark parts of elytra consist of a large triangular spot about the middle of each, dilated to the side and with its most acute point directed to the suture. On many specimens of this form the space about the scutellum and apex is more or less obscurely infuscated; the triangles vary considerably in intensity and sharpness of definition.

3a. Elytra as on Form 3 with the markings sharply limited but head, including antennae and prothorax entirely pale.

4. Like 1, but elytra entirely pale except for an infuscation (invisible from above) on the middle of each side. On many specimens of this form the greater portion of the prothorax is pale.

5. Head dark, sometimes only moderately so, prothorax almost or entirely pale, elytra as on Form 4. The most abundant South Australian form of the male.

6. Head and prothorax black, elytra pale except narrowly at suture and on sides.

7. Upper surface entirely pale, the elytra paler than the head and prothorax, these being pale castaneous. A rare form which could be easily overlooked from its resemblance to the common form of the female.

The females usually have the upper surface entirely pale, the elytra paler than the head and prothorax, these being of a pale castaneous; but frequently the head is darker (sometimes almost black) than the prothorax; on many of them the abdomen is pale. In general appearance they are close to the females (and sometimes the males) of several other species, and it does not appear to be desirable to number them.

From Victoria I have seen males of Forms 3a, 5 and 7.

In Tasmania the common form is 1, but the black (as is usual on Tasmanian insects compared with those from the mainland) is more intense, the prothorax is often entirely black and the flavous spots on the elytra are more strongly contrasted. Form 3 is common, and Form 2 also occurs there. Tasmanian females are usually darker than mainland ones, on many of them the head and prothorax being deep black, and occasionally the sides of the elytra also infuscated.

In Western Australia, Form 1 is fairly numerous, but the humeral spots are of a dingier shade than on specimens from South Australia and Tasmania, and the prothorax is usually entirely black; on only two, of the many before me, the basal half of the prothorax is of a rather bright red. Form 2 occurs there but the space beyond the median fascia is more obscure than on South Australian specimens. Form 4 also occurs there, the specimens being usually very dingy. The females usually have the head black, or dark brown, the prothorax reddish or castaneous, and the elytra flavous but with a brownish shade; occasionally the front of the prothorax is infuscated, and on some specimens the sides of the elytra as on Form 4; three females appear at first, except that the elytra are shining, to be rather brightly coloured males of Form 1. I have seen the two following forms of the males only from Western Australia.

8. Upper surface entirely black, a faint dilution on the shoulders usually indicating the position of the spots as on Form 1, but even this sometimes entirely absent. A very common form.

9. Of a dingy livid colour, the humeral spots somewhat paler than the adjacent parts, but not sharply limited.

From New South Wales I have seen but two males, one of Form 7, and a rather large one of Form 2, with elytral markings more sharply defined than usual.

Six females from Victoria, South and Central Australia probably belong to the species; they are entirely pale except for three feebly infuscated spots on the elytra, the subapical one usually fainter than the others; they resemble some of the paler males of Form 3A; it is possible, however, that they belong to *A. laticollis*.

ANTHICUS OBLIQUIFASCIATUS King, and Allies.

There are three species belonging to this group. 1. *A. obliquifasciatus* King, 2. *A. clarki* King (= *A. charon* King), 3. *A. villosipennis* Lea, and all (except *charon*) were originally referred to *Formicomus*. They are all round-headed and have the elytra strongly narrowed to base, with the intercoxal process of abdomen small and acutely triangular, the femora unarmed, and the hind ones not clavate. The sexes differ considerably in the elytra; on one sex (probably the male) at the base they are slightly wider than the widest part of the prothorax, and shoulders are present although they are strongly rounded; on the other sex they have the sides continuously narrowed to the base, where the width is scarcely greater than that of the base of the prothorax, and decidedly less than its greatest width, and shoulders are absent.

ANTHICUS LATICOLLIS Macl.

Syn.—*A. excavatus* Champ., *A. triangularis* Lea.

The types of *A. laticollis* have broken hind legs, but the hind tibiae are not notched as on the males of *A. crassipes*, and *A. brevicollis*; in colour the elytra agree well with those of the male of the latter, but the antennae are entirely pale, the hind femora are often partly black, but are mostly entirely pale. The species occurs on both sides of the continent, and *A. excavatus* (of which *A. triangularis* has already been noted as a variety) appears to be a synonym. In general appearance the males of Forms 2 and 3 of *A. crassus*, with pale head and prothorax, are scarcely to be distinguished from it, except by the subopaque elytra.

ANTHICUS STENOMORPHUS Champ.

Fifteen specimens that I took on Pelsart Island and at Geraldton appear to belong to this species, but on only one of them are the dark median and apical markings connected (and that rather narrowly) along the suture; the median fascia varies from about thrice as long as the pale fascia behind it (the pale portions of the elytra are almost white) to but little longer; the infuscation about the base is absent from three specimens but distinct (although of variable extent) on the others; the head varies from no darker than the prothorax to almost black, the under surface also varies considerably in colour. The male differs from the female in having the head slightly larger, the apical segment of abdomen with a shallow depression, the legs stouter, and the front tarsi considerably wider.

ANTHICUS LEAE Pic.

Syn.—*A. exiguus* Lea (nom. praeocc.), *A. rubriceps* Lea (nom. praeocc.).

The synonymy of this species has been unfortunate. I named it originally, in 1894, as *A. exiguus* (These Proc., 1894, p. 616); but that name had recently been used by Champion for an American species (Biol. Cent. Am., iv. (2), 1890, p. 240). On my attention being called to this I purposed altering the name to *A. rubriceps* (These Proc., 1896, p. 295), but Pic in the same year (Feuille jeun. Nat. 1895 (1896), p. 180) had named an European species *A. rubriceps,* so that, although the name *A. leae* was not proposed until 1897 (Ann. Soc. ent. Belge, 1897, p. 344) it must stand for the species.

A specimen from Cairns, belonging to this species, differs from the type in having the whole of the upper surface (except for an infuscated elytral fascia just beyond the middle, and a space about the scutellum) flavous, and the legs still paler.

Anthicus bryanti Pic.

This beautiful species is common at Cairns and Mount Tambourine in Queensland, and has also been taken at Wollongong (New South Wales) and Ringwood (Victoria). It varies in length from 2 to 3 mm. The depressed part of the derm supporting the sub-basal fascia of silvery pubescence on the elytra is often quite as black as the other parts, but is usually more or less conspicuously reddish; the subapical fascia of pubescence is nearly always narrowly connected with the sub-basal one along the suture, and frequently has a wider prolongation along the suture half-way to the apex.

Anthicus pallipes Lea.

In the original description of this species I omitted to mention that the prothorax is opaque, except that the dilated front sides are shining, this giving the "angled" appearance noted, and being a conspicuous feature of the typical form and all the varieties. On the typical form, common at Cairns, the upper surface is black or blackish (the head and prothorax are often dark reddish-brown) and the elytra have two interrupted flavous fasciae: one sub-basal, the other post-median; but the sub-basal one is occasionally continuous, and may even have a slight sutural prolongation towards the base.

Variety A. A still more common form in North Queensland than the typical one, has the upper surface pale, except that on the elytra there is a large dark spot (usually black) on each shoulder, a wide black median fascia, rather narrow near the suture, then strongly dilated and rather abruptly terminated before the sides, and a deeply infuscated fascia near the apex, rather widely connected along the suture with the median one, so as to form a fairly regular x; the tibiae on specimens of this and the following varieties are usually entirely pale. On an occasional specimen (including one from Rockhampton and another from the Blackall Range) the median fascia is dilated so as to occupy almost one-third of the elytra.

Variety B. A specimen (trapped by sticky seeds of *Pisonia brunoniana* at Kuranda) is pale as in the preceding variety, with the elytral markings reduced to a large blackish spot on each side of the middle, and the humeral and sub-apical ones to faint infuscations.

Variety C. Seven specimens, from Melville Island, are even paler than the variety A, but have the median fascia larger and more dilated to near the sides, along which they are connected with the sub-apical fascia, the connection along the suture is very narrow and faint, so that the resemblance of the dark markings to an x is lost. On two specimens, from Darwin, the pale portion at the tip of the elytra is so obscure that it can scarcely be distinguished from the subapical fascia; on all other specimens of the varieties the tips are conspicuously pale.

One specimen from Cairns is much smaller (2 mm.) than usual, and is entirely pale, except for three feeble infuscations on each elytron.

ANTHICUS SCUTELLATUS Lea.

At first glance the type and other specimens of this species appear to belong to Form 7 of *A. crassus,* as the elytra, although hardly sub-opaque, are less shining than is usual, but the prothoracic punctures are considerably larger, coarser, and decidedly asperate, those on the head are also much coarser, and occupy more of the surface; the punctures are not as dense as on *A. luridus,* but are very much coarser.

ANTHICUS XEROPHILUS Lea.

On an occasional specimen of this species the head is considerably darker than the prothorax, and on the elytra there is a fairly dark infuscation at the base; the notch at the base of the head is more conspicuous on some specimens than on others, and is always present. One specimen was taken at Port Wakefield from a nest of ants of the genus *Pheidole.*

ANTHICUS INGLORIUS Lea.

The male of this species usually has a large, black, medio-lateral patch on each elytron, the patch narrowly continued along the side, almost, in some cases quite, to the apex (on some specimens the black space is so large that two small flavous spots are enclosed near the apex), the abdomen and metasternum are black or blackish, and the femora are sometimes partly infuscated. It has the conspicuously incurved tip of abdomen as in males of most species of the *A. brevicollis* group, and in general appearance males look like large *A. brevicollis* or *A. crassipes,* but the hind tibiae are only slightly bent, and are not at all notched; from *A. crassus* it is distinguished by the shining elytra. It is a dry-country species, occurring in many parts of the interior of Queensland, New South Wales and South Australia.

ANTHICUS GEMINATUS Lea.

The types of this species appear to represent a very rare form of a widely distributed and variable species; the most abundant form is of a rather dingy castaneo-flavous, with somewhat paler antennae, palpi and legs; its elytral markings are seldom sharply limited, and consist of a large infuscated or blackish spot on each side of the middle, and nearer the sides than suture, but the two almost conjoined, on some specimens, so as to appear as a fairly wide median fascia, and a still more obscure apical spot; on very pale specimens the apical spot is usually wanting; on dark specimens there is usually a vague infuscation about the scutellum; the abdomen is usually pale, but on some Victorian and Tasmanian specimens is dark, and occasionally the femora are partly infuscated. The hind tibiae of the male are slightly longer than of the female, and the apical half is somewhat deflected, more noticeably on some specimens than on others. The elytral pubescence is fairly dense and not depressed, but somewhat curled. On an almost equally common form the pubescence is quite flat, the general colour is darker, the markings are less sharply defined, the median and apical spots are occasionally joined along the sides, and the abdomen and usually the metasternum is black or blackish. On these darker specimens the punctures are usually more sharply defined, although they are distinct to the apex on all the forms. Comparing pale narrow specimens with suberect pubescence and two elytral spots, with larger, wider and darker ones, with depressed pubescence and three spots, the differences certainly appear to be specific; but there are so many connecting forms that I cannot regard them as representing more than one species.

Hab.—Western Australia: Bridgetown, Darling Ranges, Beverley, Vasse River; South Australia: Adelaide, Mount Lofty, Mount Gambier, Lucindale, Port Lincoln, Port Augusta; Victoria: Forrest, Geelong, Nelson, Melbourne, Carrum, Cape Otway; Tasmania: Hobart, Jordan River.

Anthicus flavipennis, n.sp.

Dark red; elytra, legs and palpi flavous. With sparse pale pubescence, and a few upright hairs.

Head oblong-ovate, rather flat, hind angles rounded, base straight across middle, except for a very feeble median notch; with dense and sharply defined punctures, except along middle, which is shining and almost impunctate. Eyes rather small, medio-lateral and prominent. Antennae moderately long and thin. Prothorax slightly longer than wide, widest near apex, sides moderately decreasing in width posteriorly and then strongly notched at basal third, a feeble subtubercular elevation on each side of base; with dense and rather large punctures, and with a shallow median line. Elytra much wider than prothorax, shoulders slightly rounded, sides very feebly dilated in middle; with rather numerous, sharply defined punctures about base, becoming smaller and sparser posteriorly, and almost vanishing about apex. Legs, especially the hind ones, rather long and thin. Length, 4.25 mm.

Hab.—South Australia: Miller's Creek (Prof. F. Wood-Jones).

The elytra are without markings, but the species is a very distinct one on account of the coarse punctures of the head and prothorax, the elytral punctures on the basal half are all more or less sharply defined, but even at the base they are decidedly smaller than those on the prothorax. The eyes are slightly longer than the basal joint of antennae, the prothorax is slightly wider than the head; the abdomen is somewhat paler than the rest of the under surface, and its intercoxal process is gently rounded off, although the notch on the metasternum before it is acutely triangular. The type is probably a female.

Anthicus acentetus, n.sp.

♂. Pale castaneous; elytra, antennae, palpi and legs paler (more or less flavous). Elytra moderately clothed with short pale pubescence, rest of upper surface almost glabrous.

Head fairly large, rather convex, oblong-ovate, a narrow impression in middle of base, hind angles moderately rounded off; punctures not very large, but sharply defined and rather dense about eyes, smaller and sparser elsewhere. Eyes moderately large, extending about half-way to neck, medio-lateral, and prominent. Antennae rather long and thin. Prothorax distinctly longer than wide, narrower than head, sides strongly rounded in front and widest at about apical fourth, sides gently decreasing in width posteriorly, and moderately notched near base, a narrow impression traversing extreme base; with fairly dense and sharply defined punctures of moderate size, somewhat sparser along middle than elsewhere, but without a median line. Elytra rather elongate, much wider than prothorax, shoulders gently rounded, sides parallel to near apex; with dense and sharply defined punctures, decreasing in size posteriorly. Apical segment of abdomen feebly impressed along middle, and notched at apex. Legs rather long, tibiae moderately stout, the hind ones subclavate. Length, 3.25—3.5 mm.

Hab.—Western Australia: Swan River (A. M. Lea).

The colours to a certain extent approach those of *A. flavipennis,* but the head is more convex, with basal impression more distinct, eyes considerably larger, and punctures much smaller; the prothorax has very different outlines and smaller punctures, and the elytral punctures are much denser and larger; on the elytra at the base they are distinctly larger than on the prothorax, about the middle they are as large as on that segment, but they are minute about the apex. The outlines and general sculpture approach those of *A. wollastoni.*

ANTHICUS CASTANEOGLABER, n.sp.

Shining pale castaneous, legs, antennae and palpi paler. Elytra with sparse, pale pubescence, rest of upper surface glabrous.

Head briefly elliptic, base completely rounded off and not notched; with sparse and inconspicuous punctures. Eyes small, medio-lateral and prominent. Antennae thin and moderately long. Prothorax distinctly longer than wide, narrower than head across eyes, sides strongly rounded and subglobular in front, notched near base, base slightly more than half the greatest width, and with a few distinct punctures, elsewhere the punctures are sparse and minute; median line absent. Elytra rather narrow, much wider than prothorax, gently dilated about middle, shoulders slightly rounded; punctures about base moderately large and sharply defined, but not crowded, becoming sparser and smaller posteriorly, and scarcely visible on apical slope. Legs moderately long and thin. Length, 3 mm.

Hab.—South Australia: Murray River.

Like *A. glaber,* on a greatly enlarged scale, but (in addition to size) differs in having the eyes smaller in proportion, prothorax narrower at base, and elytra with sparser punctures. The intercoxal process of the abdomen is rather narrow and its tip is truncated, but the notch on the metasternum is acutely triangular.

ANTHICUS EXOPHTHALMUS, n.sp.

♀. Rather pale castaneous, legs (knees excepted), antennae and palpi paler. With very sparse pubescence, and rather numerous erect or suberect hairs.

Head subquadrate and rather strongly convex, sides almost parallel behind eyes, hind angles slightly rounded, base almost straight; with rather sparse, but mostly sharply defined punctures. Eyes small, very prominent, and distant from base. Antennae rather thin. Prothorax slightly longer than wide, slightly wider than base of head, widest near apex, the sides thence obliquely decreasing to base, with a narrow transverse impression at extreme base; with fairly dense and moderately large, sharply defined punctures. Elytra much wider than prothorax, shoulders slightly rounded, sides feebly dilated to middle; punctures about base slightly larger than on prothorax but less crowded, becoming smaller posteriorly, and almost absent from about apex. Sterna with punctures as on prothorax. Legs moderately long. Length, 2.25—2.5 mm.

Hab.—Queensland: Winton (A. M. Lea).

An entirely pale species, but readily distinguished from *A. dubius, A. glaber,* and *A. pallidus* by the longer and more convex prothorax, with much coarser punctures, which are more than twice as large as on *dubius* and *pallidus,* and still larger than on *glaber*; the elytral punctures are also decidedly larger and sparser, and more noticeably decrease in size and density posteriorly, and the clothing is longer and less depressed. The base of the head is notched, but the notch is very feeble and invisible from above, although fairly distinct from oblique directions; the distance between the eyes and base of antennae is about one-third of that between them and the base of head. The elytra are slightly paler than the head and prothorax.

Anthicus ambulans, n.sp.

Pale flavous, parts of sterna and of abdomen infuscated. With sparse, pale pubescence.

Head oblong ovate, hind angles strongly rounded off, base not notched; punctures sharply defined but not very dense or large. Eyes small, prominent and medio-lateral. Antennae rather thin. Prothorax slightly longer than the greatest width, which is near apex, where the sides are strongly rounded, and the width of head, rather strongly notched near base, which is about half the greatest width; punctures much as on head; median line well-defined on basal half, but vanishing beyond the middle. Elytra elongate-elliptic, shoulders completely rounded off; punctures rather sharply defined, but not crowded on basal half, vanishing posteriorly. Legs rather long and thin. Length, 1.6—1.9 mm.

Hab.—Victoria: Birchip (J. C. Goudie, No. 298).

A minute, pallid species, differing from *A. glaber, A. pallidus* and *A. dubius* in being smaller, in the prothorax more strongly narrowed to base, and shoulders completely rounded off. Wings are present, but they are long, thin and without venation (strap-like), totally useless for flight; the wings of the three other species named are fully developed. On one of the specimens examined there are some irregular black spots on the abdomen, but they are probably accidental, or post-mortem ones.

Anthicus expallidus, n.sp.

Pale flavous, elytra and legs very pale. Clothed with very short pubescence.

Head short and moderately convex, hind angles rounded off, base not notched; punctures minute. Eyes large, extending to near base. Antennae partly moniliform. Prothorax rather flat, wider than long, widest near apex, sides obliquely decreasing to a rather deep sub-basal notch, and then less strongly decreasing to base, a rather wide depression near base and a narrow impression at base; punctures much as on head; median line very feeble and not continuous. Elytra somewhat abbreviated, much wider than prothorax, shoulders moderately rounded, sides almost parallel to near apex; punctures moderately dense about base, but small and not very sharply defined, vanishing posteriorly. Legs not very long. Length, 2.25 mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea).

A pale, depressed species, about the size of *A. dubius* and *A. pallidus*, but with much larger eyes, which extend more than half-way to base, those of the species named extending less than half-way; the prothorax is also decidedly shorter and wider (quite as short in proportion as in species of the *A. brevicollis* group). From some directions the base of the prothorax appears to have two very feeble tubercles. The type has the abdomen quite as pale as the elytra; on a second specimen, except at its tip, it is blackish, and the metasternum is almost as dark.

Anthicus phaenithon, n.sp.

♂. Pale flavo-castaneous, legs and antennae paler. Moderately clothed with very short, pale pubescence.

Head subquadrate, hind angles moderately rounded off, base moderately notched in middle; punctures small; a feeble longitudinal impression each side in front. Eyes rather small and very prominent. Antennae moderately long and rather thin. Prothorax flat; longer than wide; sides moderately rounded in front, thence oblique to base, with very small punctures. Elytra thin, much wider than prothorax, not quite covering abdomen, shoulders feebly rounded, almost parallel-sided to near apex; with dense and small, but rather sharply defined punctures, becoming very minute posteriorly. Femora moderately stout, the hind ones longer than the others and more clavate, hind tibiae rather short and stout, the front ones notched at about one-third from apex on under surface. Length, 2.5—2.75 mm.

♀. Differs in having thinner and simple front and hind tibiae, and thinner front tarsi.

Hab.—South Australia (Macleay Museum), Quorn (A. H. Elston).

Probably belongs to the subgenus *Micranthicus*; from *M. pulcher* it is distinguished by its larger head with smaller eyes, and by the apparently uniformly coloured elytra which, on close examination, are seen to be slightly darker in the middle than at base or apex, but on *pulcher* there are two distinctly pale bands, alternating with darker ones, the punctures also are more distinct than on that species. It is about the size of *A. pallidus* and *A. dubius,* but is flatter, prothorax with sides (as seen directly from above) evenly oblique to base, instead of curved, punctures of prothorax and elytra smaller, eyes larger, and legs different. The prothorax is decidedly longer than on *A. expallidus,* and the eyes are considerably smaller. From some directions the prothorax appears to be almost triangular, with its base quite even, but from others a faint subbasal depression may be seen. The hind tibiae of the male from one direction appear to be of only moderate width and notched (or feebly incurved at the middle) on one side, but when viewed at right angles to be rather strongly dilated near the apex, with the upper surface of the dilated portion grooved for the reception of the basal joints of tarsi. Two females from North Western Australia (Fortescue River, W. D. Dodd) appear to belong to this species, but have a somewhat dingier appearance, and the base of the head is more feebly notched.

Anthicus homalinotus, n.sp.

Pale castaneo-flavous, elytra and legs still paler. Sparsely and minutely pubescent.

Head short, hind angles slightly rounded, base feebly notched in middle, punctures sparse and small, but more numerous and distinct (although not large) on a large feeble depression in front. Eyes rather large, extending slightly more than half-way to base. Antennae moderately long, partly moniliform. Prothorax flat, slightly longer than wide, widest near apex, where the sides are strongly rounded, thence oblique to a notch near base, a shallow depression near base, two very feeble tubercles at base; punctures sparse and minute, but more numerous about base than elsewhere. Elytra much wider than prothorax, leaving part of abdomen exposed, shoulders gently rounded, sides almost parallel; punctures fairly distinct about base, but very indistinct elsewhere. Inter-coxal process of abdomen short and rounded off. Legs moderately long. Length, 2—2.25 mm.

Hab.—Queensland: Townsville (H. H. D. Griffith, from F. P. Dodd).

An unusually pale, flat species, close to *A.* (*Micranthicus*) *pulcher,* but even more fragile-looking, and elytra entirely pale, becoming almost transparent posteriorly; the head is also larger. On the type the sterna are as pale as the legs, and the sides of the abdomen are deeply infuscated, but on a second specimen the sterna and abdomen are of the same shade as the prothorax. From some directions the frontal depression on the head, and its punctures, are scarcely visible, but from others it is quite distinct, and its punctures are sharply defined; on the type it is vaguely connected with the medio-basal notch, but on the other specimen the connection cannot be traced.

Anthicus dolichoderes, n.sp.

Pale castaneo-flavous, elytra still paler, apical half of femora slightly infuscated, the metasternum and most of abdomen more deeply so. Sparsely and minutely pubescent.

Head moderately long and subovate, hind angles rather strongly rounded, base not notched; with fairly numerous small punctures, more sharply defined near eyes than elsewhere; median line feeble, a vague oblique impression each side in front. Eyes prominent and rather small, not extending half-way to base. Antennae moderately long. Prothorax much longer than wide, apical two-thirds with sides strongly and almost evenly rounded, notched near base, two feeble elevations at base; with fairly dense and sharply defined punctures near base, sparser and smaller elsewhere. Elytra much wider than prothorax, shoulders gently rounded, sides dilated posteriorly and rather wide near apex, leaving much of abdomen exposed; punctures fairly dense and distinct about base, but feeble elsewhere. Legs moderately long. Length, 3 mm.

Hab.—Western Australia: Cue (H. W. Brown).

A brachy-elytrous species, readily distinguished from others of the subgenus *Micranthicus* by its larger size, and much longer and differently-shaped prothorax. The intercoxal process of the abdomen is short and distinctly rounded off; there is a feeble infuscation about the base of the elytra, and a still more feeble one (scarcely visible) about apex.

Anthicus pubipennis, n.sp.

Black or blackish; under surface, legs and antennae of a more or less dull red, palpi paler. Elytra rather densely clothed with short, suberect pubescence, sparser and shorter on head and prothorax.

Head moderately long, subovate, hind angles and base rounded off, the latter not notched; with small, crowded punctures. Eyes small and medio-lateral. Antennae moderately long. Prothorax slightly longer than wide, almost as wide as head across eyes, front angles moderately rounded, sides oblique to a sub-basal incurvature; punctures as on head. Elytra much wider than prothorax, shoulders gently rounded, sides feebly dilated to beyond the middle; with crowded but mostly sharply defined punctures, becoming smaller posteriorly, but traceable even at apex. Intercoxal process of abdomen short, narrow and rounded. Legs moderately long. Length, 2.25—2.5 mm.

Hab.—Queensland: Stewart River (W. D. Dodd), Cairns District (A. M. Lea), Townsville, under seaweed (F. E. Wilson from G. F. Hill).

A black opaque species in general appearance and with outlines much as in *A. inornatus*, but darker, prothorax without median line and not subtuberculate at base. The elytral pubescence in most lights appears greyish, but in some it has a distinct golden-green gloss. The elytral punctures are larger than on the rest of the upper surface and, although small and crowded, are mostly sharply defined; they are much the same on the metasternum and abdomen. The apical half of the femora is slightly darker than the basal half. On two specimens the vague remnant of a median line may be seen on the front of the head, but not on two others.

ANTHICUS MELAS, n.sp.

Black, shining; base of femora, tibiae and tarsi more or less reddish.

Head moderately long, sides parallel from eyes to hind angles, which are gently rounded off, base scarcely visibly notched in middle, a few fairly distinct punctures about a feeble impression each side in front, elsewhere very feeble. Eyes small, prominent and much nearer antennae than base. Antennae feebly dilated towards apex. Prothorax slightly longer than wide, front sides dilated and about one-third wider than base, incurved near base; punctures scarcely traceable. Elytra much wider than prothorax, shoulders gently rounded, sides almost parallel to near apex; with rather dense and small punctures, fairly sharply defined about base, but becoming indistinct posteriorly. Legs rather thin. Length, 2 mm.

Hab.—Western Australia: Vasse River (A. M. Lea).

With small eyes distant from base, and general outlines of *A. demissus* and *A. glaber*, but body parts entirely black; the outlines are also somewhat as on *A. inornatus* and *A. pubipennis*, but those species are opaque. The intercoxal process of the abdomen is short and thin, with its tip rounded off, although at the first glance it appears to be triangular.

ANTHICUS POST-TIBIALIS, n.sp.

Flavous, apical three-fourths of elytra black, abdomen infuscated. Upper surface almost glabrous.

Head round and rather strongly convex, hind angles completely rounded off; a few small punctures in front, but elsewhere without any. Eyes small, medio-lateral and prominent. Antennae moderately long. Prothorax slightly longer than wide, rather convex, sides rather strongly rounded on apical half and suddenly incurved near base; almost impunctate. Elytra much wider than prothorax, shoulders gently rounded, sides almost parallel to near apex, a feeble transverse depression near base; punctures sparse and minute. Intercoxal process of abdomen short and obtusely pointed. Hind tibiae stout. Length, 2.25 mm.

Hab.—Northern Territory: Darwin (W. D. Dodd).

Very distinct by the hind tibiae, which are almost twice as stout as the middle ones, and quite as stout as their supporting femora, the hind tarsi are also decidedly wider than usual. The two colours of the elytra are sharply contrasted, the hind femora and tibiae, middle tibiae and front knees are darker than the rest of the legs. The antennae are thin, with the maximum width of each joint, after the first, almost equal throughout, no joint being distinctly transverse, although the seventh—tenth are each about as wide as long. The type is probably a male.

A specimen from Queensland (Cairns, F. P. Dodd), which is certainly a female (its ovipositor with two terminal setae is protruding) possibly belongs to this species; its hind tibiae are even stouter (they are slightly stouter than their supporting femora), and the antennae are distinctly shorter and wider, the joints after the second slightly but regularly increase in width, with the eighth-tenth distinctly transverse, and beyond the fourth they are distinctly infuscated (entirely pale on the type), the head and prothorax are of a dingy but rather pale red, and the base of the elytra is but obscurely paler than the rest, the transverse impression near its base is rather deeper, and on each side of the base there is a distinct subtubercular elevation, which is much more feeble on the type, the legs are also darker than on the type.

ANTHICUS ELECTILIS, n.sp.

♂. Flavous, elytra (except basal fourth) and abdomen black, head slightly infuscated. Elytra sparsely pubescent and with a few hairs, but with a conspicuous band of silvery pubescence where the two colours meet.

Head subglobular, hind angles and base completely rounded off; densely granulate-punctate between eyes, punctate only at base. Eyes large and mediolateral. Prothorax distinctly longer than wide, distinctly narrower than head, apical two-thirds with strongly rounded sides, strongly notched near base, with a rather wide depression connecting the notches, median line distinct near apex, and again near base; punctures sparse and inconspicuous. Elytra much wider than prothorax, shoulders gently rounded and oblique inwardly, sides moderately inflated to beyond the middle, with a conspicuous transverse depression near base, on each side of base a prominent subtubercular elevation; punctures sparse and inconspicuous. Intercoxal process of abdomen briefly triangular. Legs rather long, hind femora subclavate, hind tibiae distinctly longer and somewhat thicker than the middle ones, front tibiae slightly dilated on under surface to apical third, and then more strongly narrowed to apex. Length, 2.75 mm.

Hab.—Northern Queensland (Blackburn's collection).

As the femora are stout, but less conspicuously clavate than is usual in *Formicomus,* the body winged, and the intercoxal process of abdomen somewhat triangular, it seems desirable to refer the species to *Anthicus* rather than to *Formicomus*; it appears to connect the former genus (by way of the *A. unifasciatus* group) with the latter (by way of the *F. agilis* group). The colours of the type are somewhat as on the type of the preceding species, but the head is larger, more globular, the inter-antennary space very different, eyes much larger, prothorax longer, elytra more dilated, and hind tibiae much longer and thinner (although stouter than on many species of the genus). The subtubercular elevations at the base of the elytra are quite distinct from above, and very conspicuous from the sides. The two basal joints of the antennae are flavous, the others are missing from the type.

A female (from Cairns) evidently belonging to this species, differs from the type in having the upper surface black, except that the bases of the prothorax and of elytra are very obscurely diluted with red, but the band of silvery pubescence is quite as distinct; its legs are blackish, with the coxae, tarsi and part of the middle tibiae flavous, and the base of the middle femora almost white; its hind legs are somewhat shorter, and front tibiae not dilated near apex; its antennae are long, with the three apical joints black and wider than the others (so that they appear to have a loose, three-jointed club), the tip of the eighth joint and the base of the first are also infuscated.

ANTHICUS BILOBICEPS, n.sp.

Reddish-castaneous, legs somewhat paler, elytra blackish, the apex and a large spot on each shoulder reddish. Elytra with rather dense and short, pale pubescence, rest of upper surface sparsely clothed.

Head subovate, sides behind eyes parallel to near base, hind angles moderately rounded, base distinctly bilobed; with rather dense punctures, of moderate size and sharply defined. Eyes of moderate size, not extending half-way to base. Antennae rather long and thin, none of the joints transverse. Prothorax distinctly longer than wide, slightly narrower than head, decidedly convex, sides strongly rounded in front, becoming oblique towards base, very feebly notched near base; punctures much as on head. Elytra flat, much wider than prothorax, shoulders slightly rounded, sides almost parallel to near apex, punctures dense and sharply defined, becoming smaller but still distinct posteriorly. Intercoxal process of abdomen briefly triangular. Legs moderately long. Length, 3.5—3.75 mm.

Hab.—Queensland: Cunnamulla (H. Hardcastle).

The two main colours are those of *A. floralis,* from which the species differs in having the elytra longer, more parallel-sided, with the tips less rounded, and the punctures and clothing much denser; the prothorax is longer, with the subbasal incurvature much less pronounced and the antennae longer and thinner. The punctures at the base of the elytra are slightly larger and considerably denser than on the prothorax; the spots on the shoulders occupy about two-thirds of the width of the base. As the abdomen curves to its tip, and the front tarsi are rather wide, the three specimens under examination are probably males.

Anthicus modicus, n.sp.

Pale flavo-castaneous, legs paler but knees infuscated, elytra partly dark. Upper surface with short, pale pubescence, more distinct on elytra than elsewhere.

Head moderately large, parallel-sided behind eyes to near base, hind angles slightly rounded, base bilobed; with fairly dense and rather sharply defined but not very large punctures, sparser along middle than elsewhere. Eyes rather small, prominent, and much nearer antennae than base. Antennae rather long and partly moniliform. Prothorax longer than wide, greatest width near apex, where the sides are subangularly dilated, slightly wider than the base of head, and almost twice the width of base; punctures rather dense and small, but sharply defined. Elytra much wider than prothorax, shoulders slightly rounded, sides parallel to near apex; with coarse, crowded, asperate punctures about base, rapidly becoming smaller and sparser, and very minute on apical fourth. Intercoxal process of abdomen briefly triangular. Legs moderately long. Length, 2.75 mm.

Hab.—North Western Australia (Macleay Museum).

About the size of *A. floralis,* and with somewhat similar outlines, but at once distinguished by the much coarser elytral punctures, these being almost as coarse as on *A. semipunctatus* (which has the prothorax much narrower and hind tibiae of male armed). At first glance it looks like some of the paler forms of *A. wollastoni,* but the elytral punctures are slightly coarser at the base, and more rapidly decrease in size, and the markings are very different; it also resembles *A. bilobiceps,* but has much coarser elytral punctures, prothorax shorter, etc. The two colours of the elytra are distinct but not sharply limited; the dark part commences as a subtriangular infuscation about the scutellum and is continued along the suture to the middle when it is suddenly dilated (and becomes much darker) so as almost to touch the margins, but about the tips the colour becomes a dingy red; the abdomen is partly infuscated. As the front tarsi are rather wide the type is probably a male.

Anthicus sordidus, n.sp.

Of a pale, dingy, reddish-castaneous, legs and antennae paler, head and abdomen infuscated. Upper surface with very short pubescence, more conspicuous on elytra than elsewhere.

Head moderately long, hind angles and base completely rounded off; with dense and rather small, but sharply defined punctures. Eyes small, prominent, and much nearer antennae than base. Antennae rather long. Prothorax longer than wide, widest near apex, where the width is slightly more than that of head, and almost twice that of base; with dense punctures, slightly larger than on head. Elytra much wider than prothorax, shoulders slightly rounded, sides almost parallel to near apex; with dense punctures, at base about as large as on prothorax, but rather less crowded, and becoming gradually smaller, till at the apex they are much smaller but still quite distinct. Intercoxal process of abdomen briefly triangular. Legs moderately long. Length, 2.5 mm.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt).

At first glance like some of the smaller specimens of *A. wollastoni,* but head not notched or bilobed at base, prothorax more dilated in front, more strongly narrowed to base, and with denser punctures. In some lights a very faint infuscation or very feeble fascia may be seen across the middle of the elytra. As the front tarsi are rather wide the type is probably a male.

ANTHICUS INSIGNICORNIS, n.sp.

♂. Of a rather dingy flavous, legs paler, elytra with an infuscated median fascia and usually a subapical spot, occasionally the markings conjoined. Rather densely clothed with pale pubescence, and with some rather short, upright hairs.

Head rather short, hind angles rather strongly rounded, base feebly incurved to middle but hardly notched; in front with fairly numerous small but sharply defined punctures, less distinct elsewhere. Eyes rather large, hardly more distant from base than from antennae. Antennae with basal joint moderately long, second to sixth small, seventh almost as long as three preceding combined and much wider, ninth slightly shorter than seventh, slightly longer than eighth and distinctly longer than tenth, eleventh at base as wide as the preceding joints, and about as long as the ninth. Prothorax rather short, sides strongly rounded in front and notched near base; with dense and sharply defined punctures of moderate size. Elytra much wider than prothorax, shoulders rather strongly rounded, sides moderately dilated to beyond the middle; punctures about base slightly larger than, but scarcely as dense as on prothorax, becoming smaller posteriorly, but everywhere sharply defined. Intercoxal process of abdomen narrow and subtriangular. Legs thin but not very long. Length, 2.25—2.5 mm.

♀. Differs in having the joints of antennae very feebly and regularly increasing in width from near the base.

Hab.—Queensland: Cairns district (F. P. Dodd, C. J. Wild, and A. M. Lea), Port Douglas (Wild).

At first glance apparently a small species of the *A. brevicollis* group, but the five apical joints of the male are unusually large, and distinctive from all other Australian members of the family; on two of them the two apical joints are black. The median fascia of the elytra is rather wide, it is sometimes hardly more than a slight infuscation terminated before the margins, but on some specimens is much darker, extends right to the margins, and the margins themselves are narrowly dark almost to the apex; the suture in front of and behind the fascia is usually narrowly infuscated, and the infuscation is sometimes enlarged to a subapical spot; on one female the elytra, except for a large spot on each shoulder, are entirely dark. Seven of the specimens, all males, were removed from sticky seeds of *Pisonia brunoniana.*

ANTHICUS SUBQUADRATICOLLIS, n.sp.

Reddish-castaneous, legs and antennae slightly paler, elytra flavous with a large, circular subapical spot, and the margins from about the middle to near the apex black or blackish, the markings sometimes conjoined. Upper surface with short, pale pubescence, indistinct on head and prothorax.

Head subtriangular, hind angles rather prominent but rounded off, base rather strongly incurved to middle; with dense and sharply defined punctures, but almost absent from a shining median line on apical half. Eyes fairly large, extending more than half-way to base. Antennae moderately long and submoniliform. Prothorax slightly longer than wide, apical angles less rounded than usual, sides regularly and (for the genus) rather feebly diminishing in width posteriorly, notched at extreme base; punctures much as near base of head. Elytra much wider than prothorax, shoulders moderately rounded, sides parallel to near apex; punctures much as on prothorax, becoming smaller, but still sharply defined posteriorly. Intercoxal process of abdomen narrow and triangular. Legs moderately long. Length, 1.75—2.5 mm.

Hab.—Queensland: Townsville (A. M. Lea).

A subopaque species (owing to very fine shagreening), at first glance apparently of the *A. brevicollis* group, but prothorax less strongly narrowed posteriorly than is usual in the genus, so that its base is hardly one-third narrower than its apex. Excluding the eyes, the head appears conspicuously triangular, its median line is distinct in front on all the specimens, and on some of them is traceable, but very narrow, to the base. The smaller specimens have the front tarsi wider, and the apical segment of abdomen less evenly convex than on the larger ones, and are probably males; one of them has the abdomen rather deeply infuscated. I know of no closely allied species.

ANTHICUS EMINENS, n.sp.

Black; head and under surface dark red, coxae and tarsi flavous, antennae dull red, the basal and some of the apical joints blackish or deeply infuscated. Moderately clothed with not very short pubescence, and with numerous long, suberect hairs; the elytra with two pubescent fasciae (the derm beneath them somewhat reddish): one near the base, the other beyond the middle.

Head rather short, hind angles strongly rounded, base straight in middle; with crowded and somewhat asperate punctures. Eyes rather small and very prominent, distinctly nearer antennae than base. Antennae moderately long. Prothorax longer than wide, more convex than usual, sides strongly rounded near apex and strongly narrowed to base, distinctly notched near base; with crowded punctures, somewhat rougher than on head. Elytra much wider than prothorax, shoulders gently rounded, sides feebly dilated to beyond the middle, with a transverse depression (supporting the first fascia) near base; punctures moderately large and sharply defined even at apex, but much less crowded than on prothorax. Intercoxal process of abdomen narrow and triangular. Legs moderately long. Length, 2.5 mm.

Hab.—Queensland: Coen River (W. D. Dodd).

With two pubescent fasciae on the elytra much as on *A. bryanti*, but head and prothorax with much coarser punctures, elytra with sharply defined ones (on *bryanti* they are much sparser and scarcely visible), head entirely red, etc. The head and prothorax are opaque; from some directions the hind angles of the former appear to be shining, owing to the punctures there being sparser than elsewhere. On a second specimen the prothorax is of the same dull red colour as the head.

ANTHICUS ACANTHODERES, n.sp.

Dark red, antennae, palpi and legs paler, prothorax blackish, elytra with a black median fascia. Elytra moderately densely clothed with suberect, pale pubescence, sparser and depressed elsewhere.

Head (excluding eyes) subtriangular, hind angles moderately rounded, base distinctly bilobed; with a narrow, shining, continuous median line, ending in a basal notch; with crowded but rather sharply defined punctures. Eyes small, very prominent, distant from base. Antennae thin but not very long, submoniliform. Prothorax longer than wide, each side (at its widest) with an acute tubercle projecting outwards at right angles, a short distance behind it a feeble angulation, and then strongly narrowed to near base; punctures even more crowded than on head; with a vague trace of a median line near base. Elytra much wider than prothorax, shoulders gently rounded, sides parallel to beyond the middle; with dense (but not crowded) sharply defined punctures, becoming smaller posteriorly, but distinct even at apex. Intercoxal process of abdomen briefly triangular. Legs moderately long. Length, 2.75 mm.

Hab.—Queensland: Cunnamulla (H. Hardcastle).

Readily distinguished from all other Australian species of the genus except *A. scabricollis, A. tridentatus* and *A. scydmaenoides* by the conspicuously armed prothorax. From *scabricollis* and *scydmaenoides* it is distinguished by the unifasciate elytra, with square shoulders and from the description of *tridentatus* by the unifasciate elytra and prothorax with less than three tubercles on each side. In some lights the elytral pubescence appears golden.

ANTHICUS TRIVITTIPENNIS, n.sp.

Piceous-brown, head black or blackish, under surface usually paler than prothorax; elytra flavous, its base, apex, sides, suture and a dilated postmedian spot (or abbreviated fascia) on the suture more or less deeply infuscated; antennae with basal half or less flavous, the rest infuscated; palpi and legs flavous, the knees slightly infuscated. Elytra rather densely clothed with short, pale pubescence, rest of upper surface almost glabrous.

Head rather short, hind angles moderately rounded off, base bilobed; surface very finely shagreened and with rather distinct but irregularly distributed punctures. Eyes large, extending more than half-way to base. Antennae rather thin, none of the joints (except the ninth and tenth in the female) transverse. Prothorax flat, sides strongly rounded near apex, and oblique (with a moderate subbasal incurvature) to base, median line faintly impressed; surface shagreened, and with rather dense but not sharply defined punctures. Elytra much wider than prothorax, shoulders slightly rounded, sides gently dilated to beyond the middle; with fairly dense and sharply defined punctures, of moderate size near base, becoming indistinct posteriorly. Intercoxal process of abdomen acutely triangular, apical segment smaller and less evenly convex in male than in female. Legs moderately long. Length, 3.25—4 mm.

Hab.—Queensland: Cairns (E. Allen).

A flat species with head and prothorax opaque and elytral markings longitudinal; it is not close to any other described Australian one, but some specimens strikingly resemble *Dromius humeralis* (of the Carabidae) in miniature. Of seven specimens taken by Mr. Allen six have the postmedian enlargement of the sutural infuscation rather large, and with faint infuscations connecting it with the dark margins, and three of these have the apical infuscation more extensive than on the other three; the seventh specimen has the elytra dark (almost black), except for a large, round, flavous spot on each side near the apex.

ANTHICUS TRICOLORICORNIS, n.sp.

Reddish-castaneous; elytra flavous, with a rather narrow, blackish, median fascia not quite touching suture or sides; legs pale flavous, femora partly infuscated; antennae with basal joints reddish, the median ones blackish, the apical ones whitish. Elytra with fairly dense, subdepressed, pale pubescence, and with numerous erect hairs, rest of upper surface with sparser pubescence and shorter hairs.

Head short and convex, hind angles strongly rounded, base not notched; punctures sparse and scarcely visible. Eyes moderately large almost as near base as antennae. Antennae rather long, fifth and sixth joints moderately transverse, seventh to ninth strongly so. Prothorax longer than wide, sides of apical two-thirds strongly rounded and much wider than basal third, near base strongly constricted, the constriction continuous across disc; with distinct punctures in constriction, but sparse and small elsewhere. Elytra convex, elliptic-ovate, shoulders completely rounded off, near middle fully twice the width of prothorax; punctures sharply defined but nowhere dense, of moderate size near base, becoming smaller posteriorly. Intercoxal process of abdomen rather narrow and subtriangular. Legs moderately long. Length, 2.25 mm.

Hab.—Queensland: Mount Tambourine (A. M. Lea).

A beautiful and apparently apterous species, which possibly should have been referred to *Tomoderus*, but as there is no trace of a median line on the prothorax it was considered better to place it in *Anthicus*; the elytra are fasciate as in the description of the Tasmanian *T. vinctus*, but the antennae are tricoloured, and prothorax different. The three colours of the antennae are very distinct, but not sharply limited, thus the two apical joints are almost white, but the ninth is rather pale at its tip, and the fourth has its tip infuscated.

A second specimen (from Cooktown, H. J. Carter) differs from the type in being somewhat wider, elytra slightly infuscated at the base, its median fascia wider (but also not touching suture or sides) and punctures larger, denser and much more sharply defined; antennae with three apical joints entirely pale, and femora not infuscated.

ANTHICUS HERUS, n.sp.

Black or dark piceous-brown, elytra with two flavous fasciae, metasternum, part of abdomen, legs (femora sometimes deeply infuscated or blackish, except at base) and antennae dark reddish, tarsi and palpi paler. Elytra with rather dense and short, pale pubescence, shorter and less distinct on rest of upper surface.

Head rather short, hind angles and base gently rounded, the latter not notched; with crowded, asperate punctures, but leaving a narrow, shining median line. Eyes rather large and prominent, extending more than half-way to base. Antennae rather long, ninth and tenth joints feebly transverse. Prothorax slightly longer than greatest width, sides strongly rounded and widest near apex, where they are fully twice as wide as base, and slightly wider than head across eyes, strongly incurved near base; punctures much as on head. Elytra elongate, much wider than prothorax, shoulders moderately rounded, sides almost parallel to near apex; with crowded but sharply defined punctures, becoming smaller posteriorly. Intercoxal process of abdomen triangular. Legs rather long, the hind ones longer than the others, femora stout, especially the front pair. Length, 3.75–4.5 mm.

Hab.—Queensland: Townsville (F. P. Dodd).

A large, flat, opaque species; to the naked eye, on account of the elytral markings, suggestive of a greatly enlarged form of *A. myrteus,* but not even close to that species. Of the pale elytral fasciae the first, ending at the basal third, appears to be of the nature of two isosceles triangles, fairly wide on the sides and narrowed towards the suture, which they do not reach; the space between them and the base in consequence is widely triangular (on two specimens it is of a dark dingy red); the second fascia is at the apical third, very feebly curved, terminated before the sides and very narrowly interrupted at the suture. The punctures on the under surface of the head and prothorax are even coarser than on the upper surface; the elytral punctures at the base are not quite as large as those on the prothorax, but they are more sharply defined. The male differs from the female in having the head and prothorax smaller, abdomen smaller and less evenly convex, with the apical segment shorter, and its tip incurved, the front femora are stouter (although they are very stout in the female) and the front tarsi are a trifle wider.

Anthicus imitator, n.sp.

Deep shining black, two elytral fasciae, coxae and tarsi flavous, or reddish-flavous. Elytra moderately clothed with short, ashen pubescence, rest of upper surface more sparsely clothed.

Head subovate, quite semicircular beyond eyes, base not notched; with fairly dense and sharply defined punctures of moderate size, sparser along middle than elsewhere. Eyes moderately large, medio-lateral and very prominent. Antennae rather long and thin. Prothorax slightly longer than wide, sides strongly rounded in front, where the width is about equal to that of head across eyes, and is almost twice that of base, strongly constricted near base, the constriction traceable across disc; punctures much as on prothorax, but more crowded and less sharply defined in sub-basal depression, median line traceable as a narrowly impressed line towards base, as a slightly shining one towards apex. Elytra much wider than prothorax, shoulders moderately rounded, sides almost parallel to near apex, feebly transversely impressed near base; punctures sharply defined, rather dense, but not crowded near base, becoming smaller posteriorly. Intercoxal process of abdomen obtusely pointed. Length, 3—3.5 mm.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt), Port Lincoln (Rev. T. Blackburn), Kangaroo Island (J. G. O. Tepper); Western Australia: Beverley (E. F. du Boulay), Swan River (A. M. Lea).

A deep black species with elytral markings approaching those of *A. myrteus,* although the pale fasciae occupy a smaller proportion of the elytra, but much larger, prothorax longer and with more distinct punctures, and even the antennae black; from *A. herus,* which has very similar fasciae, it differs in being smaller, shining, less flat, with much smaller and more sharply defined punctures. In general appearance it resembles some of the dark forms of *A. hesperi* on an enlarged scale, but the shape is more elongate, the head is smaller in proportion, more rounded at the base, with smaller and more prominent eyes, etc. The elytral fasciae vary in size and intensity, the first ends in a straight line at the basal third with its sides almost touching the base and narrowed to the suture (which is not reached); as a result the black basal space is widely triangular; the second fascia is post-median, narrowly interrupted at the suture and not touching (sometimes rather distant from) the sides. The sexual differences of the abdomen and legs are slight.

ANTHICUS MACELLUS, n.sp.

Of a rather pale red, head somewhat darker, abdomen deeply infuscated, elytra blackish, with four large, flavous spots, placed so as to form two interrupted fasciae, legs and palpi flavous. With very short, pale pubescence, more distinct on elytra than on the rest of the upper surface.

Head long, hind angles and base moderately rounded, the latter not notched; with a feebly shining and narrow median line. Eyes small, medio-lateral and prominent. Antennae long and thin. Prothorax considerably longer than wide, sides strongly rounded near apex, and strongly incurved near base, base about two-thirds the width at the dilated sides, with two very feeble elevations; median line faintly impressed and short. Elytra much wider than prothorax, shoulders gently rounded, sides feebly dilated to beyond middle; punctures scarcely visible. Legs rather long and thin. Length, 2 mm.

Hab.—Northern Queensland (Blackburn's collection).

An unusually narrow, depressed species, with head, prothorax and part of elytra opaque, owing to density of minute punctures, these being scarcely visible under a hand lens. The elytral spots are shaped much as on *A. strictus*, but the sub-basal ones are posthumeral instead of humeral; the two species, however, have little in common. The sub-basal spots are dilated outwardly and touch the sides but not the suture, and are scarcely triangular, the space between them and the base is of a dingier red than the head, beyond them the derm is of a rather shining black, the postmedian spots are large, of irregular shape, and are narrowly separated at the suture; near them on the sides the derm is pale, so that, from directly above, there appear to be four postmedian spots, appearing as a thrice interrupted fascia.

ANTHICUS JUCUNDUS, n.sp.

Piceous-red or piceous-brown, elytra with two flavous fasciae, parts of femora and of tibiae deeply infuscated or blackish, rest of legs paler. Rather sparsely pubescent, and with dark, straggling hairs.

Head subovate, rather convex, hind angles and base strongly rounded, the latter not notched; with small but rather sharply defined punctures, sparse on basal half, more numerous and in parts dense, but not crowded in front. Eyes rather small, very prominent, and distant from base. Antennae long and thin. Prothorax longer than wide, sides dilated and strongly rounded near apex, strongly notched near base; with dense and sharply defined punctures of moderate size. Elytra elongate-elliptic, base very little wider than head across eyes, shoulders strongly rounded, sides moderately dilated to about the middle, a shallow transverse impression near base; with dense and fairly large punctures about base, about as large on black median portion as on prothorax, but much less crowded and becoming smaller but still sharply defined about apex. Intercoxal process of abdomen acutely triangular. Legs moderately long. Length, 3—3.25 mm.

Hab.—Tasmania: St. Patrick's River (Aug. Simson), Bruni Island (A. M. Lea); Victoria (Blackburn's collection).

In general appearance approaches some forms of *A. pallipes*, but the prothorax is wider, with coarser punctures, front sides not conspicuously shining, and the elytra with shoulders more rounded off. From *A. rarus* and all its varieties it is distinguished by the larger prothorax with much denser punctures, and by the sub-basal depression on the elytra, the elytra are also smaller in proportion, with less prominent shoulders, and cover but small remnants of wings, quite useless for flight. On one specimen the head and dark parts of elytra are almost black. Of the elytral fasciae the first occupies, but is not confined to, the sub-basal depression, being dilated on the sides (the dark basal space in front of it is triangular about the scutellum, and notched on each side before the shoulder); the second fascia is at the apical third, is not interrupted by the suture, and on two specimens is connected by a narrow sutural vitta with the apex; as a result on these the elytra appear to have a large dark spot on each side of the apex; these specimens also have the margins of the elytra narrowly pale throughout. The male differs from the female in having the abdomen smaller, its tip with a small triangular notch, the antennae and legs slightly longer, and the front tarsi somewhat dilated.

ANTHICUS MACROPS, n.sp.

Dark chocolate-brown, head and abdomen almost black, prothorax obscurely reddish at base, elytra with a whitish sub-basal fascia; antennae flavous, the apical joints infuscated; legs slightly infuscated, the coxae and tarsi paler. Elytra with very short, sparse, depressed pubescence; rest of upper surface glabrous or almost so.

Head almost circular, hind angles and base evenly rounded, the latter not notched; punctures minute and sparse, scarcely visible on basal half. Eyes large, scarcely more distant from base than from antennae. Antennae moderately long, eighth to tenth joints slightly transverse. Prothorax strongly dilated near apex, strongly constricted near base; with a transverse, sub-basal depression, containing rather dense and sharply defined punctures, elsewhere very minutely punctate; a feeble elevation on each side of base. Elytra with shoulders slightly rounded, sides gently dilated to beyond the middle, where the width is fully twice that of the widest part of prothorax; punctures sparse and very minute. Intercoxal process of abdomen short and obtuse. Legs moderately long. Length, 2.25 mm.

Hab.—Queensland: Emerald (A. M. Lea).

A second specimen (from Dalby, Mrs. F. H. Hobler) is paler than the type, its head and abdomen are no darker than the dark parts of the elytra, and its prothorax is of a dingy red, becoming paler at the base. The intercoxal process is not triangular, although it appears so at first glance, as the metasternum in front of it is triangularly notched. The sub-basal fascia is rather narrow, terminates just before the basal third, and is slightly longer than the dark space in front of it. The species is structurally close to a bifasciate one identified by King as *A. comptus*, but has a single elytral fascia as on many other species, which although at first glance apparently all forms of one, are really structurally distinct, and their more salient features may be briefly noted as follows:—

A. unifasciatus King. Eyes of moderate size and prominent, base of head evenly rounded.

A. constrictus Macl. Eyes smaller than on *A. macrops*, but still of fairly large size, antennae with fourth to tenth joints of even width, although decreasing in length to tenth (this may be a male feature only); on *macrops* the fourth is the thinnest of all the joints, the others feebly increasing in width to tenth (as on most species of the genus).

A. unicinctus Champ. Base of head suddenly dilated so that its widest part projects beyond the outer edges of the eyes (in Champion's figure this is not shown as prominently as on a cotype received from him); the eyes themselves rather small and prominent.

A. adelaidae Champ. I have not seen a specimen of this species; it is described as having large eyes but "a very fine long erect hair" in each puncture of the upper surface; on both specimens of *macrops* the clothing is evidently in perfect condition, and is nowhere erect or long.

A. politulus Lea. Eyes small, prominent, and distant from base; more of body parts darker (usually black) than in the other forms.

A. macrops, n.sp. Eyes large, occupying more than half the distance between antennae and base, and scarcely bulging beyond the even rotundity of the sides, base strongly and evenly rounded, without defined hind angles.

ANTHICUS OSCULANS, n.sp.

Head and most of under surface black or blackish, prothorax of a more or less dull red, or reddish-brown, becoming paler about base; eltyra flavous, a narrow basal space somewhat dilated about scutellum, a large median spot on each, connected with the side. and the apical third chocolate-brown; antennae reddish, from one to five apical joints infuscated; legs flavous, parts of femora and sometimes of tibiae infuscated.

Head rather short, hind angles and base strongly rounded, the latter not notched; apical half with small and fairly numerous punctures, becoming very faint posteriorly. Eyes of moderate size, medio-lateral and prominent. Antennae moderately long. Prothorax with sides strongly rounded and dilated in front, strongly notched near base; a transverse depression with dense and distinct punctures near base, elsewhere with sparse and minute ones; two feeble elevations at base. Elytra at base twice the width of prothorax, leaving part of abdomen exposed, shoulders gently rounded, sides feebly dilated to beyond the middle; punctures sparse and inconspicuous. Intercoxal process of abdomen narrow and obtusely pointed. Legs rather thin. Length, 2—2.5 mm.

Hab.—South Australia: Quorn (A. H. Elston), Murray River (H. S. Cope).

Appears to connect the groups about *A.* (*Micranthicus*) *pulcher* and *A. myrteus*; from the latter it is distinguished by the slightly flatter form, more parallel-sided elytra with the median fascia represented by a triangular spot on each side, often hardly more than slight infuscations and with the tip of each always distant from the suture; from *pulcher* it is distinguished by the larger head, with smaller eyes, the elytra with different markings, slightly larger, and covering ample wings, although leaving part of the abdomen exposed. On the darker specimens the pale parts somewhat resemble a rough X and the dark markings on each elytron are narrowly connected along the side; on the paler ones the base is scarcely infuscated, and the medio-lateral spot on each is faint or altogether absent, so that the only distinctively dark part of the elytra is the apical third. Of nine specimens under examination seven have an exserted ovipositor, and I can find no distinctively masculine features on the other two.

ANTHICUS MELANOSTICTUS, n.sp.

Reddish-castaneous, legs and antennae paler, elytra with a fascia (sometimes divided into two large spots) and the apex black. Moderately clothed with suberect pubescence, slightly longer on elytra than on head and prothorax.

Head subovate, hind angles moderately rounded, base very feebly incurved at middle; with rather dense and sharply defined punctures, but leaving an almost impunctate median line. Eyes rather small, very prominent, much nearer antennae than base. Antennae moderately long, eighth to tenth joints transverse. Prothorax slightly longer than wide, sides strongly rounded and widest near apex, thence almost evenly decreasing in width to base; punctures dense, sharply defined and slightly larger than on head. Elytra much wider than prothorax, shoulders slightly rounded, sides almost parallel to near apex; punctures on basal half larger than on prothorax, becoming smaller and sparser posteriorly but distinct to apex. Intercoxal process of abdomen short and subacute. Legs moderately long. Length, 2.5—3 mm.

Hab.—Queensland: Townsville (F. P. Dodd), Cairns, Emerald (A. M. Lea); Northern Territory: Darwin (W. K. Hunt); North Western Australia: Derby (Dr. A. M. Morgan), Fortescue River (W. D. Dodd).

At first glance resembles some of the multitudinous forms of *A. hesperi,* but the prothorax is of different shape, the head is smaller and the punctures are decidedly coarser; the markings are almost as on some of the larger forms of *A. kreusleri,* but all the punctures are decidedly coarser; *A. xerophilus* is considerably narrower with much smaller punctures, and the notch at the base of its head is always distinct; on the present species the basal incurvature is very faint, and could hardly be regarded as a notch; in general appearance it is somewhat like *A. gawleri,* on a greatly reduced scale. The head varies from no darker than the prothorax to almost black, the abdomen is often deeply infuscated. The black elytral fascia sometimes occupies the whole of the median third, except for a very narrow interruption at the suture, is connected along the sides with the black apical fourth or fifth, and also by an infuscation along the suture, so that a spot (conspicuously flavous) is enclosed on each elytron; but on an occasional specimen the pale sutural space is increased, so that the fascia, from above, appears as two large, disconnected spots. The punctures on the metasternum are slightly coarser than those on the prothorax. The male differs from the female in having the hind tibiae slightly more curved, all the tarsi slightly more dilated, and the apical segment of abdomen less evenly convex.

Anthicus mimetes, n.sp.

Pale reddish-castaneous, head and prothorax opaque; elytra flavous, base, apex, and a median fascia blackish or deeply infuscated; legs flavous. With very short, depressed, pale pubescence.

Head short, hind angles moderately rounded, base not notched; with minute crowded punctures, but leaving a narrow, shining median line. Eyes rather large, prominent, not much more distant from base than from antennae. Antennae thin, but not very long. Prothorax slightly longer than wide, sides in front strongly rounded, and much wider than base, strongly notched near base, with a feeble depression connecting the notches, behind it two very feeble elevations: punctures much as on head, but becoming more noticeable about base. Elytra much wider than prothorax, shoulders slightly rounded, sides very feebly dilated to about the middle; with dense but inconspicuous punctures. Intercoxal process of abdomen narrow and gently rounded. Legs rather thin. Length, 2—2.25 mm.

Hab.—South Australia: Barossa, Quorn (A. H. Elston), Lucindale (F. Secker), Mount Lofty; New South Wales: Wagga Wagga (R. Helms), Forest Reefs (A. M. Lea).

A depressed species readily distinguished from the many similarly coloured ones by the opaque head and prothorax. The elytral markings vary in extent and intensity, and on some specimens might be regarded as consisting of three fasciae; the median fascia is always conspicuous, but on some specimens is narrowed towards and interrupted at the suture, it occupies about one-fifth or one-sixth of the length of the elytra, the apical mark is semicircular, the base on some specimens is conspicuously dark, on others it is but slightly infuscated about the scutellum; the sides of the abdomen are sometimes infuscated. The elytral punctures are not sharply defined, even at the base. The sexual differences of the legs and abdomen are but slight. Specimens with the basal marking faint rather strongly resemble *A. xerophilus,* but on that species the head and prothorax are shining.

ANTHICUS GLOBICEPS, n.sp.

Pale reddish-castaneous, elytra flavous with black or infuscated markings, antennae and legs flavous, apical joints of the former more or less infuscated. Upper surface with depressed, whitish pubescence, more distinct on elytra than elsewhere.

Head rather short, hind angles and base continuously rounded, the latter not notched; with dense and small, but in some lights rather sharply defined punctures. Eyes comparatively large, medio-lateral and very prominent. Antennae rather short, three or four of the subapical joints transverse. Prothorax slightly longer than wide, front sides strongly dilated and almost twice the width of base, strongly notched near base; with dense and small punctures, becoming larger in a feeble sub-basal depression. Elytra elongate, much wider than prothorax, shoulders slightly rounded, sides almost parallel to near apex; punctures fairly dense and small, becoming scarcely visible posteriorly. Intercoxal process of abdomen short and gently rounded. Legs rather thin. Length, 2—2.25 mm.

Hab.—Queensland: Townsville (F. P. Dodd), Cairns District (E. Allen and A. M. Lea), Stewart River (W. D. Dodd).

At first glance apparently belonging to *A. mimetes* but the head and prothorax are not opaque, the hind angles of the former are completely rounded off, and the punctures are rather more sharply defined; the shining prothorax also at once distinguishes the species from *A. pallipes,* some forms of which have very similar elytral markings. Structurally it is close to *A. myrteus* and the elytral markings are in almost exactly similar positions, but is much brighter, the head slightly smaller and with larger eyes. From *A. geminatus* it differs in the squarer shoulders, shorter head and considerably larger eyes. *A. monilis* is a more convex species, with stronger punctures, head larger and eyes much smaller. *A. nitidissimus* has a decidedly narrower prothorax and longer head, with smaller eyes. The elytra have a black or blackish median fascia and an apical patch much as on *mimetes,* and usually a dark patch on each side of the base, but occasionally the latter are scarcely traceable; those without the basal infuscations rather closely resemble *A. xerophilus,* but the head is not notched at the base. One specimen has the median fascia and apical patch larger than usual, and connected along the sides and suture, so that a fairly large, pale, transverse spot is enclosed on each elytron, at about the apical third; on another the median fascia is broken up into two transverse, disconnected spots, and the apical spot appears as two, owing to the suture and tips being narrowly pale. The head is sometimes moderately infuscated; the four apical segments of abdomen are usually infuscated or black, but occasionally are no darker than the metasternum. On one specimen, from Cairns, the elytral markings are all reduced to feeble infuscations, although the median fascia is continuous.

Six specimens (from Darwin, W. K. Hunt) are smaller and paler than usual (although the four apical segments of abdomen are dark) with the elytra less parallel-sided, the median fascia reduced to two obtusely-pointed, transverse spots, almost touching the sides, but some distance from the suture, and with the infuscation about the scutellum very faint.

ANTHICUS FUSCOTIBIALIS, n.sp.

Pale reddish-castaneous; elytra black or blackish with a complete sub-basal fascia, and an interrupted postmedian one, or two transverse spots, flavous; legs pale castaneous or flavous, tibiae infuscated; antennae with apical half or more infuscated; abdomen blackish, except for part of the basal segment. Elytra with rather sparse, depressed, pale pubescence, sparser on rest of upper surface; with a few short, scattered hairs.

Head rather short, sides behind eyes parallel for a short distance, base moderately rounded and not notched; with rather sharply defined and numerous but small punctures in front, sparser and more irregular elsewhere. Eyes rather small, medio-lateral and very prominent. Antennae moderately long, three or four joints transverse. Prothorax distinctly longer than wide, sides in front strongly dilated and almost twice the width of base, strongly notched near base, a distinct depression connecting the two notches across disc, base with two obtuse elevations; punctures sparse and small, more distinct about sub-basal depression than elsewhere. Elytra with shoulders slightly rounded, sides moderately dilated to beyond the middle, where the width is fully twice that of the widest part of prothorax; with sharply defined but not very large or crowded punctures near base, becoming much smaller posteriorly. Intercoxal process of abdomen slightly wider than usual, the tip semicircular. Legs moderately long. Length, 2—2.25 mm.

Hab.—Western Australia: Beverley (E. F. du Boulay), Kalgoorlie (W. du Boulay), Geraldton (A. M. Lea); South Australia: Port Lincoln (Rev. T. Blackburn).

A rather flat species. The pale sub-basal fascia is rather wide, much as on *A. unifasciatus* and allied species, and is connected along the suture with the base; the base itself is usually not as dark as the other dark parts of the elytra and is sometimes but moderately infuscated (such specimens seem to approach some forms of *A. xerophilus,* from which they differ in the head not notched at base); the postmedian spots are somewhat obliquely placed and narrowed towards the suture, which they never appear quite to reach, although on some specimens the part separating them from the suture is rather slightly infuscated. Of the thirteen specimens under examination two have the head slightly infuscated, and of these one has the prothorax infuscated in front; all have the tibiae conspicuously darker than the femora and tarsi. In the male the tip of the abdomen is slightly notched, and the legs are slightly longer than in the female.

ANTHICUS ACUTIBASIS, n.sp.

Chocolate-brown, some parts almost black; elytra with a sub-basal fascia and two postmedian spots flavous, under surface reddish-castaneous or flavous, abdomen (except basal segment) blackish, antennae and legs flavous, knees and sometimes parts of femora infuscated. With sparse pubescence and a few straggling hairs.

Head rather long, hind angles and base strongly rounded, with rather dense and sharply defined punctures; with a shining, impunctate and almost continuous median line that, posteriorly, appears as a pointed ridge. Eyes of moderate size, much nearer antennae than base and very prominent. Antennae moderately long, ninth and tenth joints conspicuously transverse. Elytra with sparse and minute punctures. Length, 2.5—2.75 mm.

Hab.—Northern Queensland (Blackburn's collection).

At first glance appears to be a large variety of the preceding species, but the consistently larger size, longer head with basal projection and stronger punctures, thicker and entirely pale antennae, finer elytral punctures and tibiae (except at the knees) no darker than the adjacent parts, are sufficiently distinctive. The prothorax (except at apex), elytra (except for the punctures), abdomen and legs, are sculptured as described on that species. On three specimens the prothorax is of a rather bright castaneous with the head but little darker; on two others they are as dark as the dark parts of the elytra; on three of them the front femora are darker than the others, and have an obscurely pale longitudinal vitta. The pale elytral markings are placed as on the preceding species, but the sub-basal fascia is interrupted near the suture by a subtriangular extension of the basal infuscation; the transverse postmedian spots are more widely separated from the suture, and on one of them are rather narrow and less sharply defined.

Two specimens from the Northern Territory (Melville Island, W. D. Dodd) have the general colours dingier, but with the sub-basal fascia (which is not interrupted at the suture) and transverse postmedian spots white; on one of them the head has comparatively dense and coarse punctures, with the median line not traceable, except at the base, where it appears as a rather narrow ridge, causing the head to appear pointed there; on the other specimen the head is smaller, with smaller punctures but the ridge quite as distinct.

On all the specimens (although more noticeably on some than on others) the base of the head is seen to be quite acute, owing to the ridge being abruptly terminated, although not overhanging; from directly above, however, the base appears strongly rounded off. They all have a medio-apical ridge on the prothorax, although this is indistinct with the head in position.

Anthicus foveifer, n.sp.

♂. Black or blackish-brown, prothorax of a dingy red, base paler, elytra with four flavous spots or two interrupted fasciae, antennae and legs flavous, three or four apical joints of the former, and tibiae and most of femora of the latter, infuscated. Upper surface with depressed pubescence and a few short hairs.

Head rather short, hind angles and base strongly rounded, the latter not notched; with sparse and small, but fairly sharply defined punctures, becoming denser in front. Eyes comparatively large, medio-lateral and prominent. Antennae moderately long. Prothorax longer than wide, front moderately convex, sides in front strongly rounded and almost twice the width of base, strongly notched at basal third; transversely depressed and with distinct punctures near base, smaller and sparser ones elsewhere; two feeble elevations at base. Elytra with shoulders slightly rounded, sides moderately dilated to beyond the middle, where the width is more than twice the widest part of prothorax; punctures feebly defined. Abdomen with intercoxal process wider than usual, and gently rounded, apical segment with a rather deep fovea extending from base almost to apex, and occupying rather less than the median third. Legs rather long and thin. Length, 2.25 mm.

Hab.—Western Australia: Beverley (F. H. du Boulay).

In general appearance the type resembles a very large specimen of *A. strictus*, but the head is much shorter, its base is more strongly rounded off and the eyes are fully twice as large. From *A. fuscotibialis* it differs also in the much larger eyes, and by the sub-basal fascia being composed of two slightly oblique or curved spots, narrowing towards and almost meeting at the suture, instead of a straight and continuous fascia. In some respects it approaches *A. myrteus,* but the large abdominal fovea of the male is at once distinctive. The sub-basal fascia is interrupted before the suture by a subtriangular extension of the dark base, the transverse spots or interrupted fascia at the apical third are quite distinct, but not sharply limited; the metasternum and abdomen, except where they meet, are quite as black as the head.

Anthicus parvulus, n.sp.

Reddish-castaneous, legs somewhat paler, elytra with a black submedian fascia, their base and apex, head, apical half of antennae and most of abdomen infuscated. Elytra with depressed pale pubescence, rest of upper surface very sparsely clothed.

Head (excluding neck) about as long as its greatest width, hind angles and base strongly rounded; the latter slightly notched, with rather sparse and small, but sharply defined punctures, sparser along middle than elsewhere. Eyes small, medio-lateral and very prominent. Antennae moderately long, three or four joints transverse. Prothorax slightly longer than wide, sides strongly rounded in front, strongly narrowed towards and notched near base; punctures small. Elytra not quite concealing abdomen, shoulders slightly rounded, sides slightly dilated to beyond the middle, where the width is fully twice that of the widest part of prothorax; with rather dense and moderately large, sharply defined punctures, becoming minute beyond the fascia. Metasternum with dense and sharply defined punctures. Intercoxal process of abdomen obtusely pointed. Legs rather thin. Length, 2 mm.

Hab.—Victoria: Beaconsfield, in December; Queensland: Goodna, in October (F. E. Wilson).

About the size of, and structurally rather close to *A. monilis,* but with sparser punctures, although on the basal half of the elytra they are quite as large, the head and prothorax are slightly smaller, the antennae are not entirely pale (on some of them the tip of the apical joint is pale) and the elytral markings are reduced to a narrower submedian fascia, with the basal and apical infuscations rather faint, although on two specimens these are almost as dark as the fascia; this is slightly beyond the middle, on one specimen it is quite even, but on most of them it is narrowed towards the suture and on two is interrupted there; at its widest it is about one-seventh the length of the elytra. One specimen has the abdomen entirely pale. The notch at the base of the head is small and invisible from most directions, but is fairly distinct when viewed obliquely from behind. The male differs from the female in having the tip of the abdomen slightly notched, the legs slightly longer, with the front tarsi wider.

Anthicus abundans, n.sp.

♂. Colours and markings variable. Moderately clothed with subdepressed pubescence, and with scattered erect setae or short hairs.

Head short and wide, hind angles slightly rounded, base almost straight; punctures of moderate size and sharply defined but sparse, more numerous near eyes than elsewhere. Eyes large and prominent, scarcely more distant from base than from antennae. Antennae moderately long, none of the joints distinctly transverse. Prothorax distinctly wider than long, sides widest and strongly rounded near apex, where the width is equal to that of head across eyes, strongly narrowed to and notched near base; with sharply defined and fairly numerous punctures, but nowhere crowded. Elytra rather elongate, shoulders gently rounded, the width across them not much more than widest part of prothorax, sides gently dilated to middle; with numerous, but not crowded, sharply defined punctures of moderate size, becoming smaller posteriorly, but distinct even at apex. Abdomen with intercoxal process narrow and acutely triangular; apical segment with a fairly deep medio-apical incurvature. Hind tibiae rather long, apical two-thirds slightly incurved on one side. Length, 2.5—3 mm.

♀. Differs in having the head smaller, antennae shorter and thinner, abdomen more evenly convex and larger, the tip not at all incurved, legs shorter, hind tibiae straight and front tarsi narrower.

Hab.—Queensland: Cairns District (Blackburn's collection and A. M. Lea), Townsville (F. E. Wilson from G. F. Hill), Bundaberg.

As with most members of the *A. brevicollis* group the markings are very variable, the elytra are rather long for a member of that group, but the head, with its large eyes, and the short prothorax are normal. From most directions the head appears to be quite straight or gently rounded at the base, but from some a very feeble median incurvature (it could not be regarded as a notch) may be traced. The darker males have the head (muzzle obscurely reddish), prothorax (base obscurely reddish), and elytra (four flavous spots excepted) varying from dark reddish-brown to black; the abdomen (partly or entirely), parts of the legs, and from five to seven apical joints of antennae more or less deeply infuscated; such dark males are more abundant than the other forms, and have two flavous triangular humeral spots distinctly separated from the suture by a triangular extension of the dark basal portion, and two obliquely transverse spots at the apical third, not quite meeting at the suture; on other specimens the pale spots gradually enlarge till the two humeral ones become a wide sub-basal fascia, scarcely or not at all interrupted at the suture, and the postmedian spots are dilated (but still separated at the suture) so that there is left a fairly wide black median fascia; on other specimens the pale portions are still more enlarged, till the basal infuscation almost vanishes, the black median fascia is reduced to two suboval spots, rather distant from the suture, and an apical infuscation (sometimes very faint). The females also vary greatly in colour but usually have the pale elytral spots enlarged to rather wide fasciae, of which the postmedian one is usually narrowly interrupted at the suture, but the other is continuous. Eight females that I cannot distinguish structurally from others that certainly belong to this species, have most of the under surface blackish, the prothorax reddish-castaneous, with the apex slightly infuscated, and the elytra pale except for an apical spot and a triangular infuscation about the scutellum; but many of the females having no distinctive features of the legs and abdomen, can scarcely be distinguished from females of other species; and by their colour and markings alone, many males cannot be distinguished from other species. The hind tibiae of the male from one direction appear to be moderately wide and straight, but from another they appear to be thinner, with the inner side of the apical two-thirds slightly but distinctly incurved to the middle, and more or less blackish there; on *A. brevicollis* and *A. crassipes* the incurvature is much more evident (it commences as a sudden notch) and the whole tibia has an outward curve. The punctures of the head and prothorax are much sparser than on *A. discoideus* and *A. baudinensis*; the elytra of the male are not opaque, as in *A. crassus*; the markings distinguish from *A. inglorius, A. latus, A. luridus* and *A. immaculatus.* Some of the paler forms whose elytra are but feebly infuscated about the base and with three isolated dark spots, approach some of the darker forms of *A. laticollis,* but they have at least some joints of the antennae dark, even in the female. Specimens may be taken in abundance at lights.

ANTHICUS CORDICOLLIS, n.sp.

Of a rather dingy flavous, head and prothorax flavo-ferruginous. With pale pubescence, short and depressed on head and prothorax, slightly longer and less depressed on elytra; the latter in addition with numerous suberect hairs.

Head large, hind angles and base moderately rounded, the latter not notched; with densely crowded punctures. Eyes small, prominent, distant from base. Antennae moderately long. Prothorax cordate, wider than long, sides strongly rounded in front and strongly diminishing in width to base; punctures as on head. Elytra elongate, elliptic-ovate, shoulders completely rounded off; with rather dense and sharply defined punctures of moderate size, becoming smaller posteriorly, the interspaces with extremely minute punctures, but scarcely shagreened. Intercoxal process of abdomen narrow and subacute. Legs moderately long. Length, 4.25 mm.

Hab.—Western Australia: Cue (H. W. Brown).

Evidently an apterous species, at first glance apparently belonging to *Formicomus,* but the intercoxal process narrow and femora unarmed. The head and prothorax are opaque, mostly owing to the density of punctures; in some lights the former has a finely granulated appearance, and the latter, owing to the pubescence, appears to be finely strigose, but it is really not so.

FORMICOMUS.

By various works consulted *Formicomus* would appear to be distinguished by the body being apterous, with humeral angles completely rounded off, intercoxal process of abdomen wide and usually truncated, and hind femora strongly clavate. The majority of Australian species agree with these characters, but a few are winged, and these have the shoulders not completely rounded off, a few have the hind femora less strongly clavate than usual, and some have the intercoxal process narrower than usual, although apparently never triangular. The species are usually of large size, and usually have the hind femora dentate, or the front ones of the male only.

FORMICOMUS QUADRIMACULATUS King.

This species varies considerably in size and colour, most specimens have the prothorax conspicuously reddish, the head infuscated, and the elytra blackish; with two reddish fasciae interrupted before the suture, and clothed with white pubescence. Sometimes the head is quite as pale as the prothorax; occasionally all parts (except the clothing) of the upper surface are blackish. King did not mention the fact, which, however, is quite apparent on several specimens from his collection, that the derm beneath the white elytral markings is usually reddish; but on small dark specimens the derm of the elytra is sometimes entirely black; he also did not mention that the hind femora are strongly unidentate. On most specimens in good condition there appears, from many directions, an oblique line of whitish pubescence on each side of the prothorax, the two meeting at the middle of the base so as to form a distinct V. Two specimens, from Western Australia and New South Wales, have the reddish sub-basal markings on the elytra dilated to the base and suture, but leaving a fairly large, round, dark spot isolated on each side near the base; on a somewhat similar specimen from South Australia the spots are but feeble infuscations, and the punctures on the elytra are rather stronger than usual. Two unusually small specimens, with the elytral derm entirely dark, were taken at Murray Bridge from a nest of the ant, *Ponera lutea.*

FORMICOMUS MASTERSI King.

Syn.—*F. Kingi* Macl.

In general appearance this species is close to large dark specimens of *F. quadrimaculatus,* but differs in having the hind femora strongly and unequally bidentate, the teeth being placed side by side, the inner one larger than the outer; the prothorax is usually darker on the anterior sides than elsewhere, and has (on specimens in perfect condition) V-shaped pubescence as on the species named; there are also two similar, transverse, reddish fasciae on the elytra, interrupted before the suture, and clothed with white pubescence, but the subbasal fascia is usually more distinct than the postmedian one; occasionally both are absent or very feeble, but the clothing covering them appears to be always conspicuous on non-abraded specimens. A cotype is in the South Australian Museum, and many specimens from Morgan and other localities on the Murray River.

Macleay described the type of *F. Kingi* as having the hind femora "very strongly toothed on the under-side near the apex." Six cotypes before me are bidentate; the teeth vary somewhat in size on the specimens but one is always smaller than the other; they agree perfectly with South Australian specimens of *F. mastersi.*

FORMICOMUS SPECIOSUS King.

The head and prothorax (especially the latter) of this species are densely and coarsely punctured, the transverse spots or interrupted fascia (near the base of the elytra) of silvery clothing are placed within depressions, and the hind femora are strongly dentate, the teeth being placed side by side as in *F. mastersi,* from which it may be readily distinguished by the elytra and punctures. A specimen was taken at the Swan River, by Mr. J. Clark, from a nest of the twig-mound ant, *Iridomyrmex conifer.*

FORMICOMUS DENISONI King.

Syn.—*F. nigripennis* Champ.

A common species in North Queensland. Although King described the elytra as *"nigro-cyaneis"* they are nearly always deep shining black, the bluish gloss being very seldom in evidence, and the head and prothorax are of a bright red; the legs, especially the front ones, vary somewhat in colour, but (except at the base of the femora) are usually black. The front femora are strongly dentate in the male, edentate in the female. The length varies from 3.25 to 4.75 mm. Some specimens from North Queensland differ from typical ones in being entirely black, except that parts of the mouth are obscurely diluted with red; one has the head, front tarsi and some of the mouth parts of a dull red, all other parts being black. *F. nigripennis* was described from a small male of the species.

Formicomus interruptus, n.sp.

Dark reddish-brown, elytra darker, but with two pale interrupted fasciae, palpi and most of legs paler. With rather sparse, pale pubescence, but fairly dense on sides of prothorax posteriorly, dense on elytral fasciae and on sides of under surface; a few straggling hairs scattered about.

Head subovate, rather feebly convex, hind angles moderately rounded off; with crowded and small asperate punctures, sparser (but still crowded) in front than behind; with a feeble median line. Eyes small, medio-lateral and rather prominent. Prothorax with sides widest near apex, where they are evenly rounded, then oblique but with a feeble incurvature to base; punctures much as on base of head; median line scarcely traceable. Elytra elongate-elliptic; basal half with rather dense and moderately large, sharply defined punctures, becoming very small posteriorly. Intercoxal process of abdomen rather wide and truncate. Femora stout, the hind ones strongly clavate and with a large, acutely triangular tooth. Length, 3.5—4.5 mm.

Hab.—Queensland: Townsville (F. P. Dodd).

At first glance like some of the forms of *F. quadrimaculatus,* but elytral punctures sparser and much more distinct on the basal half, and prothorax shorter but with somewhat similar pubescence; the prothoracic punctures are stronger than on *F. Kingi.* The head and prothorax are subopaque, due entirely to the punctures; the elytral fasciae are rendered very distinct by their clothing (which, however, appears to be easily abraded), the first is at the basal third and is interrupted close to the suture, the other is at the apical third and its sutural interruption is wider. I can find no external indications of sex in the three specimens under examination.

Formicomus latibasis, n.sp.

Flavous, head and prothorax somewhat ferruginous, elytra with two pale, interrupted fasciae. Rather sparsely clothed, but on the elytral fasciae and parts of under surface more densely so.

Head briefly ovate, widest almost at base, where the angles are feebly rounded off. Eyes small and medio-lateral. *Prothorax* slightly wider than long, widest and strongly rounded near apex; with a distinct, open, medio-basal fovea. Elytra elongate-ovate; with dense and minute punctures throughout, with some larger (but still small) ones becoming rather numerous towards base. Length, 4.5 mm.

Hab.—South Australia: Kilkerran (Blackburn's collection).

The type may be immature but is structurally sufficiently distinctive to be named. It is closely allied to the preceding species, with abdomen and hind femora similar, but differs in having the head decidedly wider, with the hind angles less rounded off; the prothorax is wider with the medio-basal fovea distinct (on that species it is hardly indicated), and the elytral punctures are smaller; the punctures on the head and prothorax are of the same nature, but are smaller and the median line in the former is even less distinct; its clothing is also sparser. It is also allied to *F. quadrimaculatus,* but the head is at least half as large again, the prothorax is shorter and with a medio-basal fovea; this is one (the most distinct) of three enlargements of the sub-basal impression.

Formicomus pubifasciatus, n.sp.

Black; head, prothorax, antennae, palpi and legs more or less red. Finely pubescent, but the elytra with two interrupted fasciae of white pubescence: one at the basal third, the other at the apical third.

Head rather large, from clypeus to base scarcely as long as the greatest width; with crowded, small, asperate punctures, a few of larger size; median line faintly defined but continuous. Eyes rather small and moderately prominent. Prothorax slightly longer than wide, sides widest and strongly rounded near apex, thence oblique to base; punctures minute and densely crowded. Elytra elongate-elliptic; with dense and minute punctures. Intercoxal process of abdomen wide and truncate. Hind femora strongly clavate, strongly and acutely dentate. Length, 4 mm.

Hab.—Western Australia: Cue (H. W. Brown).

Differs from *F. quadrimaculatus* in the head being considerably larger, with eyes slightly nearer base; elytra slightly bronzy and with denser and more sharply defined punctures; although decidedly small, the punctures are so dense that from some directions the surface appears microscopically granulate; it is, however, somewhat shining, but the prothorax and head are opaque. The legs are paler than the prothorax, and this is paler than the head, which is somewhat infuscated in front. The elytral fasciae appear to be easily abraded, and on the type the supporting derm is no paler than the adjacent parts.

FORMICOMUS MELASOMUS, n.sp.

Black, parts of appendages reddish. With rather sparse pale pubescence, but forming two interrupted fasciae on elytra: one at the basal third, the other at the apical third.

Head briefly ovate, hind angles rather strongly rounded off; with dense and small but, in some lights, sharply defined punctures; median line faint. Eyes small, prominent and distant from base. Prothorax slightly longer than wide, slightly narrower than head, widest and strongly rounded near apex, sides thence oblique to base; punctures much as on head; median line faint but continuous. Elytra elongate-elliptic; with minute punctures, becoming very faint posteriorly. Intercoxal process of abdomen rather wide and truncate. Hind femora strongly clavate, strongly and acutely dentate. Length, 3—3.5 mm.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt), Narracoorte (A. M. Lea); Western Australia: Yilgarn (Blackburn's collection from E. Meyrick).

Structurally resembling *F. quadrimaculatus* on a small scale, but darker, more convex, eyes smaller, etc. The head and prothorax are somewhat shining, despite the density of punctures, these, however, not being asperate. The antennae are reddish, but with the apical half more or less deeply infuscated; the coxae, basal half of femora, tarsi and tibiae (wholly or in part) are reddish; in some lights the derm beneath the pubescent fasciae is seen to be obscurely reddish on some specimens, but not on others. Four, of the five, specimens under examination have male genitalia exposed, and have the basal segment of abdomen less convex, and front tarsi slightly wider than on the other specimen, these being the only external indications of sex.

FORMICOMUS DENTIVARIUS, n.sp.

Colours variable. Rather densely clothed with fine pubescence, varying in colour with the derm; with numerous long, erect, dark hairs scattered about.

Head of moderate size, subovate, hind angles rather strongly rounded off; with dense and rather small but (except where partially concealed by clothing) sharply defined punctures. Eyes small, medio-lateral and very prominent. Prothorax transverse, distinctly wider than head, all angles widely rounded off, near apex much wider than base; punctures much as on head. Elytra elliptic-ovate; with dense and minute punctures, and with numerous larger ones, especially towards base, but all more or less obscured by clothing. Intercoxal process of abdomen not very wide, gently rounded off or almost truncate. Hind femora very stout, strongly clavate, with one strong and acute tooth, and usually with one or more smaller ones. Length, 2.5—6 mm.

Hab.—Western Australia: Cue (H. W. Brown).

Not very close to any other Australian species, except the following one and with a greater range in size than any other member of the family known to me. The teeth on the hind femora vary in number from one to four; there is a long and rather thin one inwardly, near this on the outer side there is a ridge with feeble undulations on some specimens, but on others the undulations are developed into teeth, usually small, but generally acute. On some specimens, from certain oblique directions, all four are distinct, and from an inner direction there appear 1, a long thin tooth, 2, a small one, 3, a longer but still small one, then, 4, a still smaller one or feeble tubercle; of these the 4th is the first to disappear, then the 2nd, and rarely the 3rd, the 1st being always present but varying in length. The narrowly impressed line at the base of the prothorax is not traceable across the middle from above, although distinct from the sides. The head and prothorax are both subopaque and on each a feeble median line may be traced from certain directions. All the specimens have the legs, antennae and palpi more or less reddish, but the tibiae at base and the hind femora at apex are sometimes darker than the adjacent parts; the head is black or blackish, but in front is obscurely reddish; the prothorax varies from entirely reddish (but usually with the front and front sides infuscated) to entirely blackish; the elytra are black or blackish, with the suture, sides and two interrupted zig-zag fasciae reddish, the sides and fascia clothed with white pubescence. From the side each elytron may be seen to have the pale part rather wide at the base, and narrow at the apex; from the shoulder a wide stripe projects obliquely backwards from the pale side, terminating in an acute point slightly before the middle of the elytron, with its front inner portion produced obliquely forwards, but not to the suture; at the apical third another stripe or fascia projects at a right angle inwards to near the suture, with a deep notch almost in line with the point of the sub-basal fascia. The smallest specimen has the whole of the upper surface dark, except that parts of the elytra are obscurely diluted with red, its elytral fasciae, although not distinct in themselves, are fairly indicated by the white pubescence; its hind femora are rather conspicuously infuscated near apex.

FORMICOMUS TRIDENTIPES, n.sp.

Blackish; prothorax (front infuscated), legs, antennae and palpi reddish; under surface and parts of elytra obscurely reddish. Moderately clothed with short and mostly dark pubescence, but becoming golden on part of prothorax, and silvery on parts of elytra; in addition with numerous dark, erect hairs.

Head and prothorax with sculpture as described in preceding species, but with somewhat coarser punctures. Elytra slightly larger in proportion, and with distinctly larger punctures. Intercoxal process of abdomen wide and truncated. Hind femora strongly clavate and tridentate. Length, 5 mm.

Hab.—South Australia: Port Lincoln (A. M. Lea).

In general appearance fairly close to some specimens of the preceding species, and with the head and prothorax almost identical, except that the punctures are slightly coarser, but the elytra have the reddish markings very obscure and the white pubescence clothing them differently directed, especially the sub-apical one, which, at its inception, instead of being directed at a right angle to the side, is directed obliquely forwards, so that if continued it would meet its fellow at the suture slightly before the middle; the sub-basal marking is curved, and on the right side is like an irregular J, the apex of the suture is also clothed with silvery pubescence; the intercoxal process of the abdomen is fully twice as wide and is truncated, it is decidedly wider than the apical segment is long (on the preceding species it is decidedly narrower than that segment is long) and the second joint of the hind tarsi is fully as long as the claw joint, instead of (as on that species) much shorter. The hind femora are tridentate, each having two acute teeth side by side (the inner longer and thinner than the outer), and a small acute one behind the inner one. The type is in perfect condition; when examining its upper surface I thought it was possibly a variety of the preceding species, but the differences in the abdomen and tarsi are conclusive; the margins and suture of its elytra are very narrowly and obscurely reddish, and there are two obscurely reddish spots on each elytron: an angular one on each shoulder, and an irregular postmedian one.

FORMICOMUS OBTUSIDENS, n.sp.

♂. Shining black; elytra with a flavous fascia not quite touching sides or suture at basal fourth, base of antennae, coxae, base of femora and tarsi more or less obscurely reddish. With sparse, ashen pubescence, and with a few erect hairs.

Head rather small, hind angles completely rounded off to the narrow neck; with fairly dense and sharply defined punctures in front, becoming much sparser and smaller posteriorly. Eyes large, prominent and medio-lateral, slightly longer than basal joint of antennae. Antennae with eighth to tenth joints wide and triangularly dilated to apex. Prothorax much longer than wide, subglobular in front, strongly constricted near base; with fairly numerous punctures on disc, and with a feeble median line. Elytra subovate, dilated from shoulders (which are not completely rounded off) to beyond the middle, transversely depressed beneath sub-basal fovea, and with sparse and small, but fairly distinct punctures. Abdomen with intercoxal process moderately wide and feebly rounded, apical segment with a round median fovea, each side of apex deeply notched so as to expose portion of the genitalia. Femora stout and strongly clavate, front pair near base each with a long tooth dilated to and notched at apex, front tibiae thickened and dentate near middle. Length, 3.5—4 mm.

♀. Differs in having thinner and shorter antennae, and simple abdomen and front femora and tibiae.

Hab.—Northern Territory: Melville Island (W. D. Dodd).

The intercoxal process of the abdomen is less conspicuously truncated than is usual in *Formicomus*, and wings are present, in consequence of which the shoulders are less rounded off than is usual; but as the femora are strongly clavate and the species is certainly congeneric with *F. agilis*, which is also winged, it was referred to *Formicomus*. From *F. agilis*, to which at first glance it appears to belong, it differs in the prothorax having a very feeble median line instead of a deep groove, and the tooth of the front femora of the male longer and of different shape. The head, behind the eyes, is almost semicircular in outline; on most of the specimens from the island it is deep black, but on several it is dark reddish-brown; on such specimens the antennae and legs are also somewhat paler.

FORMICOMUS ACUTIDENS, n.sp.

♂. Black; basal joints of antennae obscurely reddish, coxae and base of femora flavous.

Head subglobular; with crowded but fairly sharply defined punctures about base, but less distinct in front, owing to the intermixture of smaller ones. Eyes rather small, medio-lateral and prominent. Antennae slightly thickened towards apex. Prothorax distinctly longer than wide, front two-thirds globular, the basal third much narrower; with a few inconspicuous punctures along middle; median line very faint. Elytra elliptic-ovate, sides somewhat dilated to middle, shoulders fairly prominent; punctures sparse and minute. Abdomen with intercoxal process rather wide and gently rounded, apical segment irregular on each side of and depressed in middle. Femora strongly clavate, front pair each with a long and acute median tooth; front tibiae notched near apex, hind tibiae long, thin and rather strongly curved. Length, 3 mm.

Hab.—Queensland: Cairns District (A. M. Lea).

The presence of wings, strongly dentate front femora of male, and shoulders not completely rounded off, associate this species with the preceding, and with *F. agilis,* from which it is at once distinguished by the absence of a flavous fascia in a sub-basal depression on the elytra; the hind tibiae are also decidedly longer and more strongly curved than on those species and the cephalic punctures are different; in its scarcely visible median line it is nearer the preceding species than *agilis,* but its femoral tooth is an acute spine.

FORMICOMUS ALATUS, n.sp.

Black, shining; parts of three basal joints of antennae, parts of femora, of tarsi and of palpi more or less reddish. With fairly numerous, dark, erect hairs, mixed on the elytra with sparse, pale pubescence.

Head subovate, hind angles and base completely rounded off; with rather sparse and small, but sharply defined punctures, becoming larger and somewhat crowded in and about some frontal impressions. Eyes prominent, medio-lateral and rather large. Antennae long. Prothorax longer than wide, sides strongly rounded and widest near apex, notched near base; upper surface with rather dense and sharply defined but asperate punctures, flanks almost impunctate. Elytra much wider than prothorax, sides of base oblique to shoulders, sides gently dilated to beyond middle; punctures sparse and minute. Intercoxal process of abdomen not very wide and gently rounded (almost truncate). Femora stout, the hind ones strongly clavate. Length, 3.5 mm.

Hab.—Queensland: Cooktown (H. Hacker), Darnley Island (H. Elgner).

A deep black, winged species, evidently allied to *F. obtusidens* and *F. acutidens*; each of the two specimens under examination is a female; they differ from the females of the former species in having the elytra of uniform colour, and no joint of antennae transverse (even the tenth is slightly longer than its apical width), from the latter species (apart from differences which are certainly sexual) in having the head larger, with much sparser punctures, the prothorax with much denser and coarser punctures, and the elytra without a postmedian fascia of pubescence.

TOMODERUS UNIFORMIS, n.sp.

Flavous. Moderately clothed with depressed, pale pubescence, interspersed with some suberect setae.

Head distinctly transverse, hind angles strongly rounded off; with dense and sharply defined punctures, becoming smaller in front, with two small inter-ocular impressions, appearing like large punctures; basal slope with a shallow median line. Eyes large and prominent. Antennae moderately long, most of the joints submoniliform; eleventh as long as ninth and tenth combined. Prothorax about as long as its greatest width, sides strongly rounded and widest near apex, where the width is equal to that of head, deeply constricted towards base; densely and rather strongly punctate, and with a conspicuous median line. Elytra almost parallel-sided, shoulders moderately rounded; with rather dense and large, seriate punctures about base, rapidly becoming smaller and almost disappearing on apical slope. Hind legs long and thin, the others shorter. Length, 2—2.25 mm.

Hab.—Victoria: Mooroopna, in April (F. E. Wilson), Geelong (H. W. Davey).

Distinguished from *T. leae* by its larger size and dense and sharply defined punctures on head and prothorax; *T. denticollis* is described as having minute scattered punctures on those parts. As there is a foveate impression on the apical segment of abdomen, on the three specimens under examination, they are presumably all males.

TRICHANANCA APTERA, n.sp.

Piceous-brown, under surface somewhat paler, legs and palpi flavous, knees, tarsi and antennae slightly darker. Clothed with rather sparse, pale pubescence, and with numerous suberect, dark hairs.

Head moderately large and, excluding mouth parts, distinctly transverse, base strongly rounded, with rather small and sparse, unevenly distributed punctures. Antennae rather long and moderately stout, eleventh joint as long as ninth and tenth combined. Prothorax distinctly longer than wide, strongly constricted at basal third, with an irregular median line; coarsely and irregularly punctate, or granulate. Elytra rather narrow, shoulders rounded, sides gently dilated to beyond the middle; with rows of large, suboblong punctures, close together near base, smaller posteriorly, and feeble about apex. Legs rather long and stout. Length, 4—4.5 mm.

Hab.—Queensland: Mount Tambourine, two specimens from rotting leaves (A. M. Lea), Brisbane.

An apterous species; the only previously described apterous one is *T. concolor,* from which it differs in being darker, in having the head less transverse, with smaller punctures, and longer and thinner antennae, the prothorax is also decidedly longer, with narrower median line, and different punctures. Structurally, except for the want of wings, it seems near *T. pisoniae,* but the shoulders are more rounded off, and consequently not so much wider than the base of the prothorax. On one specimen the elytra have a faint coppery-green gloss.

TRICHANANCA MICROMELAS, n.sp.

♀. Black; antennae, coxae, trochanters and knees rather obscurely reddish, palpi and tarsi paler. With rather sparse, pale pubescence, interspersed with darker, suberect hairs.

Head (excluding neck) distinctly transverse, hind angles rounded off; with sparse and small punctures; a shallow depression each side in front. Antennae rather long and thin, eleventh joint as long as ninth and tenth combined. Prothorax about as long as its greatest width, front sides strongly inflated and distinctly wider than head, strongly constricted near basal third; with rather dense and sharply defined punctures, becoming smaller in front; flattened along middle. Elytra thin, elongate-elliptic, shoulders rounded off; with seriate punctures large and close together about base, rapidly getting smaller and almost disappearing about apex. Length, 3 mm.

Hab.—Victoria: South Gippsland (H. W. Davey). Unique.

A black, apterous species, and the smallest of the genus; from the other apterous species, *T. concolor* and *T. aptera*, it may be distinguished by its small size, dark colour, and by the almost complete absence of a median prothoracic line; from most directions, indeed, it appears to be really absent, and it is only in certain lights, and from oblique directions, that a faint line may be traced.

MECYNOTARSUS.

Of the described Australian species of this genus *apicipennis, kreusleri* and *mastersi* are abundantly distinct. At first glance the processes on the margin of the prothoracic projection would appear to be of considerable use in distinguishing species, but on *ziczac* they certainly vary in number, usually being eleven (five on each side and an apical one), very rarely nine; on some specimens they are thirteen, and even fifteen, owing to minute supplementary ones at the base; on *amabilis* they are usually nine, but occasionally eleven; on *albellus* they are nearly always eleven; on my specimens of *concolor* nine. The clothing on all these latter is variable; on *albellus* it is usually of a snowy whiteness, but on *amabilis, concolor* and *ziczac* the elytral scales are mostly white, with pale brown markings of varying shades of colour, and varying from covering much of the surface to covering so little and the colour so faint that it is difficult to distinguish them from *albellus*. Consequently I have set aside many specimens which may belong to unnamed species, but which it is not desirable to name as new.

MECYNOTARSUS KINGI Macl.

A Gayndah specimen labelled by Olliff as *M. kingi*, agrees with the type of *M. amabilis*, although Macleay made no mention of elytral markings.

MECYNOTARSUS MACULATUS, n.sp.

Pale castaneous, legs and antennae flavous. Densely clothed with white, subsquamose pubescence, sparser on prothoracic projection than elsewhere, its under surface sparsely pubescent, elytra with two or three pale yellowish spots. Length, 2.5—2.75 mm.

Hab.—Tasmania: Hobart (A. M. Lea); New South Wales: Sydney (H. W. Cox); Northern Queensland (Blackburn's collection); South Australia: Port Lincoln (Lea).

Structurally close to *M. ziczac*, but each elytron with two or three disconnected spots (on that species the median markings are more extended and are connected along the suture with sub-basal and subapical markings); the spots are not as dark as the derm on which they rest, but as this is normally concealed they are distinct; there is one near the middle of each elytron, nearer the suture than side, usually transversely subtriangular, with the wide end near the suture (which it never appears to touch), but occasionally it is semi-double; on the suture close to apex there is often a similarly coloured spot but seldom sharply defined, and often entirely absent. The prothorax is about the shape of that of *ziczac*, but the tubercles on the outer edge of its process are usually nine in number (occasionally eleven), the apical one is sometimes semidouble, and rarely appears as two. The elytra are evenly convex without a sub-basal depression, and the hind tarsi are slightly longer than the tibiae. The male differs from the female in having the abdomen smaller, less convex, and with the apex notched.

Mecynotarsus hortensis, n.sp.

Derm normally concealed but mostly dark reddish-brown, under surface paler, legs, antennae and palpi more or less flavous. Densely clothed with subsquamose pubescence, silvery white on under surface and legs, variegated on upper surface. Length, 2—2.5 mm.

Hab.—Western Australia: Swan River, common in gardens (A. M. Lea).

With about the same range of size as in *M. ziczac,* but elytral markings darker, more sharply defined and somewhat different in pattern, and average number of tubercles on prothoracic process less. On the upper surface the pale scales are usually darker than on the under surface; on the prothorax there are usually two ill-defined dark spots at the base; on the elytra there is a conspicuous brown, or purplish-brown median fascia, not touching sides or suture, and with more or less jagged outlines, occasionally the part on each elytron is obscurely connected along, but not on, the suture, with a less distinct basal infuscation, beyond the middle the suture is narrowly dark, and then the dark part suddenly dilates to a large and almost circular apical spot. There are usually nine tubercles on the outer edge of the prothoracic process, but on several specimens the two basal ones on one side are sometimes conjoined so that there appear to be but three on one side.

Mecynotarsus phanophilus, n.sp.

Flavo-castaneous, head and prothorax darker, legs, antennae and palpi paler. Densely clothed with white or whitish pubescence, on the elytra variegated with median and subapical markings. Length, 2.75 mm.

Hab.—Queensland: Cairns District, to light (A. M. Lea).

At first glance like some varieties of *M. ziczac,* but prothorax with only nine tubercles on the outer edge of the process, the process itself shorter and wider, and the part of the prothorax behind it distinctly transverse, with its greatest width very little less than that of the base of the elytra; lines drawn to connect the apical tubercle with the basal one on each side, and these with each other, would represent an equilateral triangle; on *ziczac* the triangle would be a narrower one, and the outer lines somewhat rounded. On the only two specimens taken, the clothing being in perfect condition, the surface has not been abraded to be sure as to the colour of the derm, although it is evident that the elytra are paler than the rest of the upper surface, but the tubercles on the prothoracic process are (except for sparse pubescence) glabrous, and dark castaneous. On the prothorax the clothing is denser and more uniform than on the elytra, on the latter there are four pale brown spots (disconnected on one specimen, connected two and two on the other) representing a median fascia, and a short line directed obliquely backwards on each side from the suture at the apical fourth.

Mecynotarsus lateroalbus, n.sp.

Dark castaneous, parts beneath the pale clothing paler, legs, antennae and palpi paler. Upper surface with dense chocolate-brown clothing, slightly variegated on prothorax, and with two conspicuous white patches on the side of each elytron; under surface and legs with white clothing. Length, 2.5—2.75 mm.

Hab.—South Australia: Mount Painter (H. G. Stokes), Parachilna (H. M. Hale); Western Australia: Cue (H. W. Brown).

A beautiful species, with prothorax (except for the tubercles) and legs sculptured as on *M. ziczac*, but the elytra with very different clothing; on one specimen from above they appear to be entirely dark, except that the inner tips of the pale lateral spots are just perceptible, on the others they are continued across about half of the disc, and are narrowly connected on the margin. The three specimens under examination quite evidently belong to but one species, but on one specimen there are nine tubercles on the outer edge of the prothoracic process, on the second specimen two of the tubercles on each side are conjoined, and on the other, three on each side are conjoined so that it has a medio-apical tubercle, a tubercle on each side near it, and then a ridge to the base on each side.

A NOTE ON PROTEIN PRECIPITATION IN GRASSES.

By Margaret H. O'Dwyer, B.Sc., Science Research Scholar in the University of Sydney.

[Read 27th September, 1922.]

Dr. Petrie, writing on the amount of non-protein nitrogen found in the seeds of *Acacia pycnantha* and of various other legumes, cereals, etc., (Proc. Linn. Soc. N.S.W., 33 (4), 1908, p. 837) drew attention to the views of several well-known scientists on the precipitation of proteins by Stützer's Reagent. He himself found, as the result of a series of experiments, that tannin and alcohol were practically equal in precipitating power, and that Stützer's Reagent (copper hydroxide) precipitated 13 per cent. more nitrogen than either of the other two reagents. As copper hydroxide is the only reagent mentioned in this connection in the Methods of Analysis of the Association of Official Agricultural Chemists of America (1921), it would appear that no special work on the precipitation of the proteins in feeding stuffs has, so far, been carried out in the United States.

It occurred to me, therefore, that an attempt to precipitate the proteins in some of the grass samples by the various reagents mentioned by Dr. Petrie might give some interesting results. These are shown in the subjoined Table. It will be seen that higher results are given by Stützer's Reagent than by either tannin salt solution, or by alcohol. In Technical Methods of Chemical Analysis (Lunge and Keane, 1911, p. 449) a method based on that of O. Kellner and worked out by Barnstein is mentioned. The grasses given in the Table have also been treated by this method, but still higher results than those given by Stützer's Reagent have been obtained in each case. Lunge and Keane state that the results obtained by this method and Stützer's have been found to agree in the case of most feeding stuffs, but that vegetable products containing alkaloids and other nitrogenous compounds, such as amides, give a precipitate containing a little more nitrogen when treated by Barnstein's method than when that of Stützer is used, this difference, they say, never exceeding 0.2 per cent. of nitrogen.

Experimental.

The various precipitants were prepared as follows, an aqueous extract of the material being made in each case.

Name and Date.	Locality and Nature of Soil.	Stage of Growth.	Name of Precipitant and percentage of protein precipitated in each case.			
			Stutzer's Reagent.	Tannin Salt Solution.	Barnstein's Reagent.	Alcohol.
Schedonorus Hookerianus 27 Sep. 1920 (dried in laboratory).	Glen Innes Exp. Farm. Gravelly and comparatively poor.	1st	6.50	5.13	7.00	5.32
Schedonorus Hookerianus 3 Oct. 1920 (dried at Farm).	Glen Innes Exp. Farm. Gravelly and comparatively poor.	1st	11.23	10.06	12.03	9.95
Panicum prolutum 19 Oct. 1920 (dried at College).	Hawkesbury Agric. Coll. Light grey silt.	1st	8.63	7.92	9.12	8.02
Danthonia semi-annularis 3 Nov. 1920 (dried at Farm).	Cowra Exp. Farm. Sandy loam, granite origin.	1st	10.85	9.05	11.34	8.96
Panicum prolutum 8 Nov. 1920 (dried at College).	Hawkesbury Agric. Coll. Light grey silt.	2nd	5.88	5.16	6.25	5.23
Danthonia pilosa (?) 29 Dec. 1920 (dried at Farm).	Yanco Exp. Farm. Chocolate loam, clayey subsoil.	2nd	6.50	5.82	7.23	5.95
Eragrostis leptostachya 12 Jan. 1920 (dried at College).	Hawkesbury Agric. Coll. Light grey silt.	2nd	9.20	8.71	9.55	8.79
Schedonorus Hookerianus 9 Feb. 1921 (dried at Farm).	Glen Innes Exp. Farm. Gravelly and comparatively poor.	3rd	6.70	6.30	6.92	6.29
Andropogon intermedius 16 Feb. 1921 (dried at Farm).	Bathurst Exp. Farm. (data not available).	3rd	3.62	2.98	4.03	3.02
Andropogon intermedius 31 May 1921 (dried at College).	Hawkesbury Agric. Coll. Light grey silt.	3rd	4.52	3.94	5.03	4.01

Stützer's Reagent was prepared according to the directions given in Methods of Analysis of the Association of Official Agricultural Chemists of America (1921). Each c.c. of the Reagent contained 0.01 gram of copper hydroxide. The tannin salt solution used contained 10 per cent. tannic acid, and 10 per cent. sodium chloride.

Barnstein's method consists in adding to the hot aqueous extract 25 c.c. of copper sulphate containing 60 g. of $CuSO_4.5H_2O$ per litre. Then 25 c.c. of dilute sodium hydroxide solution (12.5 : 1000) are slowly added while the solution is stirred. The precipitate is then allowed to settle and further treated as in Stützer's method. Lunge and Keane consider that the concentration of the copper sulphate and of the sodium hydroxide solutions is chosen so that the whole of the copper is not precipitated by the alkali, while the precipitate contains as much effective cupric hydroxide as is used in Stützer's method. The time taken in the preparation of Stützer's reagent, the making up of which is rather a lengthy process, would also be saved by the use of this reagent.

For the actual determinations:—

(1) 20 c.c. of Stützer's reagent were added to an aqueous solution, formed by boiling 1 grm. of the material in 50 c.c. of water, according to the directions given by the Assn. Offic. Agric. Chemists of America in their methods of analysis (1921), and the N determined in the precipitate by Kjeldahl's method.

(2) 1 grm. of the material was boiled in 50 c.c. of water, and the hot solution treated with 15 c.c. of the tannin salt solution, centrifuged, washed with the reagent, and Kjeldahled in order to determine the amount of nitrogen present.

(3) 1 grm. of the material was treated with 50 c.c. of H_2O and the estimation made according to the details given above (Barnstein's method). The N in the precipitate was determined as before.

(4) 50 c.c. of the aqueous extract were evaporated down to 10 c.c. and poured into 90 c.c. of alcohol 94 per cent., making the solution of the strength of 85 per cent., heated to boiling, allowed to stand 3 hours, and filtered. From the filtrate the alcohol was then distilled off and the N determined as usual in the residue (Petrie, 1908).

The protein content in each case was found by multiplying the amount of N present by the factor 6.25 (*vide* These Proceedings, xlvi., 1921, p. 244).

The results obtained in the small number of grasses so far examined appear to bear out Dr. Petrie's contention that Stützer's reagent precipitates some of the non-protein nitrogen. This is a point of considerable importance.

My thanks are again due to Professor Watt, Mr. G. Wright, and Dr. Petrie and others for very valuable assistance in the prosecution of this work.

[NOTE:—Since the writing of this paper, the author has been engaged in research work under Dr. Schryver in the Bio-chemical laboratory of the Imperial College of Science and Technology, South Kensington, London. In this laboratory important work is being carried out on the proteins of plants (Chibnall and Schryver, Biochem. Journ., 15 1921, p. 60; Buston and Schryver, Biochem. Journ., 15, 1921, p. 636) the results of which should be applicable to grasses, and I hope at some future date to have an opportunity of further examination of Australian grasses by methods other than those outlined in the paper. M.H.O'D.]

FURTHER REPORT ON THE NUTRITIVE VALUE OF CERTAIN AUSTRALIAN GRASSES.

By Margaret H. O'Dwyer, B.Sc., Science Research Scholar in the University of Sydney.

[Read 27th September, 1922.]

Some little time ago (Proc. Linn. Soc. N.S. Wales, xlvi., 1921) the author communicated to the Society a paper which dealt with the results of certain analyses of the native grasses of Australia, taken with regard to their nutritive value. The results were based mainly on the examination of the first stage of growth of each grass, i.e., the period about half-way between the time when it begins to shoot and the early flowering period.

At the time certain data relating to the second and third stages were available. These have since been added to, and as the author will have, at any rate, for some time, no chance of extending this information, the publication of these results in their present state may be of some value.

The second stage chosen for analysis is that known as the early flowering period, and the third stage that at which the seed is quite set.

Some interesting features have been observed in the grasses examined and the results of the analyses are given in the subjoined table.

A sample of *Pollinia fulva* was obtained from Hawkesbury Agricultural College. The experimentalist there stated that this grass was suffering from a fungoid disease, which Mr. W. L. Waterhouse, Lecturer in Plant Pathology in the University of Sydney, considers is probably smut. On analysis the percentage of crude protein in this sample was found to be exceptionally low, the percentage of ether extract and of pentosan less than that generally met with in grasses examined at the same stage, while the percentage of the crude fibre was higher than usual. *Andropogon intermedius* from Bathurst Experiment Farm, which the experimentalist reported to be ergot-infected, also showed a low percentage of protein. These points should prove of some interest when further diseased samples are being analysed.

Analyses of Various Grasses at Second and Third Stages of Growth.

Name and Date.*	Locality and Nature of Soil.	Stage of Growth.	Total Moisture. %.	Percentages air-dried material. Moisture.	Ash.	Crude Protein.	True Protein.	Crude Fibre.	Ether Extract.	Pentosan.	Carbohydrates other than Pentosan.	Albuminoid Ratio.
D. pilosa (?) 29 Dec. 1920.	Yanco Exp. Farm. Choc. loam, clayey subsoil.	2	50	10.78	9.36	8.05	6.50	28.84	4.27	26.06	6.14	1: 5.220
P. prolutum 12 Dec. 1920.	Hawkesbury Ag. Coll. Light grey silt.	3	60	8.22	4.04	6.74	5.39	35.85	2.97	21.42	15.37	1: 6.472
E. leptostachya 12 Jan. 1921.	Hawkesbury Ag. Coll. Light grey silt.	2	63	8.47	5.99	11.98	9.20	28.90	3.89	25.29	6.28	1: 3.382
E. leptostachya 12 Jan. 1921.	Hawkesbury Ag. Coll. Light grey silt.	3	56	7.96	4.23	8.14	6.93	30.62	3.64	26.34	12.14	1: 5.755
S. Hookerianus 9 Feb. 1921.	Glen Innes Exp. Fm. Gravelly and comp. poor.	3	57	8.30	5.08	8.58	6.99	33.63	4.0	25.91	7.51	1: 5.908
P. prolutum 10 Feb. 1921.	Wagga Exp. Farm. Mod. to heavy clay loam.	3	59	8.04	5.81	8.38	6.91	34.20	3.70	24.60	8.36	1: 6.227
Pollinia fulva 7 May 1921.	Hawkesbury Ag. Coll. Light grey silt.	3	45	7.30	3.82	3.59	2.89	37.25	2.15	19.50	23.50	1: 13.34
A. intermedius 31 May 1921.	Hawkesbury Ag. Coll. Light grey silt.	3	—	9.03	6.12	5.76	4.52	37.50	1.98	22.39	12.70	1: 11.163
P. prolutum 24 Jan. 1921.	Bot. Gardens. Sandy loam.	3	59	8.15	4.99	5.95	4.23	34.59	3.01	23.94	14.84	1: 7.680
P. decompositum 24 Jan. 1921.	Bot. Gardens. Sandy loam.	3	58	7.20	3.94	5.33	4.20	31.25	3.25	25.30	19.53	1: 9.813
S. Hookerianus 24 Jan. 1921.	Bot. Gardens. Sandy loam.	3	59	8.89	5.68	10.33	8.03	33.69	4.85	26.23	2.30	1: 3.274
S. Hookerianus 9 Feb. 1921.	Glen Innes Exp. Fm. Grav. and comp. poor.	2	69	9.03	6.94	10.71	7.39	27.23	4.08	23.59	11.03	1: 5.431

*The names of the grasses in the table are *Andropogon intermedius* R.Br., *Danthonia pilosa* (?) R.Br., *Eragrostis leptostachya* Steud., *Panicum prolutum* F.v.M., *P. decompositum* R.Br., *Pollinia fulva* Benth. and *Schedonorus Hookerianus* Benth. Each sample was dried at the Institution from which it was obtained.

A sample of *Andropogon intermedius* from Hawkesbury gave off a fruity odour when being cut up for analysis. This odour, which partly disappeared after the fine material had been exposed to the air for some time, was only noticed in the stems and leaves of the plant, the seeds being apparently quite free from it.

Mr. W. M. Carne, Lecturer in Botany at Hawkesbury Agricultural College, states that the scent is normal to the species and that odours are common to the Andropogons in flower, being specially marked in the lemon-scented species, one of the sources of Citronellal. He also says that some species such as *A. pertusus* and *A. intermedius* (syn. *A. punctatus*) have distinct depressions in the outer glumes, and that these pits may be associated with glands (*vide* Otto Stapf. The Oil Grasses of India and Ceylon, Kew Bulletin, 1906, p. 297).

An effort was made to obtain a larger amount of this grass from the College in order to discover, if possible, the nature of what is probably a volatile oil of some kind. Unfortunately, the grass garden had been cleaned up in the meantime and the grasses cut down. It is hoped, however, to secure another sample at a later stage in the work.

A chemical examination of the dried material showed that the percentage of ether extract was lower than usual. The percentages of moisture and ash were slightly above normal, while the percentage of crude fibre was high. Unfortunately, the grass was not weighed immediately after cutting, so that the total moisture content is not available. The percentages of total moisture set down in the tables in this report, as before stated (Proc. Linn. Soc. N.S.W., 46, 1921) can only be regarded as approximately correct.

In order to obtain some idea of the differences in weighing the grasses on ordinary and on chemical balances, some 1 lb. samples were obtained from the Botanic Gardens, weighed immediately after cutting on an ordinary balance there, and then re-weighed on a chemical balance immediately on arrival at the University about half an hour later. The difference in the weighings was in each case about 20 grams. The amount of moisture lost between the times of the two weighings should not be large, as the samples were well packed, so that the greater part of the difference of 20 grams is apparently due to the fact that a rough balance was used for weighing the samples in the first instance.

The high percentage of ash found in the sample of *Danthonia pilosa* (?) which came from Yanco Experiment Farm may be explained by the fact that the grass had been pulled up by the roots and a considerable amount of soil and earthy matter was found to be adhering to the leaves and stems.

THE GEOLOGY AND PETROGRAPHY OF THE CLARENCETOWN-PATERSON DISTRICT, Part ii.

Tectonic Geology and Physiography.

By G. D. Osborne, B.Sc.

[Read 25th October, 1922.]

A detailed account of the stratigraphical and regional geology of the Clarencetown-Paterson District was given in Part i. of this series (Osborne, 1922). From the matter there presented, certain tectonic features were implied, but no details of the very interesting structures developed in the area were given. It is the purpose here to describe these structures and the local physiography in detail, the description of the former being a contribution to the knowledge of the tectonics of Eastern New South Wales and of the latter indicating the important influence exerted by the arrangement of the strata upon the evolution of the topography.

In addition to acknowledgments already made, the writer desires to thank Dr. Leo A. Cotton, Dr. W. R. Browne and Mr. C. A. Sussmilch for help in discussion on the points specially dealt with below.

General Tectonics of the Area.

The broad structural features comprise two irregular plunging anticlines and their complement, an asymmetric plunging syncline, which have been extensively faulted. It will be convenient to name these features the Paterson and Williams River anticlines and the Dunn's Creek syncline. The individuality of these three units is best displayed in the southern part of the area and as one goes north it is found that the warps smooth themselves out and merge into a more unified surface constituting a dome-like structure, the core of which exists somewhere about Hilldale or Welshman's Creek. Very little is known of the tectonics to the north, but it is evident that the simple dome-like bulge round about Hilldale gives place to more complicated folding northwards, the small syncline shown on the map near Wallarobba forming part of this folding.

The plunging anticlines are not simple, regular structures, but, as is the case of most plunging folds, possess a number of irregular bulges and local depressions which give rise to some interesting forms of outcrop where dissection is fairly well advanced. The extent of the three folds may now be briefly given.

Starting at the west the Paterson anticline is shown by the existence of a fairly steady change in the strike from Mt. Johnstone, where the beds dip at 18° in a direction W. 10°S., to Dunn's Creek, where the dip is to the south-east at 40°. Near Paterson Township the strike is about due east and west. Taking into consideration the relation of the topography to the disposition of the strata, one can see that S.S.W. of Mt. Johnstone there is a pronounced bulge upon the general anticlinal surface and that, at Hungry Hill, there is evidence, in the dips and present positions of the rocks that, prior to the strike-fault shown at that locality, the structure was that of a local flat strike-trough superimposed on the main dome.

The Paterson anticline is adjacent to a syncline which trends up the valley of Dunn's Creek, the axis of the basin bearing about north-east and south-west. The existence of a general dip of 40° to the south-east and of 25° in direction N. 60°W. on opposite sides of the fold indicates the asymmetry of this structure. An interesting point about this area is that, on account of the syncline occurrence, a small outlier of Permo-Carboniferous rocks has been preserved. Equally important is the evidence that, a little to the north of these rocks, the surface of the basin is quickly bent up into a less inclined position so that disconnected outcrops of the Paterson dellenite occur at the head of Dunn's Creek possessing a local flat dip.

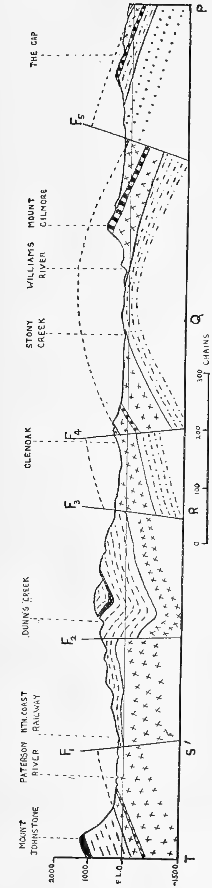
The eastern limb of the syncline trends down towards Butterwick, from which place the fairly simple disposition of the Williams River anticline begins. A glance at the map will show this fold clearly delineated by the outcrop of any of the indicator horizons. There is some evidence for assuming a local twist in the general curve of the outcrop near Felspar Creek.

The faulting, most of which, as will be explained below, occurred in Palaeozoic times, has complicated matters, but by mentally restoring the strata to their pre-faulting positions, one can clearly see that the folding was the outcome of tangential pressure exerted in a general east or west direction, followed by subsidiary warping in a meridional direction. The significance of the irregularities of the folding will be considered on a later page.

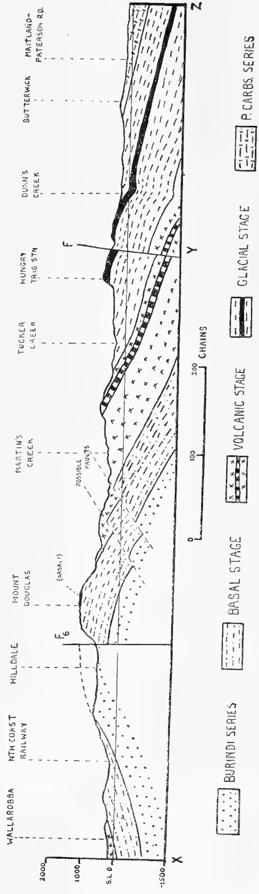
The sections across the area, most instructive from the point of view of physiography and tectonics are those along the lines P Q R S. and X Y Z (Plate xxvi.), descriptions of which are given below.

Section P Q R S. (Text-fig. 1.)

At Mt. Johnstone on the western end of the line, the Paterson toscanite is found capping the bold Mt. Johnstone ridge. dipping at 18° in a direction W 10° S. Coming down the face of the ridge the lower portion of the Glacial Stage is passed over and the beds of the Volcanic Stage are reached. These have been much eroded and form the flat land bordering the Paterson River. To the east of the river an important fault, F_1, throwing to the east, is crossed, and the lowest members of the Glacial Stage again come to view. These and the succeeding beds are traversed in the valley of Tucker Creek and, passing the fault, F_2, the northern end of the Dunn's Creek syncline is reached, the line passing to the south of where the synclinal surface is warped up into the broad dome-like fold, thus permitting the inclusion of the Main Glacial Beds in the section. Soon the line of traverse is back on to the lower portion of the Glacial Stage which is exposed in very rough country. The section now shows the Williams River anticline, which is broken by two large faults, F_3 and F_4, a small area of Volcanic Stage rocks being passed over between these dislocations.



Text-fig. 1. Section along P Q R S on Map (Plate xxvi.).



Text-fig. 2. Section along line X Y Z on Map.

The interesting group of rocks on the Langlands Estate is then crossed and the line of section comes upon the Basal Stage beds. These are seen to roll over to the south-east and the hornblende-andesite is found with dip-surface just before the Williams River is crossed, after which a long line of Volcanic Stage rocks is seen. These are exposed in the Gilmore ridge and to the east a large fault, F_5, is encountered, causing a repetition of part of the beds and the appearance of the Burindi Series in juxtaposition with the Glacial Stage. The section ends upon the easterly dipping Kuttung rocks.

Section X Y Z. (Text-fig. 2.)

The section along the line X Y Z traverses the area in a direction generally parallel to the axes of the folds, thus giving the succession of the beds right from the Burindi Series to the Permo-Carboniferous System.

Near Wallarobba the lower members of the Volcanic Stage are found dipping to the north-north-east, the conglomerates and tuffs of the Basal Stage appearing as one comes south. Just beyond the Wallarobba Tunnel the passage into the Burindi Series occurs, details of which were given in the former paper. Here the dip begins to change and along the high land between the Tunnel and Mt. Douglas the beds lie very flat. Just to the north of Mt. Douglas a fault occurs throwing down the Kuttung Series. There are outliers of Tertiary basalt hereabouts, and then the section passes on to the Volcanic Stage. A long line of outcrops of these rocks occurs until the northern side of Tucker Creek Valley is reached, where the Glacial Stage beds begin at the foot of a timbered slope composed of hard toscanite (Mt. Gilmore type) and dacite.

The lower portion of the Glacial Stage then gives rise to country of medium relief, this being succeeded near Paterson by the rugged hills of toscanite (Paterson type). The northern scarp of Hungry Hill is very steep and presents a striking example of differential erosion. On the southern side of the dip-slope the lower portion of the Glacial Stage reappears, as a result of strike faulting, and is in turn followed by the Paterson toscanite. This shows a variable inclination and eventually dips down in a local trough near Dunn's Creek. A long stretch of mature country is the expression of the Main Glacial Beds which pass, apparently conformably, into the Lower Marine Series.

The two sections just described are essentially at right angles in their directions, but can be drawn along the general dip directions of the strata, thus indicating the plunging nature of the folds.

Faulting.

The area under consideration is extensively faulted and the writer proposes to go into some detail in connection therewith.

An inspection of the map (Plate xxvi.) shows the general parallelism of the major faults, the average trend being N. 20° E. In addition to these essentially meridional faults there are two fairly important faults whose strike makes a wide angle with the direction of the major set. Numerous small dislocations and series of step faults are found in the railway and road cuttings, and in the State Quarry at Martin's Creek. Here a very interesting set of structures was to be seen at the time of the writer's last visit. Numerous small faults, and examples of sliding between adjacent masses of andesite were in evidence. These structures were probably developed when the folding occurred, the lines of movement being determined by the joint systems, whose formation preceded the latter stages of the folding.

It is to be noted that, in the area under discussion, the faults are, with one small exception, of the normal type, in the generally accepted use of that term. The magnitude of the faults and the exposures of the rock are such that very little data as to the disposition of the fault surfaces could be obtained. The larger faults will therefore be considered as possessing a small hade, and the amount of throw from place to place referred to in general terms. Where, locally, sufficient data are available, the stratigraphical displacement has been calculated, this term being defined as the displacement of any datum point or stratum at right angles to the plane of the bedding. Although the evidence points to dominant vertical dislodgment, there has been, as in the case of almost every fault, actual differential lateral movement of the earth blocks.

Detailed Account of the Faults.

Fault $F_1 F_1$.—This fault is of most interest throughout the area and is first made apparent by the disposition of the members of the Volcanic Stage just south of Martin's Creek Station. The hypersthene-pitchstone and hornblende-andesite are truncated and placed against the quartz-keratophyre and conglomerate which overlie them by a considerable amount. Almost any of the lavas in the Volcanic Stage can be used to indicate the displacement but the hornblende-andesite is most instructive. The strike of this unit from Martin's Creek to the fault line is N. 12° W. with a slight easterly drag near the fault, but the opposite edge of the lava (displaced to the north) strikes due east, quickly changing towards the south. This type of change is illustrated by the beds adjacent to the fault at almost any point along it. Then, at the point where the fault crosses the Paterson toscanite (*see* map) there is practically no horizontal displacement shown, but the behaviour of the strike of the rocks nearby points to dislocation, and the fault is not a pivotal one as the necessary results on the south of the Paterson lava do not occur.

The explanation of this peculiar set of outcrops is to be found by considering the structure of the fold here. A pitching anticline is present, irregularly domed, and of the nature of a bulge with a definite steepening in one particular portion, so that the two dislocated units of toscanite have appeared adjacent, subsequent to the faulting and denudation.

The fault line has not a constant direction and the approximate throw increases from 500 feet near Paterson to about 1,500 feet in the neighbourhood of Mt. Douglas, the downthrow side being to the east. Beyond this locality the ultimate behaviour of the fault cannot be determined owing to the absence of indicator horizons to delineate the structure.

Fault $F_2 F_2$.—This fault occurs to the east of Martin's Creek and has a marked effect on the disposition of the lava flows and the resulting topography. The truncation of the southerly dipping keratophyre and Mt. Gilmore toscanite and the placing of the latter against the hornblende-andesite near portion 99, Parish of Barford, are the most striking evidences of this fault. In a creek to the north of Red Hill, along the line assumed for the fault, beds of the Glacial Stage, whose normal dip nearby is 20° to the south, have a dip of 55° in an easterly direction. This fault which throws to the east has a fairly constant throw of about 850 feet in the northern portion of the area, but its effects in the Dunn's Creek locality are difficult to determine. It is clear that it has helped to produce the complications in the structure at the head of that stream. The Dunn's Creek area may be described briefly here. The syncline is very marked, its existence being established by numerous dips. The axis of plunging is S. 30°

W. and an overlap occurs in the beds. A careful examination up the course of Dunn's Creek failed to show any signs of faulting, although the line of the creek and also the junction of the toscanite and overlying tillites are in the direction of the fault, wherefore it seems likely that the fault is connected with the steep flexure existing along the stream. Of further interest are the occurrences of Paterson toscanite lying fairly flatly a little to the north, and the outlier of Lower Marine Beds to the east. These Permo-Carboniferous rocks must exist in a basin-shaped depression as they disappear in the direction of plunging of the syncline although the grade of the surface is not steep.

Mention of the structure of Hungry Hill can now be made. Here there is a strike fault indicated by the occurrence of the lower portion of the Glacial Stage surrounded by the Paterson toscanite. The fault has a throw of 250 feet to the north, and the stratigraphical displacement at the point Y is 300 feet. The fault is lost in the alluvium of the Paterson River to the west and its effects to the east are uncertain. One hesitates to join this fault to the one just previously described on account of the undisturbed strata between the ends of the fault as shown on the map. F_2 possesses a small branch about midway along its extent, the hypersthene-pitchstone outcrops serving to indicate this.

Fault F_3 F_3.—This long fault is encountered on the Seaham-Paterson road where it strikes north. It can then be traced, with a fair amount of ease, from Butterwick to the north, the strike becoming N.N.E. The consideration of the positions of the Paterson toscanite and of the Volcanic Stage lavas near Glenoak gives adequate evidence of its position and extent. Some very locally disturbed areas are to be found, high and discordant dips being obtained. The throw in the north is about 650 feet while in the south it is of the order of 900 feet, the west being the downthrow side.

A small branch fault from F_3 occurs near Oakendale, an actual scarp being discernible; the significance of this will be considered under the physiography section.

Fault F_4 F_4.—Near Glenoak one has not to travel more than half a mile east from F_3 before another large fault is encountered. This has a trend essentially parallel to F_3, the downthrow side being, as in the case of F_1 and F_2, to the east. The total horizontal displacement ("shift" of some writers) is well shown by considering the two toscanite units, in the Glacial and Volcanic Stages respectively. The fault appears to be of the type in which there is a sag, the throw decreasing on either side of the sag-point. In this case the maximum throw is approximately 1,200 feet.

Fault F_5.—This fault may be traced from the Limeburner's Road on the north, through the country east of the Gilmore Ridge, to the flat swampy land known as Balacara Swamps, the downthrow side being to the west. As a result of this fault the strata to the east of the Williams River have been duplicated and the Burindi Series has been brought to light by erosion. Beds of the Glacial Stage appear against the Burindi Series and at the point where the line P Q R S crosses the fault there is a stratigraphical displacement of 4,500 feet. The general throw of the fault is 6,200 feet, and the existence of this heavy fault explains the very great apparent thickness determined by Jaquet for the easterly dipping beds along this section (Jaquet, 1901).

There is no doubt that the fault in question is continued a long way to the south and, after passing the region of the Balacara Swamps, it trends down the present course of the Lower Williams River. It is, therefore, the same fault mentioned by Professor David in 1904, who, writing of the Carboniferous strata between Raymond Terrace and Seaham, says: "It is assumed that these strata have split along the axis of the anticline, and have been heavily faulted towards the west, this line of the fault determining in this part of its course the trend of the Williams River."

Thus F_5, which is a strike-fault along the eastern fall of the Gilmore ridge, becomes a dip-fault further to the south, on account of the plunging nature of the Williams River anticline. Mr. C. A. Sussmilch has informed the writer, in conversation, that as a result of observations upon the Kuttung rocks between Seaham and Raymond Terrace, east of the Williams River, he has been able to confirm the opinion of Professor David, and to obtain some details of the faulting.

There still remains something to be said of the east and west fault, F_6, near Hilldale and the other small dislocations. F_6 cuts right across the line of section X Y Z and shows at that point a stratigraphical displacement of 500 feet. The average throw of the fault is approximately the same. It can be defined by observing the extent of the marine (Burindi) rocks. This fault, throwing to the north and with some transverse movement, has displaced the core of the Hilldale Dome in the Burindi Series some distance to the west.

A small fault in the Gilmore ridge causes a break in the capping of the scarp by the Mt. Gilmore toscanite, and also displaces the Martin's Creek andesite, making a small break in the outcrop through which the Williams River now flows.

The only reversed fault observed in the area is about half a mile north of Martin's Creek Station. It brings the hypersthene-pitchstone against the hornblende-andesite and produces a peculiar tongue-shaped plan of outcrop of the tuffs separating these two beds. It indicates movement from the west and it is interesting to note the following mention by Prof. David (1904, p. 339) of faults in the Hunter River area to the south: "The faulting in almost every case is of the nature of normal faulting; such rare overthrusts as do occur show evidence of a thrust from the west."

General Considerations concerning the Faulting and Folding.

In the area under discussion there are five large faults all striking within the interval N—N. 30° E., three faults with smaller throws and a general east-west trend, and numerous small dislocations including an underthrust whose features are not of great significance.

In many areas the existence of two sets of faults with trends at right angles to one another indicates two periods of fracture, often separated by a wide interval of time, and in the area under description such a possibility must be considered. But it is also possible that the variable composition and resistance of the rocks and the peculiarity of the folded structures may have determined the positions of minor faults such as those that do not strike north and south in this case, and therefore that the whole of the faulting could have been the outcome of the same impression of diastrophic force. Also one should observe that the three faults of general east-west orientation all show up as physiographic features, for which reason a Tertiary age might be assigned to them.

The writer has been unable to decide whether or not there have been two distinct periods of faulting.

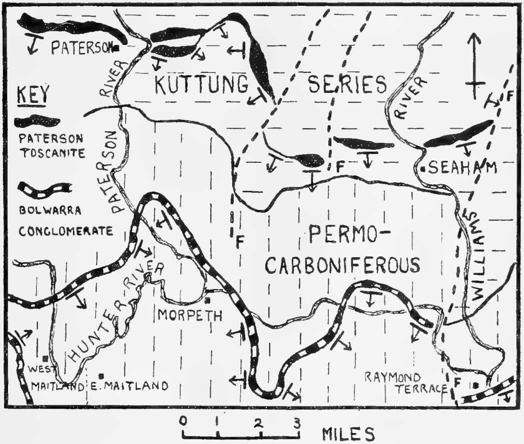
It is almost beyond doubt that the large meridional faults are pre-Mesozoic in age for the following reasons:—The faults show no *direct* physiographic expression or control. Indirectly they affect the topography in having arranged the hard and soft strata in certain patterns, but no scarps belonging to them exist, and there is direct evidence that the area was faulted by the north-south system of fractures and then planated or reduced to a surface with a few very broad valleys, and that on this peneplain basalts were extruded before the present topography was developed. This would place the faults as pre-Miocene or pre-Pliocene in age. Further, since they almost undoubtedly belong to the same series which have affected the Permo-Carboniferous and Carboniferous strata to the south and south-west, a pre-Mesozoic age may be assigned to them, for Prof. David found evidence of the occurrence of faulting and erosion of the Permo-Carboniferous beds to the extent of 5,000 feet before the Triassic sediments were laid down upon the eroded surface of the Palaeozoic rocks.

The origin of the faulting is a matter of interest. As the dislocations are, with one small exception, normal, one must see evidence of tensional forces at the time of their development. Chamberlin and Salisbury (1905, p. 521), James Geikie (1905, p. 109) and others, adhere to the general conception that block (normal) faulting is the outcome of tensional stress indicating a local extension of the earth's crust, reversed faulting being due to compression; and Hobbs (1921, p. 48-49) has shown that a constant cumulative compressional stress exists within the earth's shell, whose effects, though temporarily superseded by the displacements during periods of sudden relief, are reasserted immediately after such periods. The writer has shown (Osborne, 1921), from a study of the late Palaeozoic folding in the area a little to the south—folding which produced the structures now under discussion—that heavy normal faulting occurred at the close of the folding period. This is equivalent to saying that at the close of the period of folding, the extent of the vertical displacements had reached the maximum, but since folding implies compression, it seems reasonable to regard the extent of faulting as now measured, as representing the integration of a large number of small displacements which occurred during short periods of tensional stress, or periods of relief from the longer intervals of compression which obtained during the folding.

The folding itself is the outcome of thrusting in an east-west direction. It is difficult to say exactly in which sense this force acted, but with the conception of oceanic and continental segments in the earth's crust, and of crumpling along their borders by segmental adjustments on the principle of isostasy, it is natural to regard the sagging of the Pacific Ocean segment, which has been a subsidence area for a long time (*cf.* Andrews, 1922, p. 14) as contributing to the folding which compressed the rocks of the Hunter District. It is also possible that some thrusting in an easterly direction may have originated by the sinking of the important synclinal segment which exists between southern New England and the Bathurst area.

Structural Relations between the Kuttung Series and the Permo-Carboniferous System.

Much has been said upon the question of the actual relationship between the Kuttung Series and the Permo-Carboniferous beds. C. A. Sussmilch is positive in his view of conformity in the Paterson-Seaham District, while T. W. E. David shows that there is distinct unconformity between the two at Pokolbin and hesitates to make a definite conclusion about the series generally. There is much work yet to be done, and the writer has not been able to find, in the area he has examined, any definite evidence either way. In almost every locality where a passage might be expected, one of two sets of conditions occurs. Either alluvium puts the determination of the relationship beyond possibility or no reliable dips can be obtained sufficiently near the supposed junction line. It is interesting and important to note that both east and west of Paterson the state of affairs is as follows: The Paterson toscanite is found making the feature, in most cases a broken ridge, dipping at any angle from 15° to 40°; following the dip-slope of the lava, tillites and varves are found generally giving rise to land of moderate relief, exceptionally helping to form the ridges, and occasionally registering reliable dips about the same as the underlying toscanite. The succeeding outcrops of Permo-Carboniferous strata are frequently sporadic and in no case productive of reliable dips, until in some instances, as south of Webber's Creek a good dip is found when one is well into the Permo-Carboniferous Series. In every case of measurement, the dips of the Permo-Carboniferous rocks were less than those of the Kuttung rocks. If conformity exists, one must postulate monoclinal flexures all along the feet of the ridges west and east of Paterson, with the exception, of course, of Dunn's Creek. Further towards Seaham it is hopeless to expect a section showing the passage, and things are far from satisfactory at Seaham itself.



Text-fig. 3. Sketch Map showing the relations between the folding in the Kuttung Series and Permo-Carboniferous System.

This matter has been given full description above since it is an important one, and since a study of the structure in the Permo-Carboniferous and Kuttung provinces leads to some interesting information. The sketch-map (Text-figure 3) indicates the plan of the outcrops of the Paterson toscanite, the junction of the

Permo-Carboniferous beds and the Kuttung Series, and the Bolwarra conglomerate, alluvium being excluded from the map. In addition part of the outcrop of the Mt. Gilmore toscanite is shown to the north. The two indicators, the Paterson toscanite and Bolwarra conglomerate, are reliable datum lines to express the structure in the Kuttung and Lower Marine Series respectively. The Kuttung Series then shows clearly its disposition into two plunging anticlines and a plunging syncline. The Permo-Carboniferous rocks, however, in the same horizontal distance (14 miles) show three anticlines and two synclines and just off the left hand margin of the map there is a very compressed syncline. The stratigraphical interval between the two horizons is somewhere between three and four thousand feet. From these facts it seems likely that, were the Permo-Carboniferous beds laid down conformably upon the Kuttung tillites, then during the subsequent diastrophism, some striking irregularities occurred in the behaviour of the several units folded. The writer has studied Prof. David's map carefully and has noticed that, further to the south, some other interesting divergences among members of the Permian rocks are indicated, and, from a general knowledge of the broad structural features of the area to the north-west, feels convinced that examples of differential crumpling are evidenced. Thus, returning to the comparison between the area mapped by the writer and the Permo-Carboniferous beds to the south, it is reasonably clear that the broad dome-like structure which exists a little to the north of an east-west line from Paterson to Glenoak was produced in the initial stages of folding and has acted as a relatively resistant mass, being composed of hard lavas and tough tuffs and arkoses, against which the Permo-Carboniferous beds, predominantly of comparatively soft strata, were crumpled to a greater extent. This differential yielding would occur whatever the original relationship between the two sets of rocks, and future work, it is hoped, will help to solve this question.

Physiography.

The Paterson-Clarencetown area is only a portion of a large physiographic unit, the Hunter River area. It is outside the scope of the present paper to deal with the physiography of the latter area as a whole, but a detailed account of the topography of the area mapped will be given below, a few brief features of the Hunter River physiography only being mentioned to form a setting for the local discussion.

The outcome of the work already done on the physiography of Eastern New South Wales has been the recognition of the following major events. Somewhere in the middle or late Tertiary, Miocene or Pliocene, an extensive peneplain was developed on which rose monadnocks often capped with "older" basalt,—remnants from an older peneplain, possibly carved out during Cretaceous times. When near a state of completion, the Tertiary peneplain experienced a slight uplift and then a small subsidence, producing aggradation of the stream channels, which were subsequently flooded with the "Newer" basalts; a slight uplift succeeding and also a period of erosion with the production of very broad valleys. These events culminated in the Kosciusko uplift, with which the present cycle of erosion was introduced. The Hunter River area, in common with the rest of Eastern New South Wales, passed through all these vicissitudes, but during the last, the grand uplift, sagged behind and was not raised to as great a height as the neighbouring blocks. This, to some extent, is the reason why the Hunter area has reached a high state of maturity so soon. The evidence for this differential movement is to be found in the existence of faults on the margin of the

Barrington Tableland, information concerning which was given to the writer by Mr. Sussmilch (*cf.* Osborne, 1921, p. 130).

The peneplain of late Tertiary age on which the Newer basalts were poured occurs in remnants on Mt. Douglas at a height of 1,000 feet (neglecting the thickness of basalt capping), and also, at a height of 1,130 feet, on Red Hill and Mt. Johnstone.

From what has already been said (p. 525) it is clear that a considerable amount of erosion occurred in pre-Triassic times, and an actual peneplain may have developed, upon which were deposited the Mesozoic sediments, but no remnants of these have been found.

The age of the heavy faulting has been shown to be pre-Miocene and in all probability pre-Mesozoic, and this has physiographical interest. Had the heavy faulting been connected with the Kosciusko uplift, modified fault scarps would exist to-day, because the displacements are so large. But the topography is entirely free, with one or two small exceptions, from *direct* regulation by these meridional faults, and it goes to show how, in a cycle initiated by uplift and accompanying heavy faulting, the alignment of the fault surfaces in an area must have dominant influence on the initial stages of the resulting stream arrangement. After the peneplanation of such an area, if subsequent elevation without faulting occurs, the chief control is that of varying resistance of the strata, faults and joints being of comparatively minor significance. This would not hold in an area where the nature of the rocks was uniform.

Stress has been laid on the importance of the government of topography by the disposition of the strata in localities where the rocks are of varying composition (*cf.* Benson, 1920 and Browne, 1921). The area under consideration here exemplifies this very convincingly.

In the Clarencetown-Paterson area there are two large rivers, the Williams and the Paterson, each fed by a number of tributaries which have dissected the country to a well advanced stage. The contour map (Text-fig. 4) and the geological map (Plate xxvi.) show many of the physiographic features. Section P Q R S (Text-fig. 1) also illustrates the manner in which the two large rivers have carved their valleys along the anticlinal arches, leaving the strong synclinal structure to form a relatively resistant block.

These two rivers, when considered throughout their whole length, are essentially subsequent streams, as E. C. Andrews has pointed out (1903, p. 183), flowing in a general north and south direction under the influence of the meridional Tertiary faults and folds which occur along the Newcastle-Barrington strip. The valleys of the two rivers can each be divided into two portions, *in so far as this area* is concerned, the upper and lower portions respectively. The dividing zone in each case is a relatively narrow neck where the valley walls close in on account of the existence of a hard bar which has in all probability served, as Dr. Browne suggested to the writer, as a temporary base-level to which height the upper portion of the Valley was scooped out, involving a considerable amount of erosion.

The upper portion of the valley of the Paterson consists of a broad stretch of land at an elevation of from 100 to 150 feet, bordered on the western margin by a high ridge which curves round in sympathy with the extent of the Paterson River anticline. The case of the Williams is similar, the Gilmore ridge on the east forming the marginal feature. These two ridges owe their existence to the occurrence of a hard capping of toscanite which has protected them from erosion, the Paterson toscanite in the case of the Paterson River and the Mount Gilmore toscanite in the other case.

During the course through the upper portion of the valley, each river shows a distinct parallelism with the dominant strike of the rocks and below the hard bar, *i.e.,* in the lower portion, the effect of differential resistance is minimised (the sediments eroded being the Permo-Carboniferous) and the significance of faulting (*e.g.,* in the case of the lower Williams) is greater. A glance at the map will show that each of these two rivers possesses similar bends where passing through the Paterson toscanite. An examination of the stratigraphical data showed that the toscanite in each of these places is locally thin. One can see that these temporary minima of thickness determined the passage of the rivers which, close by, were controlled by the strike, east and west, of the rocks.

The country separating the rivers is composed of varying units and dissection is well advanced. The divide between the two drainage systems is, as shown on the contour map (Text-fig. 4), a very narrow one and it is certain that in a short time, geologically speaking, quite a decided rearrangement of the watercourses will take place, as a result of stream piracy between the tributaries of the Williams and Paterson Rivers on the one hand and the several tributaries of the Williams on the other.

Some of the small tributaries of these two large rivers, which possessed considerable grade, have aggraded the lower portions of their channels and subsequently cut into the resulting boulder beds, producing, as a result of the nature of the rock-units in association, such features as a high ridge and a level plain adjacent to one another. At the mouths of small tributaries, especially in the Valley of the Paterson, fans of boulder deposits are common.

It is now proposed to describe a number of localities after indicating the nature of the resistance of the various units, thus showing the control exercised by the disposition of the strata.

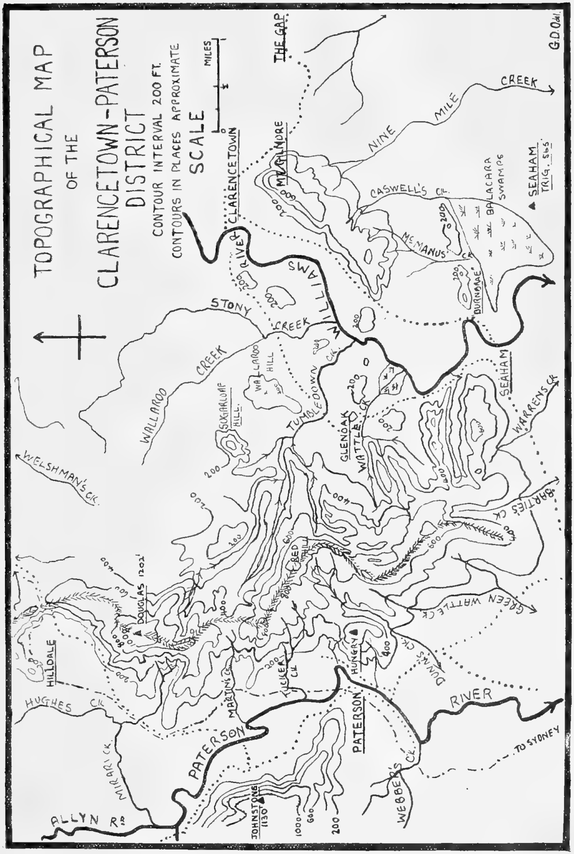
The members of the Burindi Series are chiefly non-resistant, as also are the rocks of the Basal Stage of the Kuttung Series. Both these divisions contain a lot of conglomerate, the matrix of which weathers rapidly, large tracts of residual pebbles being found.

In the Volcanic Stage, the Martin's Creek andesite and the Mt. Gilmore toscanite are the most resistant members, the others only registering medium opposition to erosive forces. Strangely enough, as Sussmilch pointed out, the dacites and rhyolites of this Stage are, in general, easily eroded, but this may be due to their lack of any great thickness. The conglomerates and tuffs are soft units and are more readily excavated than the sandstones, conglomerates, and tuffs of the Glacial Stage, which are of essentially a different composition. The toscanite of the latter Stage is a very resistant member and has had a dominant influence on the topographic evolution. The Main Glacial Beds generally produce mature type of country with lack of definition and are not hard types, while of the basalt, which occurs as cappings only, little can be said regarding corrasion, although chemical weathering has progressed to a considerable degree.

Thus it is manifest that the topography should, on account of the senile stage not yet having been reached, exhibit a variety of land forms, prevalent among which should be the occurrence of dip-slopes of hard units, and the following short local descriptions will indicate this.

Hilldale District.

Hilldale village is surrounded by hills chiefly of Kuttung rock, except to the west, while the lower country consists of Burindi beds. This arrangement is due to the erosion of a dome-like mass in the latter beds, the occurrence of the highland being possibly connected with a fault, F_6, but chiefly due to the somewhat



Text-fig. 4. Topographical Map of the Paterson-Clarencetown District.

were to play the leading role. Such was the case during the early history of the two large rivers, and to-day the same factors exercise important control over the courses of almost all the tributaries. The heavy faulting of pre-Mesozoic time must have had a great influence on the pre-Miocene or pre-Pliocene excavation, but its effects are overshadowed by the influence of the differential hardness and positions of the strata.

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DESCRIPTIONS OF TWO NEW TRILOBITES, AND NOTE ON *GRIFFITHIDES CONVEXICAUDATUS* MITCHELL.

By JOHN MITCHELL, late Principal of the Newcastle Technical College and School of Mines, Newcastle, N.S. Wales.

(Plate liv.)

[Read 29th November, 1922.]

PHILLIPSIA CONVEXICAUDATA.

Griffithides convexicaudatus, Mitchell, Proc. Linn. Soc. N.S.W., 43, 1918, 475-9, Pl. xlvi., fig. 13, Pl. xlviii., figs. 1-3, Pl. lii., figs. 5, 6.

Recently Mrs Pincombe, of Lambton, had the good fortune to find a perfect specimen of a trilobite, belonging to the genus *Phillipsia,* at the same locality on the Glen William Road, near Clarencetown, as *Griffithides convexicaudatus* Mitch., was found some years ago. This fine specimen has been passed on to me for identification and description, for which I am very thankful, as it enables me to revise my former description and conclusions regarding the generic position of that species. In the first place, after much careful study of this new specimen in conjunction with *G. convexicaudatus* Mitch., I find the differences insufficient to justify their specific separation; and as the new fossil is a *Phillipsia,* the species *convexicaudatus* must be transferred to that genus. Between the two there are small differences;—for instance, in the original type the thorax and pygidium are of equal length, and the cephalon so little shorter than either of these that the three parts may be accepted as almost equal; in the case of the new form the lengths of these parts are: head, 3.9 mm., thorax, 4.7 mm., tail, 3.9 mm., but the latter is, if they are specifically identical, not more than half mature, and this may account for the discrepancies in the relative dimensions. Another difference appears in the eyes: those of the original type seem to be shorter and deeper than those of the other; but the cephalon of the former is very imperfect, and this difference may arise through distortion. The head of the recently-found form shows all the characteristic features of a *Phillipsia* near *P. darbiensis,* and could, it appears to me, be placed as a variety of that species. In a general way every feature of the cephalon of our new trilobite agrees with the similar part of the cephalon of *P. darbiensis.* They are similar in shape, bear similar glabellar furrows, have eyes identical in shape and position and relative size; in fact the head-shields of the two forms are practically identical, and if the specific determination were made on this part of our new form alone, it would certainly be placed with *Phillipsia darbiensis* Martin. The two Austrawere to play the leading role. Such was the case during the early history of the two large rivers, and to-day the same factors exercise important control over the courses of almost all the tributaries. The heavy faulting of pre-Mesozoic time must have had a great influence on the pre-Miocene or pre-Pliocene excavation, but its effects are overshadowed by the influence of the differential hardness and positions of the strata.

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	Length	Width	Head	Thorax	Pygidium
1. *P. darbiensis* ..	17.85	10.2	6.2 long	6.2 long	5.45 long
2. *G. convexicaudatus*	25.0	14.06	7.8 (?)	8.6	8.6
3. New Specimen ..	12.5	7.8	3.9	4.7	3.9

The ratio of length to width is the same in the first and third and nearly so in the second, the measurements of the separate parts showing variation. In the case of the second specimen it is possible that the measurement given for its head is not correct, because of the damaged state of that part. I am disposed to think that in this fossil the head, thorax, and tail have almost equal lengths; and also that the variation in the length of the thorax of the third arises as a result of its immaturity. It is in the pygidia that the Australian and British examples differ most, as the following dimensions of the pygidia will show:—

	Length	Width	Segments in axis	Segments in pleurae
1. *P. darbiensis*	6.25	9.38	13	10
2. *G. convexicaudatus*	9.40	13.00	10	8
3. New specimen	3.90	6.25	10	8

It is thus seen that the ratio between length and width of these three fossils varies little and that practically the only differences worthy of consideration from a specific point of view are those which occur in the number of the segments in their pygidial axis and pleurae. No doubt these are fixed and constant differences and are sufficient to separate the two forms.

Family PROETIDAE.

Cordania gardneri, n.sp. (Pl. liv., figs. 1-7.)

Spec. Chars. Head-shield subsemicircular, densely tuberculated, strongly inflated. Glabella mildly convex, subcylindrical, relatively short, front gently rounded, sides subparallel, separated from the frontal limb by the continuity of the axial furrows, fairly densely covered with tubercles of different sizes. Basal lobes small, circumscribed, and each bearing two prominent tubercles and other smaller ones; neck-furrow shallow, its lateral extensions interrupted by the tumidity of the fixed cheeks adjacent to the axial furrows, from thence across the free cheeks wide and shallow; occipital ring moderately strong, convex and gently arched backward; lateral extensions ridged, subprominent and granulated. Frontal limb very wide, convex just in front of the glabella, thence concave to the upturned border, the convex portion thickly covered with several irregular rows of bead-like tubercles, most dense and largest near the antero-lateral angles of the glabella, the tubercles on the concave portion finer; border, along its outer edge, bears a row of moderately distinct pustules. Fixed cheeks tumid, lower than the glabella; on each, between the palpebral lobe and the axial furrow is a row of four tubercles, of which the anterior one is the largest and encroaches upon the furrow, causing it to indent the glabella. Free cheeks strongly inflated, steep between the eyes at the top and the borders at the bottom, between which they are conspicuously tuberculated; borders abnormally wide, concave between the cheeks and the thickened margins, which concave portions are only finely and sparsely tuberculate; both outer and inner edges of the margins are granulate; the genal angles are produced into stout spines. Eyes small, reniform, apparently faceted, prominent, separated from the cheeks by a distinct furrow, subdistant from the glabella and, for the greater part, in advance of the basal lobes. Anteriorly the facial sutures run from the front of the eyes straight to the inner edge of the thickened margin, thence inwardly, passing out at a very acute angle; posteriorly, they extend from the inner angles of the eyes obliquely and pass out near the fulcral angles.

Thorax composed of nine segments, sides subparallel, much wider than long (15.6 : 9.4), length equal to that of the pygidium or of the cephalon, which are approximately of equal length. Axis prominent, spread nearly equal throughout, much wider than one side lobe (approximately 5 : 3); each ring bears some seven nodules, three of which are very prominent, especially the central one, which is also subspinate, a feature of the central node on each ring, giving to the axis a subserrated aspect, more pronounced on the axis of the pygidium. Pleural lobes slope mildly from the axial furrows to the fulcral angles and thence steeply to their margins; the medial furrow of each pleura is narrow and deep, the posterior ridges, which are much stronger than the anterior ones, bear eight or more nodules, of which that on the fulcral angle is most prominent and that adjacent to the axial furrow nearly as prominent; the pleurae imbricate and their ends have a slight forward trend. Axial furrows only moderately defined.

Pygidium semi-elliptic, strongly convex and tuberculated. Axis very prominent, consisting of fourteen or fifteen rings and terminating prominently and bluntly before reaching the margin; the rings are tuberculated in a similar way to those of the thoracic axis, but the central ones of the pygidium are more spinate and recurved than are the similar ones of the thoracic axis and, in consequence, when viewed from the side, the pygidial axis has a more serrated aspect than has the axis of the thorax; these tubercles are arranged so as to form longitudinal rows, both on the axis and on the pleurae, which is also a feature of the tuberculation of the thorax. On the space between the end of the axis and the margin are a number of tubercles similar to those which are on identical positions of several species of *Brachymetopus*.

Side lobes are made up of nine pleurae in each, are strongly convex, slope steeply from the fulcral angles to and across the mildly thickened borders, where their ends are slightly depressed and tuberculated; on each pair of pleurae, except the last, the medial sutures are narrow but distinct; the posterior ridges bear large bead-like tubercles, eight in number on the anterior pleurae, but gradually decreasing to two or three on the ridges of the posterior pair; the anterior ridges also bear rows of smaller tubercles, those on the posterior ridges being so placed as to form longitudinal rows, the most conspicuous of which is that along the fulcral angles; the border is ill-defined, except posteriorly, and when it breaks away along its suture, which is not frequent, the under surface is seen to be striated; axial furrows distinct.

Dimensions: Length, 28 mm., width across the genal angles, 18 mm. From a specimen of which a longitudinal half is almost perfectly preserved, it is found that the cephalon, thorax and pygidium have approximately the same length. In both the thorax and the tail, the proportion of the width to the length is 2 : 1.

The determination of the generic position of this trilobite has proved to be a difficult problem. It does not fit either of the Carboniferous genera, and it therefore becomes a question to decide whether it possesses generic features sufficiently characteristic to justify the establishment of a new genus for its reception.

It seems impossible to place it in the genus *Phillipsia* because on no cephalon of the many of the type examined has a trace of either medial or anterior glabellar furrows been noticed. It resembles *Phillipsia* in the shape of its glabella, but the shortness of this and the great width of the limb distinguish it from that group. Other difficulties in the way of placing it with *Phillipsia* are its small eyes and their greater distance from the glabella. In its pygidial features generally, but especially in the ornamentation of this part, it resembles most closely some pygidia of *Brachymetopus*. In the absence of the fine glabellar furrows, it possesses the most important generic feature of *Griffithides*, but it lacks the pyriform and gibbous-fronted glabella; its wide limb, short glabella, eyes faceted and sub-distant from the glabella are also difficulties in the way of placing it with this group. With the *Brachymetopi*, perhaps, it agrees in a greater number of specific features than it does with the members of either of the two other genera referred to above. The bead-like pustulation of its glabella and pygidium strikingly resembles that found on *Br. strzeleckii* McCoy, *Br. ouralicus* De Verneuil and *Br. maccoyi* Portlock. Its cephalic border agrees very closely in shape and ornamentation with the borders of the first and last of the three species just referred to. Near the anterior and posterior inner angles of the eyes it bears very pronounced tubercles, similar to two borne in identical positions by *Br. strzeleckii* and, in part, by *Br. ouralicus*. Its short cylindrical glabella, wide cephalic limb or border, and small prominent reniform eyes distant from the glabella are features characteristic of the Brachymetopi. The genal spines, too, are like those of *Br. maccoyi*. Its small, pustulate basal lobes of the glabella and its occipital lobe are very similar to the like parts of several species of *Brachymetopus*.

If the pygidium of the trilobite now under discussion be compared with the pygidia of the two species *Br. ouralicus* and *Br. strzeleckii* referred to above, it will be found that it agrees with each of them in most of its details—the ornamentation of its test generally, the equality of the anterior spread of the axis and the side lobes, in having nearly the same number of rings in the axis and pleurae in each of the side lobes, the same kind of pustulation on the space between the end of the axis and the posterior edge of the margin. This latter feature is one which I have noticed on no pygidia except on those now referred to, belonging to the genus *Brachymetopus*, so that, simple feature as it appears to be, it is one of some significance. When the characteristics of our new trilobite, detailed above, are considered in conjunction with the generic characteristics of the three Carboniferous genera of trilobites, also compared and contrasted with it in the text above, the difficulty of referring it to either of those genera will, I think, be admitted, for these characteristics consist of a very remarkable blending of the generic characteristics of all three, those belonging to *Brachymetopus* (European type) preponderating. But for the absence of the fine glabellar furrows, it might be placed in the genus *Phillipsia*, as a very abnormal species. Except that its glabella is not pyriform and its eyes are small, faceted and subdistant from the glabella, and for the relatively great width of the border of the cephalic shield, a place for it might be found in *Griffithides*. Further, there seems only one feature possessed by this trilobite which stands in the way of placing it with *Brachymetopus*, and that is the presence of facial sutures; and it may be noted here that there is evidence that the process of fusion of the fixed and free cheeks had begun and the obsolescence of the facial sutures was in process of accomplishment, for the majority of the head-shields found have the free cheeks in place, yet the symphysis was not completed and the sutures remain and must be reckoned with. Some writers on trilobites seem to regard these sutures as having generic importance, but others, not less eminent, have not so regarded them. For example, in the genus *Acidaspis*, species which have their cheeks coalesced are placed with other species in which the facial sutures are present. The same practice occurs in the case of the genus *Ceratocephala,* and to overcome the difficulties surrounding the classification of the species, I might have accepted these cases as precedents and referred it to *Brachymetopus* tentatively.

However, it has been suggested to me by General A. W. Vogdes, of San Diego, Cal., U.S.A., an undoubted authority on trilobites, that a fitting resting place for the one under discussion might be in the genus *Cordania* J. M. Clarke, and, after a careful study of the genus I am persuaded to place it therein. *Cordania* was proposed by J. M. Clarke in 1892, for the reception of four species of *Phaethonides* described by Herrick (Bull. Denison Univ., 4, 1889, pp. 56-59). Since then, five other species have been added. All of the species are from the United States, and all, except *Cordania* (*Phaethonides*) *occidentalis* Herrick, from rocks of Devonian age. The exception is from the Carboniferous of the Waverley Group of Ohio, U.S.A. The pygidium of this species closely resembles the pygidium of the local form: the numbers of the segments in the axis and pleurae of each are nearly the same, and the ornamentation and general contour of the two are similar; but they differ much in their head-shields, and in size, the Australian one being much the larger. The pygidium of *Cordania* (*Phaethonides*) *spinosus* Herr. (*l.c.*), from the Devonian of the Waverley group of Licking County, Ohio, U.S.A., has a still greater resemblance to that of our specimens. The contour in each is similar—in the axis of the former there are fourteen rings and nine pairs of pleurae in the side lobes, in the latter these parts are fourteen or fifteen and nine or ten respectively; the spinate tubercles are more numerous on these same parts of the latter than they are on those of the former, though they are similar in character. The head-shields of the two are dissimilar in several respects, and the local one is of larger dimensions. In a general way the Australian form resembles *C. gasepiou* Clarke.

The genus *Cordania,* up to now, was confined to the United States, and the discovery of it in Australian rocks will prove to be of interest. Though in the United States the genus is almost exclusively Devonian, I am, because of the general aspect of the associated fossils, disposed to place the geological age of the Australian specimen as Carboniferous.

My sincere thanks are tendered to General A. W. Vogdes, of San Diego, for ample notes and suggestions which were of much assistance to me in determining the generic position of the trilobite here described. To Mr. Legge, of Legge's Camp, Myall Lakes, I wish to express my indebtedness for help which facilitated the work of collecting from this new locality. The species is dedicated to Master Frank Gardner who was the first to bring specimens of it under my notice, and who, though only thirteen years of age, is a keen student of geology.

Loc. and horizon.—Brambles farm, Myall Lakes, Parish of Eurenderee, County Gloucester, N.S. Wales, associated with *Aviculopecten, Spirifera, Conularia,* and one or two species of *Productus,* etc. Carboniferous (?); but not the equivalent, it seems to me, of any group of rocks of that age that has hitherto come under my observation in this State.

PTYCHOPARIA MERROTSKII, n.sp. (Pl. liv., figs. 11, 12.)

(For a previous reference to this trilobite see Bull. N. Terr., Dec., 1915.)

Description.—Complete form oval. Head-shield of medium length, semicircular, smooth. Glabella short, narrow, subconical, mildly convex, sparsely and faintly tuberculate, anterior pair of furrows faint, median and basal pairs fairly distinct, surrounding axial furrow shallow but distinct. Occipital furrows shallow. Occipital ring strong, smooth, but having an indistinct trace of a median tubercle, arched, lateral extensions strong. Fixed cheeks large, very mildly convex and lower than the glabella. Limb wide, approximately half as wide as the length of the glabella, convex between the front of the glabella and marginal furrow; margin fairly strongly upturned and thickened. Free cheeks unknown. Eye ridges faint and gently arching obliquely to the eye. Eye lobes small and crescentic. Facial sutures anteriorly straight and parallel, posteriorly pass out in front of the genal angle. Thorax consists of thirteen segments, widest at the fourth segment; greatest width equal to its own length and that of the pygidium together. Axis narrow, less wide than one side lobe, tapering very gradually posteriorly, ending with half of its anterior width, convexity moderate. Axial furrows shallow. Side lobes slightly lower at the axial furrows than at the fulcra and flat between these points; gently deflected between fulcra and margin, margins depressed, ends of segments rounded, free, with little, if any, forward direction; medial furrow of each pleura distinct and reaching just to the marginal end. Pygidium small, subsemielliptic, posterior margin rather straight, mildly tumid. In the axis there are four rings; three pleurae in each side lobe. There is evidence that on each ring of the axis medially there was a tubercle; similarly each pleura of the side lobes was ornamented at its fulcrum.

Dimensions: Total length, 23.4 mm., greatest width, 14 mm., length of head, 7.8 mm., of thorax, 12.5, of tail, 3.1 mm. Except for the missing free cheeks this fossil is the finest specimen of a lower Palaeozoic trilobite yet discovered in Australia. If the subgenus *Liostracus* were likely to be retained, the characteristics of our specimen should place it here rather than with *Ptychoparia*. The head-shield of our species resembles that of *P. stracheyi* Reed. The thorax and pygidium are rather closely similar to those of this species, but the ends of the pleurae of the former are rounded and horizontal while those of the latter are pointed and recurved.

The species is dedicated to Mr. A. L. Merrotsky, the discoverer, in whose possession the original still is. The above description was made from a cast, presented to the Australian Museum, Sydney (No. L. 1344).

Locality and horizon.—East of Alroy Downs, Barkly Tableland, N.W. Queensland. Probably of Cambrian age.

EXPLANATION OF PLATE LIV.

Cordania gardneri, n.sp.

Fig. 1. A nearly complete head-shield. It shows most of its characteristic features belonging to that part of the fossil, except the eyes. (x 2 approx.) Coll. Mitchell.
Fig. 2. A pygidium, viewed from above. (x 3.)
Fig. 3. Pygidium viewed obliquely from behind to show the tuberculation.
Fig. 4. A nearly complete specimen. The glabella is broken away and exposes the hypostome in situ. (x 2¼). Coll. Mitchell.
Fig. 5. A side view of the same specimen shown in fig. 4.
Fig. 6. Portion of a head which shows the left side very perfectly and the close resemblance it bears to the head of a *Cyphaspis*.
Fig. 7. Photo. of pygidium, showing serration of axis.

Phillipsia (Griffithides) convexicaudatus Mitchell.

Fig. 8. A nearly perfect non-testiferous cast. (x 2½).
Figs. 9 and 10. Photos of a squeeze from the cover of the preceding specimen. They exhibit the details rather clearly. (x 2). Coll. T. H. Pincombe.

Ptychoparia merrotskii, n.sp.

Figs. 11, 12. Photo. of a plaster cast of the original. (x 2¼). Coll. Australian Museum, Sydney, N.S.W.

THE PHYLOGENETIC SIGNIFICANCE OF THE MARSUPIAL ALLANTOPLACENTA.

By Professor T. Thomson Flynn, D.Sc., University of Tasmania.

[Read 29th November, 1922.]

In a paper which is now in the press (Quart. Journ. Micr. Sc.) I have been able, with the aid of certain early stages in the development of the marsupial *Perameles,* to extend in a fruitful direction our knowledge of the marsupial allantoplacenta. In this communication, following out Assheton's suggestion (1909) —against that of Hubrecht (1908)—I have used the term "placenta" for any mutual development of the foetal membranes and the uterine wall—whether of intergrowth or of mere apposition—which has for its purposive function the nutrition of the embryo *in utero.*

In this way, in a typical mammal, in the ontogeny of which the placental cycle is fully developed, there are three successive stages of this cycle, (*a*) metrioplacental, (*b*) omphaloplacental, (*c*) allantoplacental.

The following scheme will indicate the scope and nature of these stages:—

<table>
<tr><td>(a). This is the stage in which the nutrient material is absorbed without the aid of bloodvessels and, in fact, long before bloodvessels are developed. During this period cleavage and early development of the blastocyst take place. The work of this period is carried on in later growth by the lower non-vascular portion of the yolk-sac wall (= metrioplacenta).</td><td>Metrioplacental stage.</td><td rowspan="2">Omphaloplacental stage.</td><td rowspan="3">Allantoplacental stage.</td></tr>
<tr><td colspan="2">(b). The bloodvessels of the vascular area of the yolk-sac wall have now appeared and are functional. This area becomes closely applied to or actually fused with the uterine wall (= omphaloplacenta). The chorion prepares a way for the oncoming allantois.</td></tr>
<tr><td colspan="3">(c). The allantois becomes attached to the placental area of the uterine wall and an intimate fusion of embryonic and maternal tissues takes place, with a corresponding close apposition of the two sets of bloodvessels, the whole forming the allantoplacenta.</td></tr>
</table>

It will be evident that in the first stage the metrioplacenta is the only one present. In the next stage the metrioplacenta and the omphaloplacenta function together, the latter being the more important, while, in the final period, the allantoplacenta which is the dominant one functions with the other two.

Suppression of one or other of these stages of the placental cycle may take place. In general, in marsupials it is the third stage which is lacking. In *Perameles* alone, as far as is known, does it assume an importance comparable with that of the Monodelphia.

Relation of the Allantoplacentation of Perameles *to that of the Monodelphia.*

This can be considered under three heads, (*a*) maternal preparation, (*b*) embryonal preparation, (*c*) allantoic completion.

(*a*) In *Perameles,* the maternal preparation consists in the formation of a passive syncytium. The nuclei of this syncytium become very regularly arranged in the deeper portion of the thickened epithelium. The arrangement is that of groups of nuclei, each nuclear aggregation being contained in a lobule-like projection of the deeper surface of the proliferated epithelium. Between these lobules, capillaries ascend into the epithelium and ramify in rich plexuses at and below its surface (Hill, 1897-9).

Hill (1900) has also described a similar maternal preparation (syncytial formation) in the pregnant uterus of *Dasyurus viverrinus* and I can myself bear witness to the occurrence of a like phenomenon in the case of *Pseudochirus cooki.*

The development of such a syncytium in the latter two genera in which an allantoplacenta does not occur is, to my mind, just as significant, phylogenetically, as the extrusion of surplus yolk, which has been shown to occur in early cleavage stages of *Dasyurus* and of *Didelphys* (Hill, 1910; Hartman, 1916, 1919). Just as the latter phenomenon points to the derivation of the marsupial ovum from an ancestral, yolk-laden, meroblastic type, so the trophospongial proliferation which occurs in the pregnant uteri of *Dasyurus* and *Pseudochirus* is indicative of the presence of a complex system of placentation in the prototypal marsupial. It is unfortunate that our knowledge of possible alterations in the mucosa of the pregnant uteri of other marsupials, particularly *Phascolarctus* and *Macropus,* is absolutely nil.

The importance of this feature of marsupial intra-uterine development becomes evident when a comparison is made with certain of the *Monodelphia.* An essentially similar process occurs, for example, in the rabbit, as Maximow (1900) and Schoenfeld (1903) have shown us; in *Castor* [Willey (1914, p. 215) says "At the beginning, the proliferating cells retain their cell-boundaries (Pl. 20, fig. 70). Eventually the proliferation will become syncytial"]; and in many others. But there is, in particular, a most striking agreement with the Insectivora. Hill (1897) has already pointed this out in the case of *Sorex* and Hubrecht's (1909, p. 357) description of maternal preparation in *Tupaia* would serve almost word for word for *Perameles.*

(*b*) This consists in the attachment, to a portion of the previously prepared maternal syncytium, of a circumscribed area of the trophoblast, the chorion.

In *Perameles,* immediately on attachment, two distinct trophoblastic layers are formed; a plasmodial layer (the plasmodiblast or plasmoditrophoblast) and a more internally situated cellular layer, the cytoblast or cytotrophoblast. Structurally and physiologically these agree with the similar layers found in the allantoplacenta of many Monodelphia. And this agreement is the more striking the more the details are examined. Phagocytosis on the part of the trophoblast, giant cell formation (diplokaryocytes and megalokaryocytes), the presence of migrating leucocytes and of pigment-laden cells and partial gland necrosis are features of a chorionic attachment in *Perameles* which in no essential way differs from that found in *Monodelphia.*

(*c*) Allantoic attachment. This has already been described elsewhere. It is quite like that of *Monodelphia* and results in a similar close apposition of foetal and maternal bloodvessels.

Conclusions to be drawn from the above facts.

The question now presents itself:—What conclusions can be drawn from the above facts as to the phylogeny of the marsupial group? We can at once rule out of court Hubrecht's suggestion (1908) that the marsupials are a group derived from the Monodelphia. The death-blow was dealt to this theory by Hill in his brilliant and forceful essay of 1910 and it does not seem possible that it should ever again be seriously advocated.

The present conception of the interrelationships of the three mammalian subclasses rests mainly on the work of Huxley. In his paper of 1880, in applying the law of evolution to the problem of mammalian descent, Huxley came to the conclusion that, starting with a hypothetical pro-mammalian group as a basis, the evolutionary trend which resulted in the higher mammals (so-called *Placentalia*) was a continuous one, but at two periods, groups were formed, *Prototheria* and *Metatheria,* which were prototypal to the Monotremata and Marsupialia respectively. Huxley's group *Metatheria* was definitely defined as being aplacental.

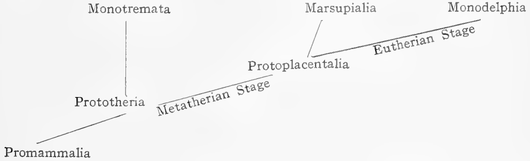
Gregory (1910) has ably and exhaustively reviewed the relationships of these groups and Bensley (1903) has emphasised the complexity of the problem of their definition.

There exist two diametrically opposed views as to the phylogeny of the Marsupialia. On the one hand, there are those who believe that the immediate ancestors of Marsupials were aplacental and that the presence of an allantoplacenta in *Perameles* is an example of homoplasy or convergent development. The modern exponent of this theory is Bensley (1903). On the other hand, Wilson and Hill (1897), Hill (1897-9) and Dollo (1899) hold the opposite opinion that the marsupials came from a placental stock.

The facts which I have been able to adduce in this and other papers can leave no doubt as to which view is right. The absolute agreement, even to minute details, of allantoplacental preparation and formation in *Perameles* with the phenomena occurring in *Monodelphia* show with the utmost certainty that this placenta in *Perameles* is no independently acquired organ. And the value of this conclusion is strengthened by the evidence afforded by changes in the pregnant uterus of *Pseudochirus* and *Dasyurus.* We can take it, then, that the available evidence shows that the marsupials are placental in origin and that the present aplacental condition of nearly all marsupials represents a condition of degeneration from the ancestral complex placental condition.

Huxley's plan of the relationship of the mammalian subclasses as indicated in his text-figure needs, therefore, certain modification. His metatherian group being definitely defined as aplacental, cannot be regarded as immediately ancestral to the Marsupialia and the term *Placentalia* as applied to the Monodelphia loses its significance.

My own views as to these relationships are expressed in the accompanying diagram.



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THE EFFECT OF SUSPENDED RESPIRATION ON THE COMPOSITION OF ALVEOLAR AIR.

By H. S. Halcro Wardlaw, D.Sc.

(From the Physiological Laboratory of the University of Sydney.)

[Read 29th November, 1922.]

In a previous communication the present author has described the change which takes place in the composition of alveolar air when the ventilation of the lungs is stopped by holding the breath, or by rebreathing the same air (Wardlaw, 1916).

When the ventilation of the lungs was stopped by holding the breath under normal or atmospheric pressure, the carbon dioxide content of the alveolar air rose as the period of holding the breath increased. The rise showed two distinct phases.

During the first 30 seconds the alveolar carbon dioxide rose in a manner which could be expressed by an exponential formula. In other words, the rate at which the carbon dioxide content was rising at any instant depended on the difference between the carbon dioxide content at that instant and a certain final or constant value which it seemed to be approaching. This final value was 6.7 % or 48.5 mm. Hg. After holding the breath for about 30 seconds the average carbon dioxide content of the alveolar air had reached 6.6% or 48.1 mm. Hg. and had almost ceased to rise.

As the holding of the breath continued, however, the second phase appeared, and the alveolar carbon dioxide content began sharply to rise again. The experiment could be continued only 5-6 seconds after the appearance of this second phase owing to the difficulty of holding the breath longer than about 35 seconds under the conditions of the experiment.

When the ventilation of the lungs was stopped by holding the breath under a negative pressure of about 30 mm. Hg less than atmospheric pressure, or by rebreathing the same air from a bag, the alveolar carbon dioxide content again rose as the period of holding the breath, or of rebreathing, increased; but the rise in this case showed only one phase. During the whole period of the experiment the alveolar carbon dioxide content rose in a manner which could be expressed by an exponential formula. The final or constant value which seemed to be approached in this case was 8.35 % or 60.5 mm. Hg. At the end of the experiments, in about 40 seconds, the average alveolar content of carbon dioxide had risen to 7.45 %, or 53.9 mm. Hg and was still rising.

The alveolar oxygen content in each of the above two series of experiments fell in a regular manner which showed only one phase, and could be expressed by an exponential formula. In each case the oxygen content was still falling rapidly at the end of an experiment.

When the breath was held under atmospheric pressure the final alveolar oxygen content which seemed to be approached was 7.62 % or 55.0 mm. Hg. The value actually reached at the end of the experiment was 11.21 % or 81.0 mm. Hg.

When the breath was held under negative pressure or when the same air was rebreathed, the alveolar oxygen content appeared to approach towards a final value of zero. The average value actually reached at the end of the experiments was 9.2 % or 66.5 mm. Hg.

There is little doubt that the final values approached under conditions of normal pressure represent the composition of alveolar air in equilibrium with mixed venous blood. The figures obtained lie close to those found for the tensions of the gases in venous blood by other workers using different methods, as was stated before. The second rise in the alveolar carbon dioxide content is probably due to the return of a large body of blood to the lungs after leaving them during an experiment in an incompletely arterialized condition.

The question raised by these experiments, however, is this: What is the significance of the final values which seemed to be approached under conditions of negative pressure of rebreathing? Does the simple occurrence of negative pressures in the lungs, or of respiratory movements, alter the tensions of the gases in the venous blood?

In the work referred to, the final values of the alveolar carbon dioxide content were always approached from below, that is, the carbon dioxide content always rose during an experiment. The periods for which the experiments could be continued were limited to 30-40 seconds, as the breath could not be held longer without interfering with the success of the experiment.

The experiments, therefore, had to be terminated before a definite conclusion could be reached as to whether the composition of the alveolar air actually would reach the constant values which the form of the variation indicated.

Methods.

In the experiments described in the present paper, confirmation of the previous work has been sought by approaching the final carbon dioxide tensions from above as well as from below, and by adopting a method which enables the experiment to be continued for much longer periods without inconvenience.

The final alveolar carbon dioxide values have been approached from above by breathing air containing a percentage of carbon dioxide greater than the final value expected.

The periods of the experiments have been extended by using a method employed by Yandell Henderson and Prince (1917). Instead of holding the breath for periods increasing in length until no further increase is possible, the subject holds his breath for a series of short periods of only 5-10 seconds.

He begins an experiment by expiring as deeply as possible into an empty rubber-lined bag, and immediately closing the tube connecting the mouthpiece with the bag. The expiration is made at the end of a normal inspiration. The subject then breathes normally for about 5 minutes to allow any respiratory and circulatory disturbances caused by the deep expiration to subside. He then expires as deeply as possible into the air, and takes a deep inspiration from the bag containing his expired air. This inspiration he holds in his lungs for 5-10 seconds, then expires into the bag again, as deeply as possible, immediately closing it as before. The subject then breathes normally for about 5 minutes again, empties his lungs, and takes another deep inspiration from the bag. He holds the inspiration for another 5-10 seconds and expels it into the bag, and closes the bag as before. This procedure may be repeated almost indefinitely without inconvenience. With each succeeding inspiration from the bag the subject takes into his lungs air which he has already held in his lungs for a period increasing with the number of expirations into the bag.

A limitation of the method is the fact that it is impossible to empty the lungs to exactly the same extent before each inspiration from the bag. Each inspiration is, therefore, mixed with a variable amount of residual air, and the regularity of the figures obtained is thus somewhat impaired. As will be seen from the accompanying Tables, however, the figures give a clear answer to the question which the experiments were carried out to settle: namely, whether the levels of the carbon dioxide content to which the composition of the alveolar air seemed to be tending according to the experiments of the author's previous paper, have any real existence or not.

Results.

Carbon dioxide.

In the following Table are shown the variations of the carbon dioxide content of the alveolar air as successive inspirations, made from a bag as described, are held in the lungs under normal pressure. The initial inspiration of each experiment was made from the atmosphere.

Table 1.*

Alveolar carbon dioxide content after holding expired air in lungs under negative pressure. Initial inspiration from atmosphere.

Number of inspiration	Alveolar carbon dioxide content					
	Expt. 1		Expt. 2		Expt. 3	
	Percent.	Tension	Percent.	Tension	Percent.	Tension
1	5.20	37.5	5.10	37.0	5.17	37.1
2	5.83	42.0	6.30	45.7	6.41	46.0
3	6.34	45.7	6.54	47.4	6.84	49.1
4	6.42	46.3	6.95	50.4	7.05	50.3
5	6.54	47.2	6.94	50.3	6.99	50.2
6	6.58	47.4	6.93	50.2	6.90	49.5

The above figures show that during the last three inspirations the alveolar carbon dioxide content had reached approximate constancy in each experiment. The mean figures for the period of constancy are 6.81 % or 49.1 mm. Hg., values which lie within 0.12 % or 0.7 mm. Hg. of those approached in the previous experiments.

In the next Table the variations of alveolar carbon dioxide are shown during experiments similar to those in Table 1, except that the initial inspirations were

* The percentages in the tables are by volume of the dry alveolar air. The tensions are in mm. of Hg and are also calculated for the dry alveolar air.

made from a bag containing air mixed with a percentage of carbon dioxide greater than the final values expected, so that the percentages at first fell during the experiment instead of rising as before.

Table 2.

Alveolar carbon dioxide content after holding expired air in lungs under normal pressure. Initial inspiration from mixture of air with carbon dioxide.

Number of inspiration	Alveolar carbon dioxide content			
	Expt. 4		Expt. 5	
	Percent.	Tension	Percent.	Tension
1	6.98	50.3	10.71	77.1
2	6.73	48.5	7.16	51.6
3	6.79	48.9	7.17	51.6
4	6.76	48.7	6.75	48.6
5	6.79	48.9	6.86	49.4
6			6.64	47.6
7			6.72	48.4

The above figures show that after the last four inspirations of each experiment approximate constancy had been reached. The mean figures for this period are 6.76 % or 48.7 mm. Hg. These figures are within 0.05 % or 0.2 mm. Hg. of the mean figures for Table 1, and are very close to those of the previous experiments.

From the above two series of figures it will be seen that the average final value reached by the alveolar carbon dioxide, when the breath is held under normal pressure, is practically the same, whether the final value is approached from above or below, and that the mean final values for the two sets of experiments, 6.78 % or 48.9 mm. Hg, are very close to the final values of 6.7 % or 48.5 mm. Hg indicated by the author's previous work.

In Table 3 are shown the variations of the alveolar carbon dioxide content when successive inspirations are made from a bag as described, and held in the lungs under negative pressure. The initial inspiration in each case was made from the atmosphere.

Table 3.

Alveolar carbon dioxide content after holding expired air in lungs under negative pressure. Initial inspiration from atmosphere.

Number of inspiration	Alveolar carbon dioxide content					
	Expt. 6		Expt. 7		Expt. 8	
	Percent.	Tension	Percent.	Tension	Percent.	Tension
1	5.35	38.4	5.17	37.5	5.28	37.2
2	6.67	47.8	6.76	49.0	6.48	46.5
3	6.87	49.3	7.03	51.0	7.04	50.5
4	6.72	48.2	7.12	51.6	6.93	49.7
5	7.18	51.5	7.02	50.9	7.00	50.3
6	7.11	51.1	7.05	51.1	6.80	48.8
7	7.03	50.4	7.18	52.0	6.85	49.2

The figures in this Table show that approximate constancy of the alveolar carbon dioxide was attained during the last five inspirations of each experiment. The average final value reached for the three experiments is 7.00 % or 50.4 mm. Hg. This value is only about 0.2 % or 1.5 mm. Hg higher than the mean final values for the experiments in Tables 1 and 2, and those found when the breath was held under normal pressures in the former experiments. It is very much lower than the highest values reached when the breath was held under negative pressure or when the same air was rebreathed, in the previous experiments. It is still lower than the final values which the figures seemed to be approaching. The highest values reached in those experiments were 7.45 % or 53.9 mm. Hg, and the final value approached was 8.35 % or 60.5 mm. Hg. as already stated.

In the following Table are shown the figures for the alveolar carbon dioxide content when a series of inspirations is held under negative pressure as before, but in this case the initial inspiration was made from a bag containing a mixture of air with a percentage of carbon dioxide higher than that expected in the alveolar air, so that the values rose during the first part of each experiment.

Table 4.

Alveolar carbon dioxide content after holding expired air in lungs under negative pressure. Initial inspiration from mixture of air with carbon dioxide.

Number of inspiration	Alveolar carbon dioxide content			
	Expt. 9		Expt. 10	
	Percent.	Tension	Percent.	Tension
1	10.25	73.9	10.73	77.2
2	7.42	53.5	7.49	54.0
3	7.03	50.5	7.17	51.6
4	7.01	50.5	6.77	48.8
5	6.99	50.4	7.11	51.2
6	7.11	51.2	7.00	50.4
7	7.03	50.5	7.03	50.6
8	7.08	51.0	6.89	49.6

The above figures show that during the last six inspirations of these experiments approximate constancy had been reached. The mean value of the alveolar carbon dioxide content for this portion of the experiments is 7.02 % or 50.3 mm. Hg. This value is nearly the same as that obtained in the previous experiments.

These results show that when the breath is held under negative pressure as described, final constant values are reached for the alveolar carbon dioxide content, and these values are but slightly higher than those reached when the breath is held under normal pressure in a similar manner.

Oxygen.

In the following Table are shown the values for the alveolar oxygen content when the breath is held in the manner described under normal and under negative pressure respectively; the initial inspirations were made from the atmosphere in each case.

Table 5.

Alveolar oxygen content after holding expired air in lungs under normal pressure (Expt. 3) and under negative pressure (Expt. 11).

Number of inspiration	Alveolar oxygen content			
	Expt. 3 Normal press.		Expt. 11 Negative press.	
	Percent.	Tension	Percent.	Tension
1	16.2	115.3	17.0	121.7
2	13.9	99.4	14.04	100.2
3	11.97	86.1	11.35	81.3
4	10.37	74.7	10.81	77.4
5	10.15	73.1	10.20	73.0
6	10.40	74.9	10.61	76.0

These figures show that when the breath is held under normal pressure, the alveolar oxygen content at first fell and, during the period of the last three inspirations, remained at an approximately constant level, having a mean value of 10.31 % or 74.2 mm. Hg.

When the breath was held in a similar way but under negative pressure the alveolar oxygen content fell as before and, during the period of the last three inspirations, remained at an approximately constant level having a value of 10.51 % or 75.2 mm. Hg.

The final values reached are practically the same in these two sets of experiments. They are very close to the final value of 11.21 % or 81.0 mm. Hg reached in the author's previous work when the breath was held under normal pressure. The present value for negative pressure, however, is distinctly higher than the value of 9.2 % or 66.5 mm. Hg. reached under negative pressures or during rebreathing in the previous experiments.

Discussion.

An essential difference between the present experiments and those carried out before is that, in the present case, the individual periods of holding the breath are so short that disturbances of the circulation are reduced to a minimum. In the former case, negative pressure or rebreathing was employed over periods four to six times as long as the present, the forced respirations or negative intrathoracic pressures, in increasing the filling of the right atrium, correspondingly accelerated the circulation although the pulse-rate was hardly affected.

The present experiments show that when the circulatory disturbances are minimised, an approximately constant composition of alveolar air is reached by holding the breath. This composition is almost the same whether the breath is held under normal atmospheric pressure or under a negative pressure of about 30 mm. Hg.

The existence of the constant tension of alveolar carbon dioxide indicated in the previous work is thus confirmed. It has been shown that the higher values for carbon dioxide, and the lower values for oxygen obtained under conditions of negative pressure in the former paper are not due to the effect of negative pressure directly on the composition, but rather to the acceleration of the circulation, leading to a more rapid accumulation of carbon dioxide and a more rapid removal of oxygen.

In conclusion I wish to express my thanks to Professor H. G. Chapman, in whose laboratory this work was done.

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A MONOGRAPH OF THE FRESHWATER ENTOMOSTRACA OF NEW SOUTH WALES. Part ii. Copepoda.

By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

(Plates lv.-lviii.)

Introduction.

The Copepoda of New South Wales have not been dealt with as extensively as the Cladocera. In 1855, King mentioned a species of *Cyclops, C. australis,* and four species of *Diaptomus*, but gave neither descriptions nor diagrams. The name *C. australis* was retained by Sars for the largest known Australian *Cyclops* but it has been impossible to identify the species of *Diaptomus,* as no members of that genus have been found in the vicinity of Sydney, where King obtained his specimens. The next mention of Copepoda in the State was in 1896, when Sars recorded the presence of nine species, two of which were described as new. In 1919, the present writer recorded five more species, of which three were described as new, and also a new genus *Gladioferens.* The present paper deals with twenty-three species; one is recorded for the first time in Australia, four for the first time in New South Wales and three are described as new.

With the exception of Victoria, comparatively little is known of the Copepods existing in the other States. Sars described eleven species from Victoria in 1908, six of which were new; in 1912, he added three new species and described a new genus *Hemiboeckella.* The work has been ably carried on by Searle who has published three papers, in 1911, 1912 and 1914, in which seven additional new species were described. The total number of species recorded from Victoria was thus raised to twenty-three. In 1889, Sars raised two species of *Diaptomus* from dried mud that had been collected from the Gracemere Lagoon, near Rockhampton, Queensland, one species, *D. lumholtzi,* being new. The only other Copepod recorded from Queensland was a new species of *Cyclops* described by Breinl in 1911.

The first mention of Copepoda in South Australia was made in 1917 by Chilton, who saw a species of *Boeckella* in Central Australia and recorded the fact, although the species was not identified. The six species here recorded were collected in the Botanic Gardens and in the hills near Adelaide. A species of *Boeckella* occurred in these collections, but as the specimens were all females and were not very numerous an exact determination could not be made.

G. W. Smith, in 1909, described seven species from Tasmania, of which six were new and proposed a new genus, *Brunella*. Dr. Chilton kindly sent the writer a collection of Copepoda from Cradle Mountain, Tasmania, which consisted mainly of specimens of *Boeckella longisetosa* Smith and a few of *Cyclops dulvertonensis* Smith.

Type specimens of the new species described in this paper and in Part i. have been deposited in the Australian Museum, Sydney.

The writer's thanks are due to Miss J. M. Murray, for specimens of South Australian Copepoda; to Mr. T. Whitelegge for many collections from the neighbourhood of Sydney; to Miss K. English for a collection from Yass and to Mrs. Neil Ross for several fine collections from Moss Vale and Holbrook.

The drawings for this paper were all prepared with the aid of a camera lucida; the finished drawings were done by Miss D. Harrison.

The following lists give the Copepoda recorded from all the States.

New South Wales.

CALANOIDA.

Fam. DIAPTOMIDAE.—*Diaptomus orientalis* Brady, *D. graciloides* Lilljeborg.

Fam. CENTROPAGIDAE.—*Boeckella triarticulata* (Thomson), *B. oblonga* Sars, *B. fluvialis*, n.sp., *B. coronaria*, n.sp., *B. minuta* Sars, *B. robusta* Sars, *B. pseudocheles* Searle, *Gladioferens spinosus* Henry, *G. brevicornis* Henry, *Hemiboeckella searli* Sars.

CYCLOPOIDA.

Fam. CYCLOPIDAE.—*Cyclops australis* King, *C. varicans* Sars, *Pachycyclops annulicornis* (Koch), *Leptocyclops agilis* (Koch), *L. viridis* Henry, *Mesocyclops obsoletus* (Koch), *Platycyclops phaleratus* (Koch), *P. affinis* Sars, *P. fimbriatus* (Fischer).

HARPACTICOIDA.

Fam. CANTHOCAMPTIDAE.—*Attheyella australica* Sars, *Moraria longiseta*, n.sp.

Victoria.

CALANOIDA.

Fam. CENTROPAGIDAE.—*Boeckella symmetrica* Sars, *B. oblonga* Sars, *B. asymmetrica* Searle, *B. tenera* Sars, *B. minuta* Sars, *B. pseudocheles* Searle, *B. triarticulata* (Thomson), *B. saycei* Sars, *Brunella viridis* Searle, *Br. longicornis* Searle, *Br. tasmanica* Smith, *Br. australis* Searle, *Br. ampulla* Searle, *Br. expansa* Sars, *Calamoecia australica* Sars, *Hemiboeckella searli* Sars.

CYCLOPOIDA.

Fam. CYCLOPIDAE.—*Cyclops australis* (King), *C. arnaudi* Sars, *Mesocyclops obsoletus* (Koch) var. *australiensis* Sars, *Pachycyclops annulicornis* (Koch), *Leptocyclops agilis* (Koch).

HARPACTICOIDA.

Fam. CANTHOCAMPTIDAE.—*Attheyella australica* Sars.

Queensland.

CALANOIDA.

Fam. DIAPTOMIDAE.—*Diaptomus orientalis* Brady, *D. lumholtzi* Sars.

CYCLOPOIDA.

Fam. CYCLOPIDAE.—*Cyclops pallidus* Breinl.

South Australia.

CALANOIDA.

Fam. CENTROPAGIDAE.—*Boeckella* sp.

CYCLOPOIDA.

Fam. CYCLOPIDAE.—*Cyclops australis* (King), *Pachycylops annulicornis* (Koch), *Leptocyclops speratus* Lilljeborg.

HARPACTICOIDA.

Fam. CANTHOCAMPTIDAE.—*Attheyella australica* Sars, *Moraria longiseta* Henry.

Tasmania.

CALANOIDA.

Fam. CENTROPAGIDAE.—*Boeckella robusta* Sars, *B. rubra* Smith, *B. insignis* Smith, *B. longisetosa* Smith, *Brunella tasmanica* Smith.

CYCLOPOIDA.

Fam. CYCLOPIDAE.—*Cyclops albicans* Smith, *C. dulvertonensis* Smith.

Classification.

The classification of the Copepoda is still in an unsatisfactory condition, mainly because many of the parasitic forms have not been thoroughly worked out. Giesbrecht's scheme of dividing the Eucopepoda into two suborders, Gymnoplea and Podoplea, was discarded by Sars in his Crustacea of Norway, as being artificial, and in dealing with the Copepoda as a whole, he divided it into seven great divisions, while for the Cyclopoida he revived Thorell's old terms of Gnathostoma, Siphonostoma and Poecilostoma. In dealing exclusively with the free-living forms, Giesbrecht's classification is quite a natural one, his suborder Gymnoplea corresponding with the division Calanoida of Sars and his Podoplea comprising the Cyclopoida and Harpacticoida. The following key is based on Giesbrecht's classification.

Key to the Eucopepoda.

A. Articulation between cephalothorax and abdomen occurring between the 5th and 6th segments .. .. suborder *Gymnoplea* (= *Calanoida* Sars.)

B. Antennules of male not geniculate. (All marine) Tribe *Amphaskandria.*

BB. One antennule geniculate in male. .. .. .. Tribe *Heterarthrandria.*

AA. Articulation between cephalothorax and abdomen occurring between the 4th and 5th free segments. .. .. suborder *Podoplea.*

B. Swimming forms with antennules not geniculate in the male. (Mainly parasitic). .. .. Tribe *Isokerandria.*

BB. Swimming forms with both antennules geniculate in the male. Tribe *Ampharthrandria.* (= *Cyclopoida* Sars and *Harpacticoida* Sars).

The free-living freshwater forms are all comprised in the three divisions *Calanoida, Cyclopoida* and *Harpacticoida* of Sars, so that the following key is sufficient for identification.

A. Articulation between the cephalothorax and abdomen occurring between the 5th and 6th free segments. .. .. *Calanoida.*

AA. Articulation between the cephalothorax and abdomen occurring between the 4th and 5th free segments.

B. Cephalothorax and abdomen distinctly separated. .. .. .. *Cyclopoida.*

BB. No distinct separation .. .. *Harpacticoida.*

Division 1. *CALANOIDA*.

Cephalothorax broader than the abdomen, with which it very movably articulates. Antennules elongated, those of the male transformed, either by a reduction in the number of segments or by the one being geniculated. Antennae biramous, endopodite biarticulate, exopodite multiarticulate. Five pairs of legs, the last of which are prehensile in the male. Single ovisac, when present, attached ventrally to the genital segment. A well-developed heart present. There are three freshwater families, but the majority of the Calanoida are marine.

Key to families of the Calanoida.

A. 5th pair of legs (♀) natatory. .. .. *Centropagidae.*
AA. 5th pair of legs (♀) not natatory.
  B. Endopodites of 5th legs (♀) absent. .. .. *Temoridae.*
  BB. Endopodites of 5th legs (♀) present. .. .. *Diaptomidae.*

Family DIAPTOMIDAE.

Abdomen short, composed of 2 or 3 segments in the female and 5 in the male; last segment of the cephalothorax with the lateral parts expanded in the female; caudal rami short. Antennules composed of 25 segments, the right one in the male geniculate. Antennae with the exopodite longer than the endopodite and seven-segmented. First pair of legs with endopodites composed of two segments, those of the next three pairs composed of three segments; fifth pair in the female with small simple endopodites and three-segmented exopodites; fifth pair in the male with the right leg larger than the left and provided with a movable claw. Ovisac present in the female. Two genera are included in this family, one of which is represented in Australia.

Genus DIAPTOMUS Westwood, 1836.

Syn.—*Glaucea* Koch, *Cyclopsina* M.-Edw. (part).

Lateral expansions of last segment of cephalothorax biangular, armed with two small denticles. Abdomen in the female 3-segmented, of which the genital segment is much the largest, second segment very small. First pair of legs with the last joint of the exopodites armed with only one spine outside. One hundred and sixty-two species of this genus have been described, nearly all of which are only represented in the northern hemisphere, its place being taken in the southern by *Boeckella* and allied genera. King mentioned four species of *Diaptomus* in 1855 (*D. pollux, D. maria, D. cookii* and *D. uxorius*), but no description or figures exist. It is probable that the specimens he referred to belonged to the genus *Boeckella* which is well represented in the vicinity of Sydney, since no species of *Diaptomus* has as yet been found south of Casino, on the north coast of N.S.W. Playfair recorded finding *D. gracilioides* in the Richmond River, but some doubt exists as to this being a correct identification. It is therefore only certain that one species of the genus occurs in New South Wales.

DIAPTOMUS ORIENTALIS Brady.

First described by Brady (1885), recorded from Australia by Sars (1889, Plate vii., Figs. 12-16; Plate viii., Figs. 1-4).

Female. Cephalothorax strongly built, tapering anteriorly; lappets of the last segment broadly expanded, their outer corners pointed and their inner corners rounded. Abdomen composed of two segments, the first of which is elongated and slightly expanded at the base; caudal rami short and broad, somewhat dilated near their tips, their inner edges finely ciliated; the innermost seta of each ramus is very delicate, the other five are large and densely hairy. Antennules composed of twenty-five segments and reaching beyond the first segment of the abdomen. Fifth pair of legs with the second segment of each exopodite produced inwardly to form a slightly curved process, 3rd segment very small, bearing two spines of unequal length; the endopodite, composed of one segment, nearly reaches the end of the first segment of the exopodite. Length, 1.8 mm.

Male. Similar to the female in shape, except that the caudal rami are slightly narrower. Right antennule very swollen in the middle portion. In the fifth pair of legs, the right leg has a small one-segmented endopodite and a two-segmented exopodite, the terminal segment of the latter bearing a short spine and a curved apical one; left leg with its exopodite bearing two digitiform processes and a rounded ciliated lamella. Length, 1.5 mm.

Distribution.—N.S.W.: Casino; Queensland; Ceylon; Natal.

Family CENTROPAGIDAE.

Caudal rami more or less elongated, bearing the full number of setae. Antennules in the female composed of 24 or 25 segments; right antennule in the male geniculate. Four first pairs of legs with both rami 3-segmented; fifth pair in the female biramous, natatory; in the male the exopodites transformed and dissimilar, the right leg being the stronger. Five genera of this family are represented in Australia but only three of them are known to occur in New South Wales.

Key to the genera of Centropagidae.

A. Natatory legs with the number of segments in the endopodites reduced.
- B. Endopodites of the first pair of legs one-segmented. .. .. .. *Brunella.*
- BB. Endopodites of first pair two-segmented. .. .. *Calamoecia.*

AA. Natatory legs with the endopodites three-segmented.
- B. 4th pair of legs in the female with a long spine on the inner edge of the basal segment. .. .. *Gladioferens.*
- BB. No such spine.
  - C. 5th pair of legs in the male with the exopodite of the left leg prehensile, ending in a long claw. .. .. *Boeckella.*
  - CC. Exopodite of the left leg scarcely prehensile, bearing a simple spine at the tip. .. .. *Hemiboeckella.*

Genus BOECKELLA De Guerne and Richard, 1889.

Syn.—*Boeckia* Thomson, 1882.

Last segment of the cephalothorax greatly produced laterally. Abdomen composed of five segments in the male, three in the female; caudal rami short. Five pairs of legs in the female, all natatory, and with both rami three-segmented; fifth pair with the second joint of the endopodite produced inside; fifth pair in the male very powerful, each leg terminating in a long movable claw, the endopodites rudimentary. About twenty-seven species are known and, with the exception of *Boeckella orientalis* Sars, which occurs in Central Asia, they are all confined to the southern hemisphere; seven species are found in New South Wales.

Key to species of Boeckella.

A. Basal segment of the left leg of the 5th pair in the male bearing a serrated lamella.
  B. Endopodite of the right leg of 5th pair in male, without an inward projection. .. .. *triarticulata.*
  BB. Endopodite with an inward projection.
    C. Endopodite of the left leg two-segmented. .. *fluvialis.*
    CC. Endopodite of the left leg one-segmented.
      D. Serrated lamella of the basal segment with a pointed projection. .. .. *coronaria.*
      DD. No such projection. .. .. *oblonga.*
AA. Basal segment of the left leg of the 5th pair in the male without a serrated lamella.
  B. Terminal segment of the exopodite of the 5th pair of legs in the female bearing only two spines. .. .. *minuta.*
  BB. Terminal segment bearing seven spines.
    C. Endopodite of the right leg of the 5th pair, male, does not reach the end of the second segment of the exopodite and bears a curved bristle at the base. .. .. *robusta.*
    CC. Endopodite reaches considerably beyond the second segment of the exopodite and has an inward projection at the base. *pseudocheles.*

BOECKELLA TRIARTICULATA (Thomson).

Described by Thomson (1882) as *Boeckia triarticulata*; first recorded from N.S.W. by Sars in 1896 and from Victoria in 1908 (Plate 1, figs. 1-4).

Female. Cephalothorax moderately slender, tapering slightly anteriorly; last segment expanded laterally into two bilobed lappets, the outer lobes of which extend beyond the first segment of the abdomen, the inner lobes are twisted and pointed at the tips. Abdomen about half the length of the cephalothorax; genital segment asymmetrically dilated at the base, being more swollen on the right side than on the left; caudal rami slightly longer than the last segment, widening towards the tips. Antennules comparatively short, extending, when reflexed, to the end of the second segment of the urosome. Fifth pair of legs with the endopodites extending beyond the second segments of the exopodites; the terminal segments of the latter bearing seven spines. Length, 2.5 mm.

Male. Smaller than the female. Right antennule geniculated. Fifth pair of legs with the second basal segment of the left leg provided on its inner side with a prominent triangular-shaped lamella, with a serrated edge; endopodite small and simple, reaching about half the length of the first segment of the exopodite. Right leg with a longer endopodite that almost reaches the end of the second segment of the exopodite and bears a small denticle at the tip; terminal claw equal to the length of the exopodite itself, the two other spines of equal size.

Distribution.—N.S.W.: Rarely found in the neighbourhood of Sydney; Victoria; New Zealand.

BOECKELLA OBLONGA Sars.

Sars, Arch. Math. og Naturvid., xxix., 1908, Plate 1, figs. 5-8.

Female. Cephalothorax narrower than in the preceding species, tapering slightly anteriorly and posteriorly; the lateral expansions of the last segment small, the outer lobes reaching the middle of the first abdominal segment, inner lobes straight and pointed. Genital segment of the abdomen asymmetrical, comparatively longer than in the preceding species and not so much dilated at the base. Antennules extending to the base of the caudal rami. Fifth pair of legs very similar to those of the preceding species. Length, 2.0 mm.

Male. Fifth pair of legs with the serrate lamella of the left leg smaller than in *B. triarticulata* and curved at the tip; right leg with the endopodite reaching the end of the second segment of the exopodite and having a well-defined, inwardly-directed projection near the base; the spine of the first segment of the exopodite is only half the length of that of the second segment; the terminal spine greatly exceeds the length of the ramus.

Distribution.—N.S.W.: This species has not hitherto been recorded from this State; it was collected on several occasions at Moss Vale. Sars' specimens came from Victoria.

BOECKELLA FLUVIALIS, n.sp. (Plate lvi., figs. 1-2 and 4-6.)

Female. (Pl. lvi., fig. 1). Cephalothorax long and slender, oval in outline, tapering slightly anteriorly; last segment with the lateral expansions (Pl. lvi., fig. 2) large, the outer lobe acutely pointed and extending to the end of the first segment of the abdomen, inner lobe small and rounded, with a short pointed projection in the middle. Abdomen with a long genital segment which is equal to the two succeeding segments combined; it is very slightly asymmetrical and moderately protuberant ventrally; caudal rami not divergent, exceeding the length of the preceding segment and bearing well-developed setae which are of almost equal length. Antennules long, reaching, when reflexed, almost to the end of the caudal setae. Antennae and oral parts of normal structure. Fifth pair of legs moderately strong, the second segment of the exopodite provided with the usual curved and denticulated claw, last segment of this ramus bearing seven spines, the inner apical one of which is exceptionally long, exceeding the length of the segment itself. Length, 1.8 mm.

Male. Similar in appearance to the female, but without the pointed lateral expansions of the last segment of the cephalothorax. Right antennule (Pl. lvi., fig. 6) moderately swollen and geniculated. Fifth pair of legs powerfully developed; the left leg (Pl. lvi., fig. 4) has a large rectangular-shaped lamella on the second basal segment; this lamella is irregularly serrated, the first and the last prominences being the largest. The endopodite is composed of two distinct segments; it is unarmed and has a rounded apex; the inner edge of the first segment of the exopodite is slightly curved towards the endopodite and bears numerous hairs. The second basal segment of the right leg (Pl. lvi., fig. 5) is produced inwardly to a pointed, somewhat triangular expansion; the endopodite reaches the end of the second segment of the exopodite, tapering irregularly to a point; the base is produced inwards to form a second triangular expansion which is broader than that of the basal segment; the spine of the first segment of the exopodite is equal in length to two-thirds of that of the second segment. Length, 1.7 mm.

This species is most nearly allied to *B. triarticulata* (Thomson) and *B. oblonga* Sars. It differs specifically from both these species, more especially in the length of the antennules and the formation of the fifth pair of legs in the male.

Distribution.—N.S.W.: Holbrook.

BOECKELLA CORONARIA, n.sp. (Plate lv., figs. 1-7.)

Female (Pl. lv., fig. 1). Cephalothorax long and slender, tapering anteriorly and posteriorly, the greatest width occurring about the middle; lateral expansions of the last segment of moderate size, the outer lobe extending beyond the middle of the first abdominal segment, inner lobe also acute. First segment of the abdomen exceeds the combined length of the two succeeding segments; it is very slightly dilated at the base and quite symmetrical; caudal rami longer than the last abdominal segment; caudal setae strongly developed. Antennules (Pl. lv., fig. 4) extending, when reflexed, to the middle of the caudal rami. Fifth pair of legs of normal structure, the terminal segment of the exopodite (Pl. lv., fig. 3) bearing seven comparatively short spines. Length, 1.5 mm.

Male. Right antennule (Pl. lv., fig. 7) less swollen than is usual in the genus, distinctly geniculated. Fifth pair of legs most nearly resembles that of *B. oblonga*; in the left leg (Pl. lv., fig. 6) the second basal segment bears a serrated lamella which is armed with several small denticles and terminates in a claw-like projection which also bears denticles; this projection is distinctly separated from the remainder of the lamella; endopodite of irregular shape, extending more than half the length of the first segment of the exopodite; the right leg (Pl. lv., fig. 5) has an inward projection on the endopodite as in *B. oblonga,* though it is of different shape and the endopodite itself does not terminate in a fine point as in that species but has an indentation in its otherwise rounded apex; the endopodite reaches the end of the second segment of the exopodite; the exopodite bears a terminal curved claw which is longer than the ramus, its other two spines are nearly equal in length. Length, 1.3 mm.

Note.—This species was reared from a sample of dried mud, and both males and females were plentiful in the aquarium; they were transparent, but the egg sacs were usually tinged with salmon pink.

Distribution.—N.S.W.: Corona (north of Broken Hill).

Boeckella minuta Sars.

Sars, Arch. Math. og Naturvid., 18, 1896, Plate 8, figs. 5-7.

Female. Cephalothorax elongated, slender, narrowing anteriorly; last segment expanded laterally into two bilobed lappets, outer lobe narrow and pointed, reaching beyond the middle of the first abdominal segment, inner lobe small and triangular. Abdomen slender, genital segment asymmetrical, longer than the next two segments combined; caudal rami longer than the last segment of the abdomen, but not as long as the last two segments combined. Antennules long, extending, when reflexed, beyond the caudal rami. Fifth pair of legs with a poorly developed terminal segment of the exopodite, which bears only two unequal apical spines. Length, 1.2 mm.

Male. Smaller than the female. Fifth pair of legs with both endopodites simple, one segmented, that of the right leg being larger than that of the left; the second basal segment of the left leg projects inwardly to a sharp point, both exopodites slender and provided with slender curved spines.

Distribution.—This small species is the commonest found in the State and is widely distributed. A few specimens were bred in an aquarium prepared with dried mud from Bringagee. N.S.W.: Kendall, Epping, Parramatta, Botany, Waterloo Swamps, University Pond, Lane Cove, Yarrangobilly, Bringagee, Corowa; Victoria.

Boeckella robusta Sars.

Sars, Arch. Math. og Naturvid., 18, 1896, Plate 8, figs. 1-4.

Female. Cephalothorax robust, the greatest breadth occurring in front of the middle, slightly tapering posteriorly; lateral expansions of the last segment with the outer lobes broad, extending beyond the first abdominal segment and terminating in points which are bent outwards, inner lobes very small and acute. Abdomen comparatively short, not half as long as the cephalothorax; genital segment long, asymmetrical, the right side protruding more than the left; caudal rami equal in length to the two last segments combined. Antennules short, scarcely exceeding the length of the cephalothorax. Fifth pair of legs with a well developed exopodite, the terminal segment small but armed with seven spines, endopodite almost reaching the end of the second segment of the exopodite. Length, 3.2 mm.

Male. Right antennule much swollen. Fifth pair of legs somewhat like those of the preceding species; in the right leg the spines of the exopodite are unequal, that of the second segment being longer than the first; endopodite tapering to a point and bearing a small curved bristle near its base; basal segment of the left leg produced inwardly to a point as in the preceding species, endopodite extremely small.

A single male specimen was bred from dried mud collected at Bringagee, which closely resembled this species. In the formation of the fifth pair of legs (Pl. lviii., figs. 7-9) the following differences were noted: the endopodite of the right leg was tipped with a short but distinct denticle, and was also armed with a straight upturned spine at the base, instead of the curved bristle, characteristic of *B. robusta*; in the left leg, the inward projections of the basal segment and the endopodite were of almost equal size and both rounded. Unfortunately no female specimens were obtained, so that it is impossible to decide whether this form is a variety of *B. robusta* or a distinct species.

Distribution.—N.S.W.: Sydney, Bringagee; Tasmania.

BOECKELLA PSEUDOCHELES Searle.

Searle, Vict. Nat., 28, 1912, p. 198, Plate v., figs. 1-9.

Female. Cephalothorax robust, broadly oval, tapering slightly anteriorly, lateral expansions of the last segment large, outer lobes extending almost to the base of the first abdominal segment, tips pointed and directed outwards, inner lobes very small. Abdomen short, genital segment short and broad, asymmetrical, the right side bulging more than the left, not very protuberant ventrally; second segment very small; caudal rami and setae short. Antennules short, extending, when reflexed, to the end of the cephalothorax. Fifth pair of legs with the curved process, on the second segment of the exopodite, comparatively small, terminal segment well developed and armed with seven spines. Length, 2.4 mm.

Male. Right antennule strongly hinged, the penultimate segment produced anteriorly. Fifth pair of legs of unusual form, the left leg with a small rounded lobe on the inner side of the second basal segment, exopodite with the last segment bearing two spines, endopodite small and flattened; right leg with a comparatively small apical claw, which ends in two unequal points, endopodite long and slender, extending beyond the second segment of the exopodite, its shape peculiarly characteristic, being inwardly produced at the base, somewhat swollen in the middle and blunt at the apex.

This species has not before been recorded in New South Wales.

Distribution.—N.S.W.: Holbrook; Victoria.

Genus GLADIOFERENS Henry, 1919.

Lateral expansions of the last segment of the cephalothorax reduced. Abdomen consisting of four segments in the female, five in the male. Caudal rami long and slender. Natatory legs biramous, each ramus consisting of three segments, fourth pair in the female with a long curved spine on the inner side of the basal segment. Fifth legs in the male with the terminal segment of the exopodite armed with one spine in the right leg and several short spines in the left leg. Ovisac present.

Two species known, both from New South Wales.

Key to species of Gladioferens.

A. Both rami of the 5th pair of legs in the male composed of three segments. *spinosus.*

AA. Endopodites of the 5th pair composed of less than three segments. *brevicornis.*

GLADIOFERENS SPINOSUS Henry.

Proc. Roy. Soc. N.S.W., liii., 1919, p. 32, Plate 1, figs. 1-7.
Distribution.—N.S.W.: Kendall, Waterfall, National Park.

GLADIOFERENS BREVICORNIS Henry.

Proc. Roy. Soc. N.S.W., liii., 1919, p. 35, Plate 2, figs. 10-12.
Distribution.—N.S.W.: Cumbalum.

Genus HEMIBOECKELLA Sars, 1912.

Lateral parts of the last segment of the cephalothorax not expanded. Abdomen composed of three segments in the female, five in the male. Caudal setae, of unequal length, are attached to the outer edge. Right antennule of the male hinged and with large conspicuous aesthetascs. Antennae with the endopodite imperfectly defined from the basal part. Natatory legs with both rami three segmented, terminal joint of the exopodite with two spines on the outer side. Fifth legs in the male unequal, left leg shorter than the right, endopodites of both legs distinctly segmented.

Only one species is known.

HEMIBOECKELLA SEARLI Sars.

Sars, Arch. Math. og Naturvid., 32, 1912, Plate ix., figs. 1-14.

Female. Cephalothorax moderately slender, tapering anteriorly and posteriorly. Head projecting into a well defined rostrum, divided at the end into two lappets. Abdomen short, genital segment symmetrical, narrowing towards the base, greatly protuberant ventrally; caudal rami divergent, inner edges ciliated, caudal setae of unequal length, the middle one exceeding the length of the whole abdomen. Antennules short, barely exceeding the cephalothorax. Fifth pair of legs with well developed exopodites, curved process of the second segment coarsely denticulated, terminal segment bearing three spines and three setae; endopodite reaching beyond the second segment of the exopodite. Length, 1.6 mm.

Male. Right antennule provided with numerous large and conspicuous aesthetascs. Fifth pair of legs, basal segment of the left leg produced into a large triangular projection, endopodite two-segmented, provided with a single seta; exopodite also two-segmented, first segment bearing a single spine, second segment with a simple terminal spine, a much smaller spine and a curved denticle. Right leg with a three segmented exopodite, each segment bearing a short spine; endopodite three-segmented, the second segment being produced inwardly into a long slender process.

Distribution.—This species has not hitherto been recorded from New South Wales; both males and females were abundant in a collection from Holbrook. Sars described it from specimens sent from Victoria.

Division 2. *CYCLOPOIDA.*

Cephalothorax much broader than the abdomen. Articulation occurring between the 4th and 5th free segments. Both antennules transformed in the male. Antennae usually devoid of exopodites. Fifth pair of legs rudimentary. Heart absent. Ova carried in two ovisacs which are attached laterally or sub-dorsally. There is only one free-swimming freshwater family.

Family CYCLOPIDAE.

Antennules composed of a varying number of segments, never exceeding seventeen. Antennae four-segmented, with an elongated seta at the end of the first segment. Natatory legs well developed, last pair of legs small and alike in the two sexes.

All the freshwater forms included in this family are classed by most authors in the one genus *Cyclops*. This genus, however, comprises so many species that several attempts have been made to separate them into groups. Sars in his Crustacea of Norway (1913) has gone further than this and has divided the old genus *Cyclops* into five genera; this classification appears to be a natural one and has been followed in this work.

Key to genera of the Cyclopidae.

A. 5th pair of legs composed of two segments.
- B. Distal segment armed only with setae. .. .. *Mesocyclops.*
- BB. Distal segment armed with setae and spines.
  - C. One lateral spine. .. .. *Cyclops.*
  - CC. Two spines. .. .. *Pachycyclops.*

AA. 5th pair of legs composed of a trilobate lamella.
- B. Lamella armed with one seta and one spine. .. .. *Leptocyclops.*
- BB. Lamella armed with two setae and a spine or three spines. *Platycyclops.*

Genus Cyclops Muller, 1776. (As restricted by G. O. Sars.)

Lateral parts of the three anterior segments of the cephalothorax well defined, last segment produced laterally. Abdomen slender, with the genital segment of the female dilated in front. Antennules of varying length, strongly hinged in the male. Antennae with all four segments well defined. Rudimentary palp of the mandibles with two long, plumose setae and a short bristle. Natatory legs with both rami composed of three segments, sometimes only two, endopodites of the fourth pair with two apical spines. Fifth pair very small, composed of two segments, distal segment not expanded and provided with an apical seta and a lateral spine. Seminal receptacle usually oval in shape.

Two species are known in New South Wales.

Key to species of Cyclops.

A. All natatory legs with both rami two segmented. .. .. *varicans.*

AA. 1st pair with both rami two-segmented, remaining pairs with both rami three-segmented. .. .. *australis.*

Cyclops australis (King).

Syn.—*C. sydneyensis* Schmeil.

This species was mentioned by King (1854) but no description or illustration was given, merely the name and locality "in all ponds"; since this was the only *Cyclops* mentioned by King, he probably united several species under the one name. Sars (1896, p. 74) briefly described a species of *Cyclops* from Australia under this name, it being the only unknown member of the genus in a collection sent to him from the neighbourhood of Sydney. The species was not figured until 1908 when Sars published detailed drawings (Plate iii., figs. 5-18).

Female. Cephalothorax oval in outline, tapering more posteriorly than anteriorly. Abdomen equal in length to two-thirds of the cephalothorax, its genital segment almost attaining the length of the three succeeding segments combined; caudal rami elongated, slender, exceeding the length of the last two segments combined, innermost apical seta very slightly longer than the outermost. Antennules very little longer than the first segment of the cephalothorax, consisting of twelve segments of which the 8th and 9th are unusually long. Both rami of the 1st pair of legs two-segmented, those of the three succeeding pairs three-segmented. Fifth pair with the basal segment marked only by a seta, terminal segment small, provided with a seta and a very small denticle. This is the largest Australian Cyclops known, the adult female attaining a length of from 2 to 2.5 mm.

Distribution.—N.S.W.: Byron Bay, Kendall, Centennial Park, Bourke Street, Waterloo Swamps, University Pond, Holbrook, Corowa; Victoria; South Australia.

Cyclops varicans Sars.

Sars, Christ. Videns. Sels. Forh., 1862, p. 43, Plate xxxiii.

Female. Cephalothorax moderately robust, oval in outline, the greatest width occurring in the middle; last segment slightly expanded laterally. Abdomen greater than half the length of the cephalothorax; the genital segment narrowing posteriorly; caudal rami very slightly divergent, equal in length to the last two segments combined, the innermost seta very much longer than the outer. Antennules composed of twelve segments, shorter than the first segment of the cephalothorax. Natatory legs with both rami two-segmented, endopodites of the 4th pair with both apical spines well developed. Fifth pair of legs with the proximal segment much reduced, its presence only marked by a seta, distal segment small, its seta long and slender and with a minute spinule on the inner edge. Length, .85 mm.

Distribution.—This species has never before been recorded from Australia. N.S.W.: Moss Vale, Berrima; New Zealand; North America; Africa; Turkistan; Europe.

Genus Pachycyclops Sars, 1914.

Lateral parts of the cephalothoracic segments not produced laterally, last segment very small. Abdomen moderately slender, genital segment only slightly dilated in front; caudal rami comparatively short, apical setae well developed. Antennules long and slender, composed of seventeen segments. Natatory legs with both rami composed of three segments; terminal segment of exopodite in 1st-3rd pairs with three spines outside, in 4th pair with two spines. Fifth pair two-segmented, proximal segment with a slender seta, distal segment short, armed with two unequal spines and a long seta. Seminal receptacle more or less bipartite.

This genus corresponds to Schmeil's "*fuscus-albidus*" group. One species is present in N.S.W.

Pachycyclops annulicornis (Koch).

Syn.—*C. quadricornis albidus* Jurine, *C. tenuicornis* Claus, *C. albidus* Schmeil, *C. gyrinus* Forbes.

Described by Koch in 1835, first recorded from Australia by Sars (1896) and figured in 1908 (Plate iii., figs. 1-4).

Female. Cephalothorax broadly oval in outline, the greatest width exceeding half the length. Abdomen long, genital segment cylindrical, equal to the combined length of the three succeeding segments; caudal rami short. Antennules long and slender, reaching beyond the third segment of the cephalothorax, composed of seventeen segments, of which the 2nd and 3rd, 10th and 11th are usually darker in colour than the other segments. Antennae with a very long and slender terminal segment. Natatory legs with the terminal segment of the endopodite of the fourth pair distinguished by the rudimentary distal seta. Fifth pair with the distal segment much smaller than the proximal. Length, 1.8 mm.

Distribution.—This species has a world-wide distribution and is very common in this State. A solitary specimen was raised from dried mud collected at Corona. N.S.W.: Kendall, Bangalow, Pt. Stephens, Parramatta, Five Dock, Centennial Park, National Park, Waterfall, Berrima, Yass, Bringagee; Victoria; South Australia; Hawaii; Asia; Africa; Europe; North and South America.

Genus Mesocyclops Sars, 1914.

Cephalothoracic segments scarcely prominent laterally; last segment very small and not produced laterally. Abdomen slender, genital segment elongated, slightly dilated anteriorly; caudal rami of moderate length or very short. Antennules long and slender, usually composed of seventeen segments. Antennae with the apical setae long and curved. Natatory legs with both rami three-segmented, terminal segment of the exopodite with only two spines outside, terminal segment of the endopodite unusually long. Fifth pair very small, two-segmented, the distal segment carrying two slender setae. Seminal receptacle bilobed anteriorly, the posterior portion somewhat tongue-shaped.

This genus corresponds to Schmeil's "*leuckarti*" group. One species occurs in New South Wales.

Mesocyclops obsoletus (Koch).

Syn.—*C. leuckarti* Claus, *C. simplex* Poggenpol, *C. scourfieldi* Brady.

First described by Koch in 1835 and recorded from Australia by Sars in 1896. In 1908 Sars described a special variety *australiensis* for the Australian form.

Female. Cephalothorax slender, more so than in the typical European form, first segment unusually large and the last very small. Abdomen long and slender, genital segment produced and equal to the length of the three succeeding segments combined; caudal rami less divergent and longer than in the typical form, sometimes slightly exceeding the length of the last two segments combined. Antennules composed of seventeen segments, long and slender, attaining the end of the third segment. Natatory legs with the spines of the exopodites very coarse. Fifth pair with a narrow distal segment, setae long and slender. Length, 1.3 mm.

Distribution.—N.S.W.: Kendall, Hornsby, Centennial Park, Bourke Street, Bringagee, Holbrook; Victoria; Hawaii; Asia; North and South America; Africa; and throughout Europe.

Genus LEPTOCYCLOPS Sars, 1914.

Segments of the cephalothorax produced laterally, rounded at the ends; last segment short and broad, produced on each side to a rounded hairy lobe. Abdomen slender, genital segment short; caudal rami more or less elongated. Antennules composed of twelve segments, the outer ones very slender. Natatory legs with both rami three-segmented, armed as in the genus *Pachycylops.* Fifth pair of legs formed by a trilobate lamella armed with a denticulated spine and two setae. Seminal receptacle with the posterior part not produced, forming two transverse bands. This genus comprises the species of Schmeil's *"serrulatus-prasinus"* group.

Two occur in New South Wales.

Key to species of Leptocyclops.

A. Antennules reaching the end of the second segment of the cephalothorax. *agilis.*
AA. Antennules reaching past the third segment of the cephalothorax .. *viridis.*

LEPTOCYCLOPS AGILIS (Koch).

Syn.—*C. serrulatus* Fischer, *C. varius* var. *brachyura* Lilljeborg.

Described by Koch in 1835, first recorded from Australia by Sars (1896).

Female. Cephalothorax slender, oval in outline. Abdomen slender, equal to two-thirds of the cephalothorax in length; genital segment dilated at the base, equal to the combined length of the two succeeding segments; caudal rami of moderate length, equalling the two preceding segments, diverging at the ends, outer edges denticulated. Antennules composed of twelve segments, long and slender, reaching the end of the second segment of the cephalothorax. Fifth pair of legs with a large, coarsely dentate, inner spine. Length, 1 mm.

Distribution.—This is the commonest *"Cyclops"* found in New South Wales, and is distributed practically throughout the State. Some specimens were raised from dried mud collected at Meryula Station near Cobar, N.S.W., Byron Bay, Dorrigo, Bangalow, Kendall, Moss Vale, Berrima, Bong Bong, Yarrangobilly, Lett River, Leura, Orange, Epping, Lane Cove, Parramatta, Five Dock, Botany; Victoria; New Zealand; New Guinea; Hawaii; Azores; Polar Island; Africa; North and South America and throughout Asia and Europe.

LEPTOCYCLOPS VIRIDIS Henry.

Proc. Roy. Soc. N.S.W., liii., 1919, p. 40, Plate 2, figs. 8-9.

Distribution.—N.S.W.: Kendall, Hornsby, Epping.

Genus PLATYCYCLOPS Sars, 1914.

Cephalothoracic segments expanded laterally; last segment short and broad, with its lateral parts more or less densely hairy. Abdomen robust, genital segment short; caudal rami of different shape in the different species. Antennules short, with the number of segments reduced. Natatory legs with the basal part broad, both rami three-segmented and of almost equal length, middle segment of the endopodite with a single seta inside. Fifth pair sometimes well defined, formed by a small lamella bearing two setae and a spine or this replaced by three spines. Seminal receptacle short and broad.

This genus comprises a somewhat heterogeneous collection of forms; it corresponds to Schmeil's *"phaleratus-affinis-fimbriatus"* group. Three species occur in New South Wales.

Key to species of Platycyclops.

A. Caudal rami short, not attaining the length of the last two abdominal segments combined.
  B. 5th pair of legs represented on each side by three spines. .. *phaleratus.*
  BB. 5th pair, each consisting of a lamella bearing a spine and two setae. *affinis.*

AA. Caudal rami long, exceeding the length of the last two segments combined. *fimbriatus.*

PLATYCYCLOPS PHALERATUS (Koch). (Plate lviii., fig. 1-2.)

Syn. *C. canthocarpoides* Fischer, *C. lascivius* Poggenpol.

Described by Koch in 1835, first recorded from Australia by Sars (1896).

Female. Cephalothorax short and broad, the greatest width occurring about the middle and equal to two-thirds of the length; lateral parts of the last segment produced, hairy. Abdomen strongly built, the posterior edges of all the segments denticulated; genital segment short and broad, scarcely as long as the next two segments combined; caudal rami short, bearing rows of spines. Antennules much shorter than the first segment of the cephalothorax, composed of ten segments. Natatory legs with a broad basal segment; in the 1st, 2nd and 3rd pairs, the terminal segment of the exopodite bears three coarse spines outside, the 4th pair bears only two. Fifth pair replaced on each side by three ciliated spines attached to the lateral corners of the corresponding segment. Length, 1.1 mm.

Distribution.—N.S.W.: Kendall, Berrima, University, Centennial Park, Botany; New Guinea; Ceylon; Turkistan; Europe; North and South America.

PLATYCYCLOPS AFFINIS Sars. (Plate lviii., fig. 3-4.)

Syn. *C. pygmoeus* Rehberg.

Described by Sars in 1863 (p. 47) and first recorded by him from Australia in 1896.

Female. Cephalothorax narrower than in the preceding species, first segment very long, last segment with the lateral parts slightly produced, bearing spinules. Abdomen with the genital segment slightly dilated at the base; caudal rami longer than in the preceding species. Antennules shorter than the first segment of the cephalothorax and composed of eleven segments. Natatory legs with the basal part narrower than in *P. phaleratus,* the terminal segment of the exopodite in the 1st and 2nd pairs with three spines outside, in 3rd and 4th pairs with only two. Fifth pair well defined, consisting of a small lamella bearing a slender spine, and outside a seta of the same length and in the middle a smaller seta. Length, .75 mm.

Distribution.—This is a comparatively rare species in New South Wales; it has only been found near Sydney and at Mt. Kosciusko. It occurs in China and Turkistan and throughout Europe.

PLATYCYCLOPS FIMBRIATUS (Fischer). (Plate lviii., figs. 5-6.)

Syn. *C. crassicornis* Sars.

Described by Fischer in 1853 (p. 94), first recorded from Australia by the present author in 1919.

Female. Cephalothorax somewhat more robust than the preceding species; first segment much longer than the four succeeding segments combined; last segment with the lateral parts produced, bearing stiff hairs. Abdomen equal to two-thirds of the cephalothorax in length, genital segment longer than the combined length of the two succeeding segments, slightly dilated at the base; caudal rami much longer than in the two preceding species, narrow, slightly divergent. Antennules short and thick, composed of eight segments. Natatory legs similar to those of *P. phaleratus*. Fifth pair composed of a small lamella, bearing a comparatively short spine and two slender setae. Length, .9 mm.

Distribution.—N.S.W.: Kendall, Five Dock, Centennial Park; New Guinea; Hawaii; Ceylon; North and South America; Europe.

Division 3. *HARPACTICOIDA.*

Body slender, more or less cylindrical, no distinct demarcation between the cephalothorax and abdomen. Last segment of the cephalothorax articulates with the preceding segment and is firmly attached to the first abdominal segment. Antennules small, rarely more than eight segments, both prehensile in the male. First pair of legs either similar to the succeeding pairs or transformed into grasping organs; three succeeding pairs natatory; fifth pair reduced, never natatory. Heart absent. Ova in a single ovisac attached ventrally or, more rarely, in two ovisacs.

The great majority of freshwater Harpacticids belong to the *Canthocamptidae* and this is the only family represented in Australia. This is the first record of the presence of members of this division in New South Wales.

Family CANTHOCAMPTIDAE.

Rostrum very small. Antennules usually composed of eight segments though the number may be reduced, distinctly hinged in the male. First pair of legs more or less prehensile, endopodites usually longer than exopodites; three succeeding pairs with exopodites always longer than endopodites which are sometimes reduced; fifth pair in the female more or less lamellar with the distal segment well defined and the proximal segment expanded inside. A single ovisac present.

This family comprises four genera that include true freshwater forms; two of them are represented in New South Wales.

Key to genera of Canthocamptidae.

A. Antennules composed of 8 segments.
  B. Endopodites of the 2nd and 3rd pairs of legs composed of three segments. *Canthocamptus.*
  BB. Endopodites of 2nd and 3rd pairs composed of two segments. .. .. .. *Attheyella.*
AA. Antennules composed of less than 8 segments.
  B. Antennules 7-segmented. .. .. *Moraria.*
  BB. Antennules 6-segmented. .. .. *Marshia.*

Genus ATTHEYELLA Brady, 1880.

Body slender, cephalothorax very little broader than the abdomen. Rostrum very small. Antennules comparatively short, eight-segmented. Antennae with the basal portion not subdivided, exopodite generally one-segmented, bearing two apical and two lateral setae. First pair of legs imperfectly prehensile, endopodite usually two-segmented, scarcely longer than the exopodite, rarely three-segmented and more elongated; endopodites of the three succeeding pairs reduced, two-segmented, the first segment very small, that of the third pair in the male transformed.

This genus comprises thirteen species, one of which is present in New South Wales.

ATTHEYELLA AUSTRALICA Sars.

Sars, Arch. Math. og Naturvid., 29, 1908, Plate iv., figs. 9-26.

Female. Cephalothorax moderately robust, with the first segment equal to the combined length of the next three segments. Rostral projection absent. Abdomen shorter than the cephalothorax, the ventral margins of the segments bearing coarse spinules and with groups of spinules at the sides. Anal opercle smooth; caudal rami divergent, narrowed at the tips; their inner edges bearing hairs; two slender setae on the outer edge, each accompanied by a cluster of spinules, middle apical seta very long, inner seta about half as long as the outer; the dorsal surface of each ramus bearing a well-marked carina and with a slender seta situated on a small prominence. Antennules slender, the last segment being the longest. First pair of legs with both rami composed of three segments, the exopodite reaching the end of the second segment of the endopodite. Fifth pair of legs with the inner apical seta much the longest, the proximal segment with a short triangular expansion bearing six setae. Length, .67 mm.

Male. Smaller than the female. Fifth pair of legs very small, the expansion of the proximal segment bearing two spines.

Distribution.—N.S.W.: Kosciusko, Holbrook; Victoria.

Genus MORARIA Scott, 1893.

Syn. *Ophiocamptus* Mrazek.

Segments of the body very distinct. Rostral projection prominent. Anal opercle angularly produced posteriorly. Caudal rami large, with two slender bristles outside. Antennules in the female composed of seven segments, strongly hinged in the male. Antennae with a small, one-segmented exopodite. Legs short, with the natatory setae imperfectly developed; first pair not very different from the three succeeding pairs, the endopodites of the latter are two-segmented and shorter than the exopodites. Fifth pair with the proximal segment expanded inside.

This genus consists of eight species, one of which is present in New South Wales.

MORARIA LONGISETA, n.sp. (Pl. lvi., fig. 3; Pl. lvii., figs. 1-7.)

Female (Pl. lvii., fig. 1). Body fairly robust, without any sharp demarcation between the cephalothorax and abdomen; first segment large, longer than the next three segments combined. Abdomen with the boundary line between the first two segments clearly defined. Rostrum small. Posterior margins of all the segments strongly serrated (Pl. lvii., fig. 3), the serrations being of very irregular size and shape; in addition the segments each bear a row of spinules, very short and fine in the cephalothorax but becoming longer and stronger in the posterior segments; the lateral parts of the segments slightly produced, each bearing a strong short denticle, those of the abdomen also provided with a group of spinules. Anal opercle smooth, with a triangular projection behind, the margin of which is fringed with hairs (Pl. lvii., fig. 5); caudal rami about the length of the last segment, distinctly keeled dorsally and bearing a seta about the middle of the dorsal surface; two long setae situated on the outer edge, each accompanied by a cluster of spinules; middle apical seta exceptionally long for the genus, outer seta of moderate size, inner one very small and slender. Antennules composed of seven segments, the outer portion including only three segments. Both rami of the first pair of legs (Pl. lvii., fig. 6) composed of three segments, the exopodite scarcely reaching beyond the first segment of the long endopodite; the second pair (Pl. lvii., fig. 4) has a long three-segmented exopodite and a short two-segmented endopodite, the first segment of the latter being very small, the 3rd and 4th pairs have also long three-segmented exopodites, and two-segmented endopodites but the second segments are shorter than those of the second pair. The fifth pair (Pl. lvi., fig. 3) is well developed, the inner expansion of the proximal segment being large and bearing 6 long setae. Length, .70 mm.

Male. Smaller than the female, only attaining a length of .55 mm. Antennules (Pl. lvii., fig. 7) transformed into hinged grasping organs. The three-segmented exopodite of the first two pairs of legs comparatively long and provided with long setae, the endopodite of the first pair is long and three-segmented, that of the second is very short and two-segmented; in the third pair the exopodite is three-segmented and is short and stout, the endopodite is also three-segmented, the second segment bearing an extremely long seta on the inner side and the slender terminal segment bearing two long setae. Fifth pair of legs small, the inner expansion of the proximal segment bearing two unequal setae.

This species is in some respects nearer to the genus *Attheyella* than to *Moraria*, especially in the long, well-developed caudal setae and in the structure of the first pair of legs; it is true to the genus *Moraria,* however, in the possession of a triangular expansion behind the anal opercle and in having antennules composed of only seven segments. There is no doubt that the two genera are closely allied.

Distribution.—N.S.W.: Holbrook.

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EXPLANATION OF PLATES LV.-LVIII.

Plate lv.

Boeckella coronaria.

Fig. 1.—Female (x 50); Fig. 2.—♀ lappets (x 50); Fig. 3.—♀. exopodite, 5th pair of legs (x 270); Fig. 4.—♀. antennule (x 64); Fig. 5.—♂. right leg of 5th pair (x 318); Fig. 6.—♂. left leg of 5th pair (x 318); Fig. 7.—♂. right antennule (x 64).

Plate lvi.

Figs. 1-2. *Boeckella fluvialis.*

Fig. 1.—Female (x 25); Fig. 2.—♀. lappets (x 64).

Fig. 3. *Moraria longiseta.*

♀. 5th pair of legs (x 270).

Figs. 4-6. *Boeckella fluvialis.*

Fig. 4.—♂. left leg of 5th pair (x 230); Fig. 5.—♂. right leg of 5th pair (x 230); Fig. 6.—♂. right antennule (x 64).

Plate lvii.

Moraria longiseta.

Fig. 1.—Female (x 64); Fig. 2.—♀. antennule (x 270); Fig. 3.—♀. margin of the 1st segment (x 270); Fig. 4.—♀. leg of 2nd pair (x 270); Fig. 5.—♀. end of the abdomen (x 270); Fig. 6.—♀. leg of 1st pair (x 270); Fig. 7.—♂. antennule (x 270).

Plate lviii.

Figs. 1-2. *Platycyclops phaleratus.*

Fig. 1.—Female (x 62); Fig. 2.—♀. 5th leg (x 186).

Figs. 3-4. *Platycyclops affinis.*

Fig. 3.—Female (x 96); Fig. 4.—♀. 5th leg (x 200).

Figs. 5-6. *Platycyclops fimbriatus.*

Fig. 5.—Female (x 62); Fig. 6.—♀. 5th leg (x 186).

Figs. 7-9. *Boeckella robusta.*

Fig. 7.—♂. right leg of 5th pair (x 98); Fig. 8.—♂. left leg of 5th pair (x 98); Fig. 9.—♂. endopodite of right leg (x 440).

A CONTRIBUTION TO THE PARASITISM OF *NOTOTHIXOS INCANUS* (OLIV.). VAR. *SUBAUREUS*.

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(Eleven Text-figures.)

[Read 29th November, 1922.]

Notothixos incanus (Oliv.) var. *subaureus* is a parasite which frequently occurs upon species of *Loranthus*, especially *L. celastroides, L. pendulus* and *L. eucalyptifolius,* in New South Wales. I have also found it growing upon the branches of *Phyllanthus, Eucalyptus corymbosa, Angophora lanceolata,* and several species of *Casuarina.* It branches dichotomously, and its young shoots and leaves are covered by a thick tomentum of golden-yellow, multicellular, branched hairs. The flowers are usually sessile, and occur in small pedunculate inflorescences. The fruit is slightly succulent and tomentose, and contains a single gelatinous-coated seed. The parasite is distributed over the eastern portion of the State, extending from the Coast District to the Blue Mountain Plateau, and requires moist climatic conditions during dissemination and germination.

Dissemination.

Notothixos incanus (Oliv.) var. *subaureus* flowers in May-June and the fruits ripen about twelve months later. They are small, practically oval in shape, covered with multicellular, yellowish, branched hairs, and are not explosive as in *Arceuthobium occidentale* (Pierce, 1905); the seeds are extruded by a gelatinous tissue within the fruit.

Dissemination takes place during moist, humid weather when there is little evaporation from the surface of the leaves. Under such conditions the fruits become exceedingly turgid, owing to certain gelatinous tissues swelling, and a slight movement of the branches or shock causes the fruit to drop off, and the seed to glide out.

Text-figure 1 shows a longitudinal section of a mature fruit containing one seed. The fruit is attached to a short stalk from which it is readily parted when ripe. Externally the fruit is covered by a heavily cutinised epidermis (*ep*), one layer of cells in thickness, and with the outer walls considerably thickened. Stomata with depressed guard-cells are present; numerous yellowish-coloured, multicellular, branched hairs are developed over the surface of the fruit.

Underlying the epidermis is a zone of several layers of thin-walled parenchymatous cells, many of which contain chlorophyll granules. These cells have thin cellulose walls. Traversing the centre of this zone is a narrow tracheal region, consisting of a single series of tracheae with cambiform cells on either side (*f.c.*); this zone is the fruit coat, composed of the ovary wall and the continuation of the receptacle. Within this zone is a broad region composed of three distinct layers, probably representing the integument and nucellus of the seed, namely: on the outside, one or two layers of small, thin-walled parenchyma cells; in the middle, a single layer of broad gelatinous cells with thick gelatinous walls, little protoplasm and large nucleus. This layer is the important one in bringing about the swelling and subsequent rupture of the fruit. Underlying this gelatinous layer there occur several rows of elongated cells, with a distinct row of tracheae in the centre. The gelatinous layer is attached on its inner side to this tissue and on its outer to the small-celled layer. The seed-covering is clearly seen in Text-fig. 1, *p.l.* representing the parenchymatous layer, *g.l.* the broad gelatinous layer and *Tr.l.* the inner tracheal-bearing layer. The gelatinous layer is barrel-shaped and open at both ends. The next tissue met with on passing inwards, is the endosperm (*end*), thin-walled, filled with starch grains and surrounded by a distinct, small-celled, large-nucleated, peripheral layer. At the upper end of this endosperm the large embryo is situated (*emb.*). The endosperm cells surrounding the root of the embryo are small and compact, and form a sheath around it, which looks very much like a root-cap. On germination, however, the root grows through this sheath.

The fruit coat is prolonged upwards into a short style and stigma (*st*), the cells of which are papillate. At the base of the fruit there is a mass of short reticulately and spirally thickened tracheae embedded in a region of small thin-walled parenchyma cells. Sieve-tubes are not present, as far as I could determine. This basal region represents a mechanically weak one, and it is here that the fruit separates from the stalk (Text-fig. 1, *deh.*).

In regard to the mechanics of seed dispersal, it is readily seen that the motor-tissue is the gelatinous cells almost surrounding the fruit, while the dehiscence occurs at the base. The gelatinous cells are not all arranged in the same manner. In the upper portion of the fruit they are practically at right angles to its long axis, while in the lower portion, they are obliquely inclined to this long axis. When swelling takes place, on absorption of water, or when reduced transpiration increases the turgescence of the fruit, obviously the gelatinous cells will swell differently and, therefore, tension will develop in the fruit. The lower gelatinous cells have thinner walls than the upper, which will swell more than the lower, and therefore the upper part of the fruit will become more distended than the lower. The dehiscent layer is at the base, where there is a line of mechanical weakness. When conditions are favourable, i.e., when there is sufficient humidity and reduced transpiration, the gelatinous cells swell in different degrees and directions, and the severance of the fruit from the stalk occurs. Impact of the fruit against any object will cause the gelatinous-covered seed to be extruded, but this would occur automatically by the pressure developed in the upper portion of the fruit. The swelling of the gelatinous cells undoubtedly takes place by the walls absorbing water, and not by the osmotic activity of the cell contents.

The Seed.

In *Notothixos* the endosperm with its embryo is surrounded by a gelatinous region, which is differentiated into the three zones mentioned above. These three zones probably represent the nucellus and integuments. The gelatinous covering is sticky enough to attach the seed to rough or smooth objects with which it may establish contact. On exposure to dry air or heat it dries slowly, and firmly secures the attachment of the seed. In moist conditions the gelatinous coat readily absorbs moisture, either as vapour or liquid; indeed, such absorption is of considerable importance, for it represents the only source of water to the embryo during its early growth, until its haustorium has penetrated the host's water-tissues.

The walls of the gelatinous cells consist of two layers, namely, a thick, outer, gelatinous layer capable of swelling, and a thin, spirally twisted, cellulose layer. The cell cavity is narrow, but filled with granular cytoplasm. In nearly every cell a nucleus can be seen. Text-fig. 2 shows a gelatinous cell, from a microtome section of material fixed in 1 % chromacetic.

The gelatinous layer of the cell-wall loses its water content very slowly, while the spiral cellulose layer shortens and pulls the seed into closer contact with the surface. The structure and mechanism of the cells are closely parallel to the similar structure which occurs in *Arceuthobium occidentale* (Pierce, 1905).

I have seen attached seeds, which had failed to germinate, still adhering to the surface of branches fully a year after dissemination. The empty husk of the seed, after germination, frequently sticks to the surface for months.

Germination.

The seeds of *Notothixos,* like those of *Loranthus* and *Arceuthobium,* will germinate upon anything, living or dead. Moist conditions, with diminished evaporation, are necessary for the purpose. The gelatinous layer of the walls of the seed-coat cells can then provide the developing embryo with its moisture requirements. The growth of the seedling will depend considerably upon the surface to which the seed has been attached. Any roughness of the surface, or any obstruction in the form of a knot, or leaf, or branch, prevents the excessive elongation of the root. On leaves, the root may grow until the food reserves in the endosperm are exhausted.

Just before germination the embryo appears as an almost cylindrical mass of tissue, differentiated distinctly into root, hypocotyl, plumule and cotyledons. The root-apex is rounded rather than conical and there is no root-cap. The cotyledons are somewhat pointed, and lie close together. The root and part of the hypocotyl fit closely against the endosperm, while the cotyledons are separated from it by a narrow space, which widens as germination progresses. The endosperm layer, in contact with the embryo, is composed of small, thin-walled, densely protoplasmic, large-nucleated cells, practically free of starch. The outer cells of the endosperm are full of starch. As germination proceeds, a clear space appears all round the embryo, so that the dissolved foods from the endosperm must diffuse through the fluid of this space. The peculiar differentiation of the endosperm cells immediately surrounding the embryo suggests the hypothesis that they are responsible for the solution of the starch of the endosperm.

The dermatogen of the embryo is already differentiated, while behind the meristematic cells of the root-apex, and in the cotyledons, the plerome cells, with their elongated, spindle-shaped nuclei, are already organised.

The irritability of the root.

The root is not geotropic, but strongly negatively phototropic, always growing towards the more shaded parts of a branch. Frequently very pronounced curvatures are completed before the optimum light position is attained by the root

(Text-fig. 3). The growth of the root is stopped by some roughness or obstacle in the direction of its growth; when a resistance is provided the root forms a small club-shaped holdfast. In the absence of contact with a resisting body the holdfast is not developed (Text-fig. 4).

Primarily the holdfast consists of an undifferentiated mass of actively meristematic cells, but the dermatogen cells in contact with the obstacle elongate considerably and securely attach the holdfast. These elongated cells recall the "cushion cells" of the haustoria of *Cuscuta* (Pierce, 1893). The holdfast grows as the food is transported from the endosperm. The central region of the holdfast undergoes differentiation, and a mass of tissue grows out from it into the bark of the branch. Penetration is probably dependent upon a certain amount of pressure, but mainly upon chemical solution. There is very little indication of a pressure-effect in the direction of growth of the haustorium, although, in the mature haustorium, the phloem and cortex along the margin of the sucker are crushed. The mechanical conditions for the development of pressure by the haustorium are not so efficient as in *Cuscuta*. Evidences of chemical action are numerous, namely, discolouration of the host-tissues in front of the haustorium, and the pushing inwards of the walls of the host by the penetrating epidermal cells of the sucker (Text-figs. 5, 6), and the very exact application of the tracheids of the haustorium to the vessels of the host. The epidermal cells of the tip of the haustorium are slightly papillate, fairly long and have dense cytoplasm and a large nucleus. Immediately behind this layer the cells are small and meristematic. The penetration of the haustorium leads to the destruction of a considerable wedge of cortex, phloem, cambium, and part of the wood of the host. When the haustorial tissue taps a number of vessels of the host branch, certain cells of the peripheral layer differentiate into short reticulate tracheids which link up with others already formed in the central shaft of the sucker.

Text-fig. 1. A longitudinal section of the fruit, showing epidermis (ep.), fruit-coat (f.c.), gelatinous layer (g.l.), the tracheid-bearing layer (tr.l.), endosperm (end.), embryo (emb.), stigma (st.), dehiscent zone (deh.). (x 10).

Text-fig. 2. Cell from gelatinous layer, showing gelatinous layer (g.l.), and spirally thickened cellulose layer (c.l.). (x 125).

Text-fig. 3. Seedlings of *Notothixos* showing curvatures of the root and hpyocotyl. (slightly enlarged).

Text-fig. 4. Holdfast developed from the root-apex when resistance to growth is provided. (slightly enlarged).

Text-figs. 5, 6. Portion of haustorium (H) in contact with the vessels of the host. The papillate character of the peripheral layer is shown, while some of the cells have pushed in the walls of the host-cells (v.h.). (x 110).

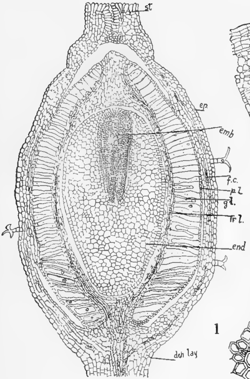
Text-fig. 7. L.S. of mature haustorium embedded in the xylem of the host; laticiferous tissues (l.t.), cambial zone (c.l.), phloem (p.h.), cork (c.) are shown. (x 50).

Text-fig. 8. Longitudinal section through host and haustorium showing relation of parasite to the host vessels. (x 125).

Text-fig. 9. Application of a haustorial tracheid to a vessel of the host. (x 125).

Text-fig. 10. Part of the central zone of the haustorium (c.) with the crushed phloem (ph.) of the host. (x 125).

Text-fig. 11. Lower epidermis of leaf showing one of the septate hairs. (x 125).



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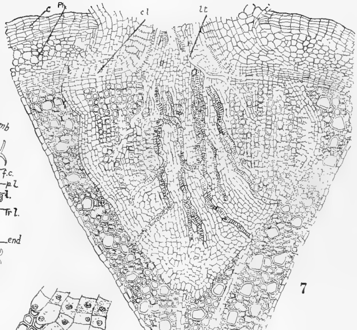

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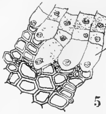

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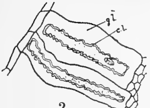

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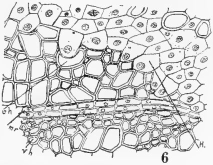

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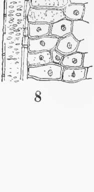

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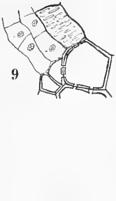

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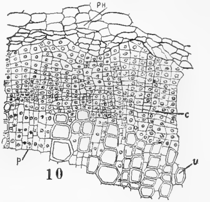

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By the time that the parasitic haustorium has penetrated the bark of the host the plumule is withdrawn from the seed-coat which has shrivelled up. The haustorium subsequently increases in diameter rather than in length, and a considerable swelling develops in the infected zone.

Old Haustorium.

The fully-developed haustorium, by solution and pressure, becomes closely applied, at the apex and along the margin, to the host tissues. On examining a longitudinal section of the haustorium, it is apparent that it has the form of a massive wedge of tissue, pointed at the apex and very broad at the base. At every part of its surface, it is in the closest contact with host-tissues—with xylem, phloem, and cortical elements. The cells at the extreme apex of the haustorium are elongated, slightly papillate, with densely protoplasmic contents and large nucleus (Text-fig. 7).

During its growth the haustorium destroys, by solution and pressure, a wedge-shaped mass of host-tissue until the apical region becomes applied to many vessels of the host-stem. During its progress through the peripheral tissues, it must avail itself of the dissolved cell-contents and cell-walls of the host, as there is very little trace left of the cells which must have lain across the path of the haustorium. As the growth of the haustorium is exceedingly slow, there is ample opportunity for the opposing cells to be absorbed. The peripheral secretory layer of the haustorium apparently exercises a chemical action upon the host-cells. Occasionally an haustorial cell pushes the wall of a vessel inwards. Such a result could only be attained in lignified walls by a previous softening action developed by a secretion from the haustorial cell. Text-figure 6 shows such a development.

In the centre of the haustorium there is a central mass of short reticulated tracheids with cambiform cells occurring amongst them and always on each side of them. Near the apex, isolated strands of these tracheids pass out towards the margin, and become applied to vessels of the host, either to the tangential or radial walls. This application of the parasitic tracheids to the water vessels of the host is most exact, and is brought about by the differentiation of epidermal and cortical cells of the haustorium into tracheids, as soon as the haustorium has penetrated the xylem. The actual penetrating tip of the haustorium is singularly free of tracheids. Text-fig. 8 shows a portion of a radial longitudinal section of a host-stem through the haustorium, and the close application of the cells of the haustorium to the host-vessels. Note the pits on the latter. Osmotic suction is probably the means of absorption in this case. In Text-fig. 9, I have shown the application of a tracheid of the haustorium to a vessel of the host.

On either side of the central group of reticulate tracheids and cambiform cells, there is a broad zone of cortical cells which, later, may become tracheidal in structure and in function. Other cortical cells, on the contrary, may form a connected strand of tracheids; these have a somewhat radial arrangement linking up with the central strand. No sieve-tubes are present in the haustorium, and *Notothixos,* therefore, recalls *Viscum album* and species of *Loranthus* in this respect.

If plastic food-stuffs are absorbed by the parasite from the host, apart from those provided by the disorganisation of the host-tissues due to the development of the haustorium, then no special provision is made for their conduction from the haustorium to the parasite's main vascular bundles. I have searched carefully, but unsuccessfully, for sieve-plates between the sieve-tubes of the host and the cells of the haustorium, and I am convinced that no such structural provision is made in order that the most important proteids may enter the haustorium. Structural evidence points to the conclusion that *Notothixos* is a water-parasite, tapping only the vessels of the host.

Pierce (1905) did not find any sieve-plates between the sieve-tubes of the Pine, and the haustorial cells of *Arceuthobium occidentale,* or in the other chlorophyll-bearing parasites, *Viscum* and *Phoradendron,* but he points out that, for a part of its life history, *Arceuthobium* is represented only by a mass of haustorial tissue embedded and concealed in the host. This part is devoid of chlorophyll. When activity is re-awakened in the spring, and new buds are developing into branches bearing leaves, it must be either at the expense of the reserve foods stored in the parenchymatous tissues of the haustorium, or in those of the host, or at the expense of foods withdrawn from the phloem of the host, or probably both sources are drawn upon. Pierce came to the conclusion that *Arceuthobium,* on account of its peculiar periodic life-history, was a more complete parasite than *Viscum* and *Phoradendron.* The penetrating part of *Arceuthobium* is probably completely parasitic, while it is free of aerial chlorophylliferous branches.

Benson (1910), in *Exocarpus,* found cytoplasm and food granules in the tracheids of the root-haustoria, and expresses the opinion that they function in the collection and conduction of soluble substances from the host-cells, since a typical phloem is reputed to be absent from the haustorium of the root-parasites described. In other words they combine the structure and function of phloem and xylem elements and are referred to as "Phloeotracheids."

With *Notothixos* the matter appears to be different. This is an evergreen form which shows considerable physiological activity prior to and during reproduction and then, after the maturation of the fruits, lapses into a phase of comparative inactivity. During this period considerable masses of starch grains are present in the parenchymatous cells of the haustorium and, when physiological work begins again, culminating in reproduction, it is apparently at the cost of these reserves. There is not the same necessity as in *Arceuthobium* for a withdrawal of food from the host-tissues. Even in times of great stringency the parasite does not seem capable of obtaining sufficient nutriment from the host to preserve itself. *Notothixos* and *Loranthus* frequently kill the end of the host branches by depriving them of water; but they frequently perish too. It seems to me that, were these parasites in the habit of extracting food from the host, they would be able to preserve themselves in times of stringency when their own leafy branches are dying. There is some evidence that the tracheids of the haustorium of *Notothixos* perform the dual function of phloem and xylem elements.

During the development of the haustorium, the cambial ring of the host-stem is interrupted, but in old haustoria this cambial ring is again practically completed by the formation of a cambial zone in the basal region of the haustorium itself. From this haustorial cambium, more or less radial rows of parenchymatous cells are cut off internally; many of these become transformed into the typical thick, reticulate-walled tracheids (Text-figs. 7, 10).

The reorganisation of a practically complete cambial ring in *Notothixos* recalls the similar feature of the haustorium of *Viscum album* which Pierce (1893) has already described. In this case the strand of tracheids in the haustorium is completely severed by a layer of compact, small, meristematic cells, so that the solutions extracted from the xylem of the host must pass through these cells In

Notothixos the position is slightly different, inasmuch as the cambial zone does not extend in a continuous ring across the haustorium, for, in the central region, continuous with the cambium, the cells are not actually meristematic; nor is the strand of haustorial tracheids severed. Conduction of liquids absorbed from the wood of the host takes place through strands of tracheidal cells towards the main xylem bundles of the mother root. In Text-fig. 7 it will be observed that the cambium passes upwards towards the vascular tissue of the main root.

Structures resembling laticiferous tissues occur in the haustorium (Text-fig. 7, *l.t.*). These contain a dense, granular, gumlike substance which stains a deep reddish colour with safranin. Most of the parenchyma cells of the haustorium contain at least one crystal of calcium oxalate.

The haustorial cambium cuts off parenchymatous cells externally, so that the phloem and cortex of the host-stem become more and more crushed and disorganised (Text-fig. 10). From this mass of cells at the base of the haustorium, there grow out, in different directions, a series of branches. As the older haustorium gradually encircles a considerable portion of the host-stem, by traversing the bark and cambium and sending lateral projections of tissue into the wood, the radiating branches formed from the haustorium, in the flux of time, come to almost encircle the host-branch. In various species of *Loranthus,* knots of considerable size are formed in the region penetrated by the haustorium, and from them new branches and secondary roots are developed, spreading the parasite over the host. In *Notothixos* the knots are small or frequently absent, and only leafy branches are developed. As a consequence, *Notothixos* occurs isolated upon the host, and no secondary roots bearing secondary haustoria and leafy shoots are developed.

The aerial branches show no definite relation to gravity, since they grow in all directions into space. They later bear the inflorescences.

The haustorium, a small part of the primary root of the parasite, embedded in the host, is therefore capable of the complete regeneration of the body of the parasite, and develops branches, leaves and flowers.

There seems no doubt that the primary haustorium of *Notothixos* is, from the morphological standpoint, a portion of the primary root of the seedling; the lateral projections of this haustorium are simply branches of this root. The structure of the root, however, is radically altered to perform certain physiological work for which the original root structure is unsuitable.

The leaves of *Notothixos* have certain characteristic xerophytic features; they are thick and fleshy; the stomata are slightly sunken. The lower surface is covered with a dense growth of peculiar, branched, septate, golden-coloured hairs (Text-fig. 11), which reduce transpiration. On the upper surface there are few hairs.

There are certain important facts in regard to the haustorium of *Notothixos,* namely, (*a*) the absence of sieve-tubes, (*b*) the absence of sieve-plates between the haustorial parenchyma and the phloem of the host, (*c*) the presence of laticiferous-like tubes densely charged with nutritive matter, and (*d*) a large amount of calcium oxalate crystals in the parenchymatous cells of the haustorium.

The non-existence of sieve-tubes leads to the inference that the parasite cannot tap the indiffusible proteids of the sieve-tubes of the host. The ordinary parenchyma of the haustorium, however, is probably able to withdraw by osmotic action the soluble and more readily diffusible foods of the host's phloem. Any difference in osmotic equilibrium between parasitic and host-tissues at the point of contact would eventuate in a flow of dissolved foods and, since the parasitic parenchyma cells, with their thin walls, large nuclei and abundant cell-sap when compared with the phloem elements of the host, represent a more efficient osmotic system, the natural tendency would be for diffusible foods to enter the haustorium.

The presence of laticiferous-like tubes in the haustorium is an important fact from the physiological point of view. These elements have no connection with the phloem of the host; they pass down the axis of the haustorium, spreading out in different directions towards the tip of the haustorium. They frequently occur in groups, close together, and stand out in distinct contrast to the ordinary parenchyma of the haustorium. They are unthickened and in numerous cases are connected to the tracheids of the haustorium. Since they are not in contact with the host's phloem elements, I conclude that they represent food-conducting structures between the haustorium and the aerial parts of the parasite. The occurrence and distribution of these structures is further evidence of the improbability of *Notothixos* normally tapping the food reserves of the host. The presence of considerable quantities of reserve food in the laticiferous-like elements and in the parenchyma of the haustorium suggests that the haustorium, during the inactive vegetative periods of the parasite, functions as a storage tissue. While the evidence available supports the view that chlorophyll-bearing parasites such as *Notothixos* are water parasites under normal conditions, it is quite possible that circumstances may occur from time to time, which may disturb the normal physiological balance between host and parasite, so that the parasite may withdraw food from the host-tissues.

Summary.

1. *Notothixos incanus* var. *subaureus* is commonly parasitic upon species of *Loranthus*, but may occur upon species of *Eucalyptus, Phyllanthus,* and *Casuarina.*
2. The fruit is small, semi-succulent, and covered with the golden hairs characteristic of the species.
3. Dissemination occurs during moist weather when transpiration from the plant is reduced and the moisture content of the fruits is increased.
4. The seed is covered with a gelatinous coat, the cells of which are so arranged that extrusion takes place from the base of the fruit after it has been shed from the plant. The walls of the gelatinous cells consist of two layers, namely, an outer mucilaginous and an inner, spirally-coiled, cellulose layer.
5. The seeds germinate on living or dead twigs and leaves, on the ground or on fences. The gelatinous seed-coat provides the embryo with water until it has penetrated to the xylem of the host.
6. The root has no root-cap; it is not geotropically sensitive, but is negatively phototropic and frequently executes considerable curvatures to bring its apex into the favourable light relation.
7. A holdfast develops from the root-apex when it presses against a resistant body; and from the centre of this holdfast the haustorial tissue grows into the host's tissues.
8. The haustorium penetrates the host by pressure and chemical solution; its peripheral layer is slightly papillate.
9. A cambium is developed in the haustorium, partially replacing the cambial ring of the stem; from this cambium secondary tissues are developed in a radial manner.

10. Sieve-tubes are not present in the haustorium, but laticiferous-like tissues are developed. These are related to the tracheids of the haustorium.
11. The haustorium is morphologically a part of the primary root of the embryo specialised for absorption from the tissues of a host.
12. The leaves are characteristically xerophytic, and the xerophily is consistent with parasitism upon the water tissues of the hosts.

I desire to record my sincere thanks to Professor Lawson for his helpful suggestions.

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NEW OR LITTLE-KNOWN SPECIES OF AUSTRALIAN TIPULIDAE (DIPTERA). i.

By Charles P. Alexander, Ph.D., Amherst, Mass., U.S.A.

(Communicated by Dr. E. W. Ferguson.)

[Read 29th November, 1922.]

During the past ten years the writer has been engaged in a study of the crane-flies of the Australasian Region, with the ultimate view of monographing the group from this Region. During the progress of this study, very large and interesting collections of Australian Tipulidae have been received for study from the authorities in charge of the collections of the South Australian Museum, the Queensland Museum, the British Museum of Natural History, the Paris Museum, the Natural History Museum in Vienna, the Bernice P. Bishop Museum in Honolulu, and other notable collections. Very valuable notes on the present condition of the Skuse Collection in the Macleay Museum were sent me by the Acting Curator, Mr. John Shewan, through the courtesy of the Senate of the University of Sydney. In addition, many individual collectors have generously submitted material, among these men being Messrs. Alan P. Dodd, Hardy, Heron, Hill, Illingworth, Searle and Tillyard. The writer's sincere thanks and appreciation are extended to these collectors and custodians of the collections above listed for their kind co-operation in this matter. In the present paper, a few undescribed species are discussed and some records of distribution for other species given. Unless stated to the contrary, the types of the new species described herein are preserved in the collection of the writer.

Dicranomyia (Idioglochina) australiensis, n.sp.

General colouration brown, the pleura pruinose; wings grey; cell 1st M_2 about as long as vein Cu_1 beyond it.

♂. Length, 4.5 mm.; wing, 4.8 mm. ♀. Length, 4.5 mm.; wing, 5 mm.

Rostrum and the very short palpi brown. Antennae light yellowish-brown, the scape a little more yellowish. Head brown, the orbits somewhat paler.

Mesonotum greyish brown, the dorsum clearer brown, the humeral region slightly paler; scutellum obscure yellow. In the female, the mesonotum is more rufous brown. Pleura grey, the lateral sclerites of the postnotum more whitish. Halteres yellow, the knobs brown. Legs with the coxae brown, dusted with grey; trochanters yellowish-brown; remainder of the legs pale brown. Wings grey; veins brown. Venation: As in *D.* (*I.*) *debeauforti* (de Meijere) but Rs more gently arcuated, so cell 1st R_1 is elongate-oval in outline; cell 1st M_2 about as long as vein Cu_1 beyond it. In the female, Rs is straighter.

Abdomen brown, the hypopygium obscure yellow. Ovipositor with the valves long and straight.

Hab.—North Australia.

Holotype, ♂, "Mou. Isl." * (G. F. Hill); *Allotopotype,* ♀.

The subgenus *Idioglochina* now includes four described species, all being Australasian, with the exception of one Formosan form. The group had not hitherto been found in Australia.

DICRANOMYIA ZONATA Skuse.

1889. *Dicranomyia zonata,* Skuse, Proc. Linn. Soc. N.S.W., (2), iv., 770.

Tasmania: Wilmot (Carter and Lea); Coll. South Australian Museum.

GERANOMYIA (PROAPOROSA) BANCROFTI, n.sp.

General colouration obscure yellow, the disc of the praescutum and the scutal lobes darker; wings subhyaline with brown dots at the origin of Rs, at *r* and at the supernumerary crossvein in cell Sc.

♂. Length, excluding rostrum, about 5.5 mm.; wing, 7.3 mm. ♀. Length, excluding rostrum, about 6 mm.; wing, 7.5 mm.

Rostrum about one-third longer than the head, pale brown, the uni-articulate palpi a little darker. Antennae obscure yellow. Head pale brownish testaceous.

Mesonotum pale testaceous yellow, the disc of the praescutum reddish-brown, produced by the confluent stripes, the colouration continued caudad onto the scutal lobes. Pleura obscure yellow. Halteres yellow. Legs with the coxae and trochanters yellow; remainder of the legs pale brownish testaceous, the terminal tarsal segments darker. Wings subhyaline with three very indistinct brown dots, one at the stigma, one at the origin of Rs, the third at the supernumerary crossvein in cell Sc; veins pale brown. Venation: Sc short, Sc_1 ending about opposite one-third the length of Rs, Sc_2 immediately beyond the origin of Rs; Rs angulated at origin; cell 1st M_2 large, rectangular, gently widened distally; *m* in alignment with the outer deflection of M_3; basal deflection of Cu_1 about one-third its length beyond the fork of M.

Abdomen light brown, the intermediate segments discoloured in the type. Hypopygium with the dorsal pleural appendage stout and black, the acute tip short.

Hab.—South Queensland.

Holotype, ♂, Burpengary, September 2, 1899 (T. L. Bancroft); *Allotopotype,* ♀, September 8, 1899. Types in the collection of the British Museum (Natural History).

Geranomyia bancrofti is related to *G. pictithorax* Alex., differing in the larger size and the colouration of the wings and thorax.

DISCOBOLA AUSTRALIS (Skuse).

1889. *Trochobola australis,* Skuse, Proc. Linn. Soc. N.S.W., (2), iv., 784-785.

New South Wales: Dorrigo (W. Heron), Coll. South Australian Museum; Ourimbah, September 3, 1904 (R. Helms), Coll. Bishop Museum; Victoria: Ringwood, September 23, 1918 (G. F. Hill), Alexander Coll.; Tasmania: Strahan (Carter and Lea), Coll. South Australian Museum.

* [This is probably Moa or Banks I., Torres Strait.—Ed.]

DAPANOPTERA RICHMONDIANA Skuse.

1896. *Dapanoptera richmondiana*, Skuse, Rec. Aust. Mus., 2, 106-110.

Queensland: Babinda, October and November 10, 1920 (J. F. Illingworth), in wet caverns along streams, Alexander Coll.; Cairns District (A. M. Lea), Coll. South Australian Museum.

Hitherto known only from the types taken in New South Wales (Upper Richmond River, in March).

PARAGYMNASTES, n. gen.

Legs provided with numerous flattened scales in addition to the usual setae; femora not clavate. Cell R_2 of the wings large and conspicuous, vein R_2 being elongate; cell 1st M_2 short-rectangular, sometimes open by the atrophy of M_3.

Genotype, *Gnophomyia fascipennis* (Thomson). (Australia).

Edwards has pointed out the close relationship existing between the genus *Gymnastes* Brunetti and the present group, which includes, besides the genotype, *P. gloria* (Alex.), *P. cyanoceps* (Alex.) and *P. nigripes*, n.sp., all the known species being Australian. It is probable that the *Gymnastes* group has been derived from flies that were generally similar to the above group of species. The species of *Paragymnastes* show a conspicuous sexual dimorphism, the pattern of the wings of the female (except *P. gloria*) being very different from that of the male. The species of *Gymnastes*, which occur in the Eastern Palaearctic, Oriental and Ethiopian Regions, are to be distinguished from those of *Paragymnastes* not only by the venational characters listed above, but by the structure of the legs and the male hypopygium.

The following comparison of characters will suffice to show the more important venational differences between the groups:

Gymnastes Brunetti. Vein R_2 short, oblique, more or less fused basally with *r*, cell 2nd R_1 being very small or triangular [*G. ornatipennis* (de Meijere), *pictipennis* (Edwards), *pennipes* Brunetti, *flavitibia* (Alexander) and *hyalipennis* (Alexander)], or cell R_2 being completely obliterated [*G. cyanea* (Edwards), *bistriatipennis* Brunetti, *teucholaboides* (Alexander) and *shirakii* (Alexander)]; Rs shorter, more or less arcuated at origin; cell 1st M_2 very elongate, strongly widened distally, approximately as long as, to one-third shorter than, vein M_3 beyond it.

Paragymnastes, n. gen. Vein R_2 long, running generally parallel to vein R_3, cell 2nd R_1 being elongate; *r* present, rarely lacking [*P. cyanoceps* (Alexander)]; Rs elongate; cell 1st M_2 short-rectangular, gently widened distally, about one-third the length of vein M_3 beyond it; rarely (*P. cyanoceps*) open by the atrophy of the outer deflection of M_3.

PARAGYMNASTES NIGRIPES, n.sp.

Legs of the male largely black, in the female with an orange subterminal ring on the femora and with the basal half of the metatarsi pale.

♂. Length, 4.2 mm.; wing, 5.2 mm. ♀. Length, 6.8 mm.; wing, 5.6 mm.

Male. Rostrum and palpi black. Antennae with the scapal segments obscure yellow, the first segment dark basally, the second segment dark apically; flagellum black. Head black, sparsely pruinose, the genae passing into reddish.

Pronotum and mesonotum shiny reddish-yellow, the praescutum with four black stripes on the posterior half of the sclerite, obliterated anteriorly; scutal lobes black; remainder of the mesonotum more yellowish. Pleura yellow, the mesepimeron sparsely pruinose. Halteres brown, the base of the stems and the knobs blackish. Legs with the coxae and trochanters yellow, the posterior and middle coxae sparsely pruinose; legs black with about the basal third of the femora obscurely paler. Wings greyish, subhyaline, the base and costal region yellowish; disc almost covered by dusky bands, leaving narrow areas of the ground-colour before the cord, before the origin of Rs and in the bases of the anal cells. Venation: As in *P. fascipennis* (Thoms.); cell 1st M_2 tending to be open by the atrophy of the outer deflection of M_3.

Abdominal tergites obscure orange-yellow, the caudal half of each segment black, the basal half less distinctly darkened medially; sternites obscure yellow; hypopygium orange-yellow.

Female. Like the male, differing as follows: The praescutal stripes represented only by a vague darkening before the suture. Femora with a conspicuous orange ring before the tip, more clearly defined on the fore legs; metatarsi with the basal half fulvous. Wings dark brown with three white cross-bands, the second complete, immediately before the cord, the last narrow, straight, extending from cell R_2 through M_3; cell 1st M_2 closed. Abdomen blue-black, the hypopygium and genital segment rich orange-fulvous.

Hab.—New South Wales.

Holotype, ♂, Dorrigo, altitude 2,000 feet, January, 1922 (*W. Heron*); *Allotopotype*, ♀.

TRENTEPOHLIA (MONGOMA) AUSTRALASIAE Skuse.

1889. *Trentepohlia australasiae,* Skuse, Proc. Linn. Soc. N.S.W., (2), iv., 834-835.

Queensland: Kuranda (F. P. Dodd), Coll. South Australian Museum; Gordonvale (J. F. Illingworth), bred from cage containing cane plants, Alexander Coll.

CONOSIA IRRORATA (Wiedemann).

1828. *Limnobia irrorata,* Wiedemann, Aussereur. Zweifl. Ins., i., 574.

Queensland: Meringa, November 14, 1920 (J. F. Illingworth), Darwin (G. F. Hill), Townsville (G. F. Hill), Alexander Coll.; South Australia: Adelaide (Barringer), Coll. South Australian Museum.

EPIPHRAGMA HARDYI, n.sp.

General colouration brownish-yellow, the mesonotum marked with dark brown; pleura largely dark brown; femora dark brown with a postmedial yellow ring; tibiae yellow with three black rings; wings light yellow, the ground-colour almost concealed by a heavy pattern of brown spots and dots.

Sex?—Wing, 9.5 mm.

Rostrum and palpi dark brown. Antennae with the scapal segments brown; flagellum broken; basal scapal segment very long. Head with a greyish-yellow pollen.

Mesonotal praescutum obscure brownish-yellow, handsomely patterned with dark brown; a conspicuous median stripe that is paler anteriorly, broadening out and becoming darker behind; this stripe is split by a capillary, darker brown vitta, on either side of which, before the suture, is a pale linear streak of the ground-colour; sublateral stripes small, barely attaining the suture; lateral margin with a large, circular, pale brown spot that is margined with darker brown; scutum with the median area dark brown, the lobes obscure brownish-yellow with dark brown centres; lateral margins of the scutal lobes dark brown; scutellum pale yellowish-brown, darker basally; postnotum with the median sclerite obscure yellowish-brown with a ⊥-shaped brown mark, the cross-bar being near midlength of the sclerite; lateral lobes of postnotum unmarked. Pleura dark brown with a narrow and rather indistinct, pale brown, ventral, longitudinal stripe. Halteres brown, the knobs darker brown. Legs with the fore coxae dark brown, only the base pale; mid- and hind-coxae light yellow, the extreme bases abruptly dark brown; trochanters light yellow; femora dark brown, paler basally; a narrow post-medial yellow ring; immediately before the tip on outer face a small, circular, yellow spot; tibiae yellow with three black rings, one subbasal, one medial and one apical, these black areas approximately equal in extent to the yellow interspaces; on one of the legs which had become detached the outer yellow ring is obliterated; tarsi dark brown. Wings light yellow, the ground-colour almost obliterated by a pattern of dark brown spots and dots that are confluent or nearly so over most of the surface, restricting the ground-colour to abundant tiny spaces over the entire disc; a series of larger areas at ends of veins R_1, R_2 and R_3; costal cell yellow with about eight brown spots that are about as extensive as the interspaces; similar large yellow blotches between the brown areas at ends of the radial veins; an ill-defined pale area in cell R immediately before the cord; veins conforming in colour to the areas traversed; costal fringe inconspicuous. Venation: Besides the supernumerary cross-vein in cell C, there are faint remnants of still other spurs in the dark spots; Sc_2 longer than Sc_1; Rs long, strongly arcuated at origin; R_{2+3} short, about one-half longer than *r-m*; *r* almost obliterated by atrophy, about twice its length from tip of R_1; inner ends of cells R_3, R_5 and 1st M_2 in alignment; petiole of cell M_1 short, about twice R_{2+3}; cell 1st M_2 long and narrow, widened distally; basal deflection of Cu_1 near midlength; arcular crossvein distinct.

Abdomen with the basal tergite light brown, dark brown laterally; second tergite dark brown; remainder of abdomen broken; basal sternites pale brownish-yellow.

Hab.—South Queensland.

Holotype, Sex?, Queensland National Park, Macpherson Range, altitude 3,000 feet, February 27, 1921 (G. H. Hardy).

This interesting fly is named in honour of the collector, Mr. G. H. Hardy.

GYNOPLISTIA SUBIMMACULATA, n.sp.

General colouration shiny black; antennae 18-segmented; pleura and coxae grey; femora yellow, the tips dark brown; wings subhyaline, almost immaculate; abdomen reddish-brown, the hypopygium and basal tergite dark.

♂. Length, 9.2 mm.; wing, 8.5 mm.

Rostrum and palpi dark brown, the former with conspicuous yellow setae. Antennae 18-segmented, the formula being 2+2+10+4, dark brownish black throughout; pectinations of moderate length. Head shiny coal black.

Mesonotum shiny black with greenish tints, the four usual stripes transversely wrinkled; interspaces with yellow setae. Pleura almost entirely covered with a microscopic appressed grey pubescence that appears like a heavy bloom, the lateral sclerites of the postnotum abruptly glabrous. Halteres pale brown, the knobs a little darker. Legs with the coxae concolorous with the pleura; trochanters dark brown; femora yellow, the tips conspicuously but rather narrowly dark brown; tibiae brownish-yellow, passing into brown at the tips; tarsi brown. Wings subhyaline, cell Sc darker; stigma small, brown, sending a small seam across the fork of Rs; a tiny brown seam at origin of Rs; veins dark brown; wing-base yellow. Venation: *r-m* very short, encroached upon by the long deflection of R_{4+5}; cell M_1 tending to become evanescent, lacking in the left wing of the type; basal deflection of Cu_1 a little more than one-half its length beyond the fork of M.

Abdomen with the first tergite shiny black; remainder of the abdomen deep reddish-brown, the hypopygium darker.

Hab.—Victoria.

Holotype, ♂, Ararat (G. F. Hill).

STIBADOCERELLA AUSTRALIENSIS, n.sp.

General colouration pale brown; pleura yellow with a transverse dark brown girdle on mesepisternum; terminal tarsal segments white; wings greyish-yellow; macrotrichiae in distal end of cell R_5; *r* present, without macrotrichiae; cell 1st M_2 open by the atrophy of the outer deflection of M_3; abdomen bicoloured.

♂. Length, 9.6 mm.; wing, 8 mm.; antenna about 12 mm.

Rostrum and palpi pale. Antennae of the male very long, the small scapal segments yellow, the flagellum dark brown, except the basal three-quarters of the first segment which is obscure brownish-yellow. Head brown.

Pronotum pale whitish-yellow. Mesonotum dark brown, the three usual praescutal stripes a little paler; lateral margins of median sclerite of postnotum a little more darkened. Propleura light yellow. Mesopleura yellow, the sternum and mesepisternum dark brown, giving the pleura the appearance of being transversely girdled; mid-ventral area of sternum pale. Halteres very long, brown. Legs with the coxae and trochanters yellow; femora dark brown, paler basally; remainder of legs dark brown, the tips of the posterior metatarsi and the remaining tarsal segments snowy-white; most of the other legs are detached but in what would seem to be the fore and middle legs all the metatarsi and the basal half of tarsal segment two are darkened. Wings with a uniform greyish-yellow tinge; veins dark brown. Venation: Sc ending about opposite six-sevenths the length of Rs, both Sc_1 and Sc_2 subobsolete; Rs elongate, gently arcuated at origin; tip of R_1 entirely atrophied, the apparent *r* (which is presumably the free base of R_2) is preserved, but entirely without macrotrichiae; petiole of cell R_3 short, less than the basal deflection of M_{1+2}; *r-m* very long, one-half longer than the basal deflection of Cu_1; cell 1st M_2 open by the atrophy of the outer deflection of M_3; basal deflection of Cu_1 about two-thirds its length beyond the fork of M; a row of macrotrichiae in the distal third of cell R_5; a few macrotrichiae in the outer end of cell M_2.

Abdomen bicoloured, dark brown, the apices of the basal segments broadly paler; on the subterminal segments the colouration is uniformly dark brown. Hypopygium dark brown.

Hab.—New South Wales.

Holotype, ♂, Narrabeen, December 3, 1921 (G. H. Hardy).

MEGISTOCERA FUSCANA (Wiedemann).

1821. *Nematocera fuscana,* Wiedemann, Dipt. Exot., i., 29.

Queensland: Gordonvale, October, 1920 (J. F. Illingworth), Alexander Coll.

This conspicuous genus of crane-flies had not hitherto been recorded from Australia.

PLATYPHASIA REGINA, n.sp.

Legs brownish-yellow, the tips of the femora and tibiae narrowly blackened; wings with R_{2+3} and Rs subequal; *r-m* present or obliterated by the fusion of R_{4+5} on M_{1+2}; cell M_1 usually sessile.

♂. Length, 20—26 mm.; wing, 21—23.5 mm. ♀. Length, 35 mm.; wing, 25 mm.

Frontal prolongation of the head light brown, darker apically above; palpi dark brownish-black. Antennae black, the second segment more reddish; pectinations of female antennae shorter than those of male. Head black, the orbital region light brown, especially behind; vertex anteriorly more or less pruinose.

Praescutum dark velvety black with four greyish-brown stripes that limit the ground-colour to the lateral margins of the sclerite and the anterior ends of the interspaces, the latter behind more yellowish; humeral region restrictedly pale; remainder of mesonotum grey or yellowish-grey in the female, the scutellum blackened. Pleura grey, conspicuously striped longitudinally with silvery white and brown; the broad silvery stripe includes the mesepisternum, mesepimeron and lateral sclerites of postnotum. Halteres dark brown. Legs with the coxae brownish-grey; trochanters brown; femora brownish-yellow, the tips narrowly blackened, these measuring less than 3 mm.; tibiae similar, the tips still more narrowly blackened; metatarsi dark brown, passing into black; remainder of tarsi black. Wings infuscated, the base and costal region broadly bright brown; a faint brown clouding along the cord, more evident along the first section of M_{3+4}; Cu seamed with brown; stigma small, pale brown. Venation: R_{2+3} subequal to Rs, sometimes a little longer or shorter; *r* at fork of R_{2+3}; *r-m* short, in some cases obliterated by the short fusion of R_{4+5} on M_{1+2}; cell M_1 varying from short-petiolate to rather broadly sessile; *m-cu* short to punctiform; cell 2nd A broad.

Abdomen with the first segment grey; second segment reddish basally, with three black stripes that are confluent posteriorly; segments three to five black with a faint reddish sublateral spot at base; remainder of tergites black, pruinose; hypopygium reddish; basal sternites reddish, the terminal segments grey pruinose. In the female, the tergites are conspicuously reddish, comparatively narrowly trivittate with black, the median stripe much broader than the lateral stripes. Ovipositor with the valves deep horn-colour.

Hab.—New South Wales.

Holotype, ♂, Dorrigo, altitude 2,000 feet, January, 1922 (W. Heron). *Allotopotype,* ♀. *Paratopotypes,* 2 ♂, 1 ♀.

LEPTOTARSUS MACQUARTI Guérin.

1838. *Leptotarsus macquarti,* Guérin, Voy. de la Coquille, Zool. ii., Dipt., p. 286, Pl. xx., fig. 1.

Victoria: Seaford (W. F. Hill), Tooradin, February 3, 1918 (G. F. Hill), near Melbourne (G. F. Hill), Alexander Coll.

LEPTOTARSUS SCUTELLARIS Skuse.

1890. *Leptotarsus scutellaris,* Skuse, Proc. Linn. Soc. N.S.W., (2), v., 107-108.

New South Wales: Blackheath, January, 1904 (R. Helms), Coll. Bishop Museum.

LEPTOTARSUS NIGRITHORAX (Macquart).

1850. *Tipula nigrithorax,* Macquart, Dipt. Exot., iv., 15, Pl. 1, fig. 5.

New South Wales: Mittagong (A. M. Lea), Coll. South Australian Museum.

HABROMASTIX PERGRANDIS, n.sp.

Size very large (wing of ♀, 23 mm.); general colouration dark brown; inner margin of eyes narrowly bordered with dull fulvous; wings darkened, narrowly marked with cream-coloured dashes and dots; *m-cu* at two-thirds the length of cell 1st M_2; cell M_1 sessile.

♀. Length, 27 mm.; wing, 23 mm.

Frontal prolongation of the head long and slender, dark brownish-black. Antennae brownish testaceous. Head dark brown; a narrow but conspicuous dull fulvous border adjoining the inner margin of each eye.

Mesonotal praescutum brown with three broad, dark brown stripes that are only a little darker in colour than the disc; scutum and scutellum destroyed; postnotum posteriorly light brown, the posterior half of the lateral sclerite of postnotum dark brown. Propleura, mesepisternum and mesosternum dark brown; posterior sclerites of pleura brownish testaceous. Halteres elongate, dark brown, the base of the stem and the knobs indistinctly pale. Legs with the coxae dark brown, the outer faces of the fore and middle coxae each with a conspicuous pale spot, posterior coxae more uniformly darkened; trochanters brownish testaceous; legs stout; femora brown, all but the fore femora with an indistinct pale subterminal ring; tibiae and tarsi brown. Wings with a strong dusky tinge; cells C, Sc and the stigma darker brown; membrane narrowly variegated with cream-coloured markings as follows: two narrow V-shaped areas beginning in cell M, continued across cell Cu, the basal one continued into cell 2nd A, the distal one ending at vein 1st A or continued as a very narrow line across cell 1st A; small spots in base of cell M; in cell R before the cord; in base of cell R_2 beyond the stigma; in the bases of cells 2nd M_2 and M_3, and in the caudal distal angle of cell Cu_1 adjoining vein Cu_2; veins dark brown. Venation: R_3 one-half longer than R_{2+3}; cell 1st M_2 large, widened distally; *m-cu* at about two-thirds the length of cell 1st M_2, the basal section of M_{3+4} about twice the second section; cell M_1 sessile.

Abdominal tergites dark brown, the caudal margins very narrowly, the caudal lateral angles more broadly obscure yellow; sternites beyond the base more uniformly pale. Ovipositor with the elongate valves straight.

Hab.—South Queensland.

Holotype, ♀, Queensland National Park, Macpherson Range, altitude 3,000 feet, February 27, 1921 (G. H. Hardy).

HABROMASTIX HILLI, n.sp.

♂. Length, 12.5—13.5 mm.; wing, 13—13.5 mm.; antenna, about 7.5—9 mm.

Most closely allied to *H. cinerascens* Skuse, from which it differs as follows:

Antennae much shorter, ending about opposite the base of the fifth abdominal segment, or about equal to three-fifths the length of the body. Mesonotal praescutum with three brown stripes, the median stripe sometimes split with pale only at the anterior end; postnotum darkened on the posterior third. Abdominal tergites with a broad dorso-median stripe, the caudal margins of the segments broadly grey, the lateral margins narrowly ochreous; basal tergite ochreous at base.

Hab.—Victoria.

Holotype, ♂, Ararat (G. F. Hill). *Paratopotypes*, 2 ♂; *paratype*, ♂, Eltham, April 17, 1920 (L. B. Thorn).

HABROMASTIX HILLI SUBLATERALIS, n.subsp.

♀. Length about 13 mm.; wing, 13 mm.

Differs from typical *hilli* as follows:

General colouration more ochreous, only the pleura grey. Wings with the pale central stripe almost obliterated, represented by two indistinct subhyaline areas in cell M, and a third in cell 1st M_2 and the base of R_5; Rs much longer, one-half longer than R_{2+3}; cell M_1 long-petiolate, the petiole about twice *m*; *m-cu* obliterated by fusion. Abdomen with two sublateral brown stripes, indistinctly separated by a line of the ground colour. Valves of the ovipositor acicular.

Hab.—Victoria.

Holotype, ♀, Ringwood, April 6, 1918 (G. F. Hill).

MACROMASTIX COSTALIS (Swederus).

1787. *Tipula costalis*, Swederus, Act. Holm., p. 286.

Victoria: Seaford, June, 1919 (W. F. Hill), Alexander Coll.; Tasmania: Wilmot (Carter and Lea), Devonport (A. M. Lea), Hobart (A. M. Lea), Coll. South Australian Museum.

MACROMASTIX MASTERSI Skuse.

1890. *Macromastix mastersi*, Skuse, Proc. Linn. Soc. N.S.W., (2), v., 133-134.

Victoria: Ararat (G. F. Hill), Alexander Coll.

MACROMASTIX CONSTRICTA Skuse.

1890. *Macromastix constricta*, Skuse, Proc. Linn. Soc. N.S.W., (2), v., 134-135.

New South Wales: Sydney, September, 1904 (R. Helms), Coll. Bishop Museum.

MACROMASTIX HUMILIS Skuse.

1890. *Macromastix humilis*, Skuse, Proc. Linn. Soc. N.S.W., (2), v., 136-137.

Victoria: Moonsons, October 19, 1918 (G. F. Hill), Lorne, October 24, 1918 (F. E. Wilson), Alexander Coll.

TIPULA DICLAVA, n.sp.

Allied to *T. leptoneura* Alexander; fusion of veins M_3 and Cu_1 extensive; cell 2nd A broad; male hypopygium with two clavate appendages extending caudad.

♂. Length, 21 mm.; wing, 24.5 mm.

Frontal prolongation of the head buffy above, darker laterally, the elongate nasus brown; palpi light brown, the terminal segment dark brown. Antennae short, the scape ochraceous; flagellum bicoloured, the base of each segment black, the remainder of each segment paler. Head brown, becoming more buffy anteriorly.

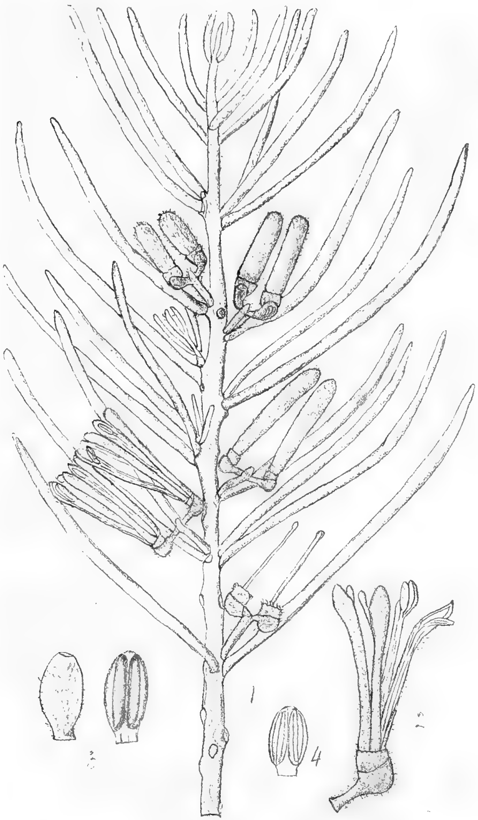
Mesonotum greyish-brown with three darker brown stripes that are subconfluent; remainder of the mesonotum brown, the median area of the scutum and scutellum indistinctly and narrowly paler. Pleura pale brown, sparsely pruinescent. Halteres brown, the base of the stem narrowly yellowish. Legs with the coxae pale, whitish pruinescent; trochanters yellow; remainder of the legs broken. Wings faintly tinged with brown, the costal region yellowish; stigma small, dark brown; veins brown. Venation: As in *T. leptoneura* and allies, in the small, pointed cell R_2; Rs short, about two-thirds R_{2+3}; cell

R_2 very small; cell 1st M_2 large, the inner end long-pointed; *m* and petiole of cell M_1 subequal; fusion of veins M_3 and Cu_1 extensive, longer than *r-m*; cell 2nd A broad.

Abdominal tergites reddish-brown, the second segment with a narrow median and lateral black stripes; fifth and sixth tergites largely brownish-black; an indistinct dorso-median brown stripe on the intermediate tergites; tergite seven chestnut-brown; tergite eight buffy; basal sternites reddish, the terminal segments darker. Male hypopygium with the ninth tergite terminating in two approximated flattened lobes that are feebly divergent, these lobes separated by a V-shaped notch; ninth tergite distinct from the pleurite. What seem to represent the modified outer pleural appendages consist of conspicuous clavate lobes directed caudad, the apex of each dilated and feebly bifid (these appendages are very narrowly attached and those of the type were accidentally broken off, mounted separately in balsam). Eighth sternite unarmed.

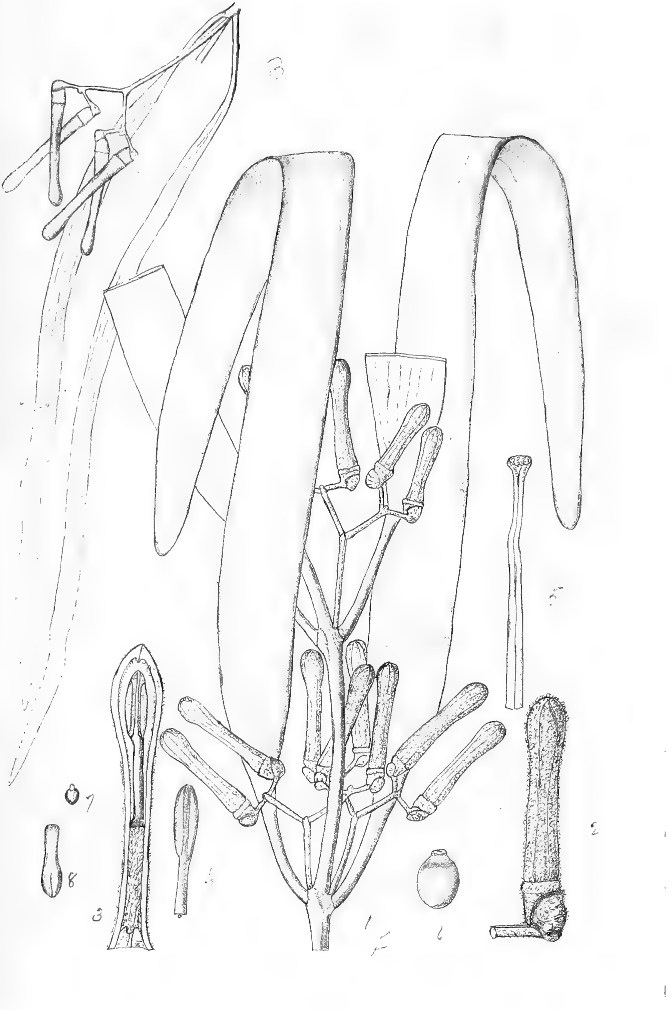
Hab.—Northern Australia.

Holotype, ♂, without exact data, received from Mr. G. F. Hill.

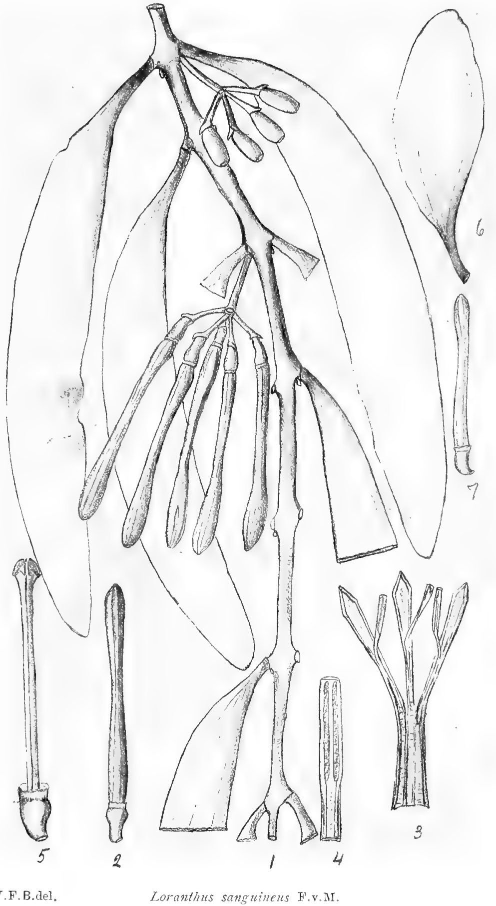


W.F.B.del. *Loranthus gibberulus* Tate.

W.F.B.del. *Loranthus bifurcatus* Benth.



W.F.B.del. A. *Loranthus ferruginiflorus* W.V. Fitz. B. *L. ferruginiflorus* var. *linearifolia*, n.var.

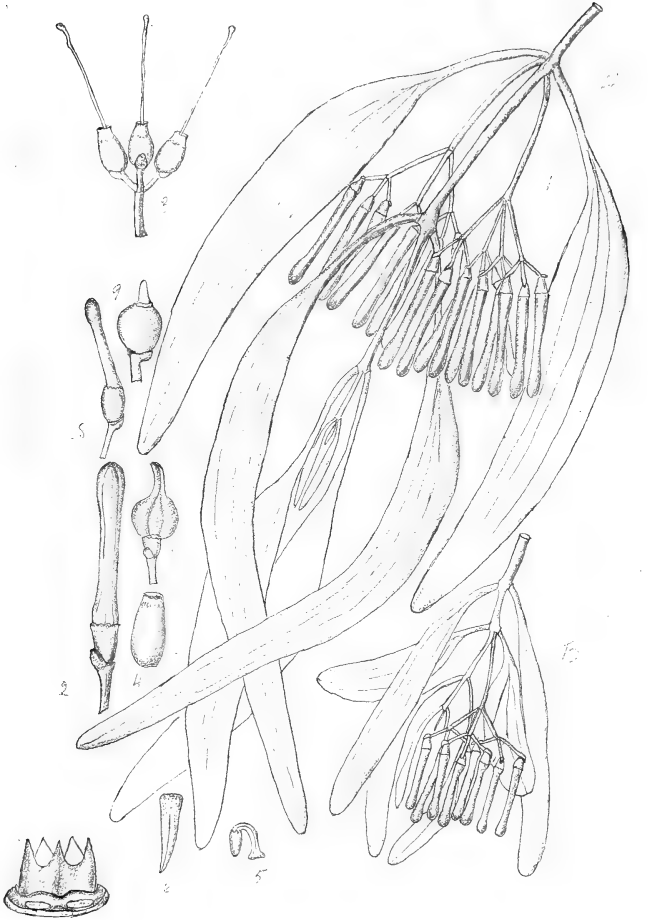


W.F.B.del.   *Loranthus sanguineus* F.v.M.

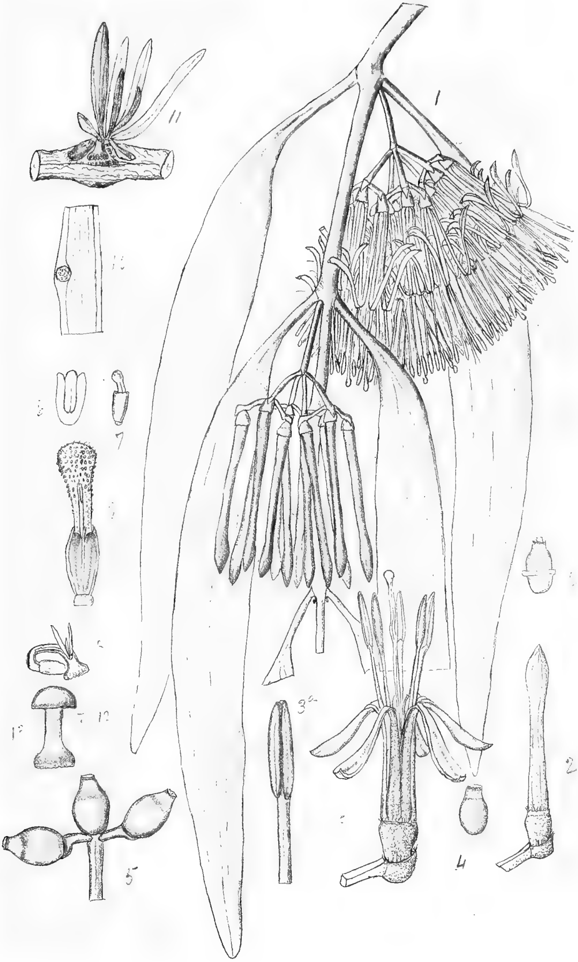
W.F.B.del.   *Loranthus sanguineus* F.v.M., var. *pulcher* Ewart.

W.F.B. del.

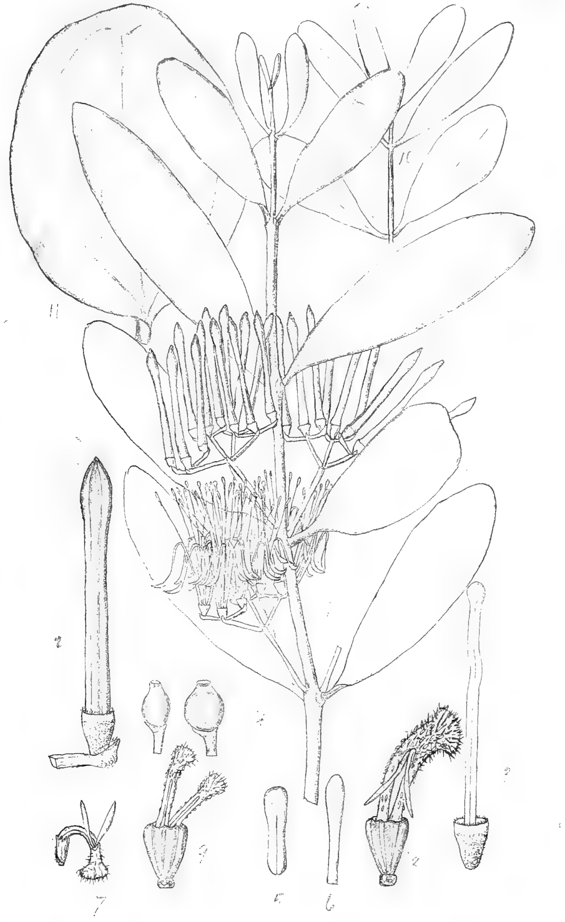
Loranthus Whiteii, n.sp.



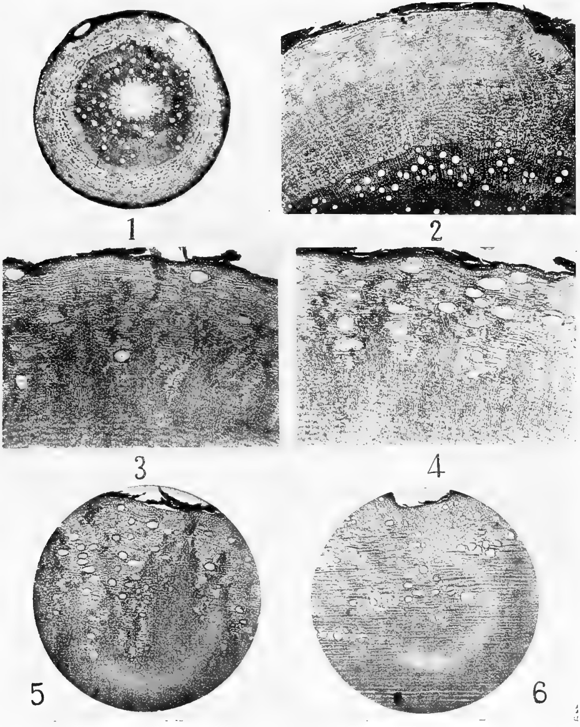
W.F.B.del. A. *Loranthus Miquelii* Lehm. B. *L. Miquelii* var. *minor*, n.var.



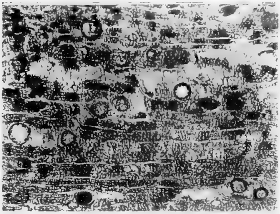
W.F.B.del. *Loranthus pendulus* Sieb.



W.F.B.del. *Loranthus congener* Sieb.



Eucalyptus Macarthuri.



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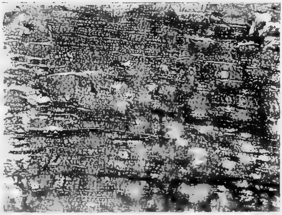

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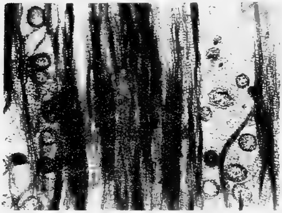

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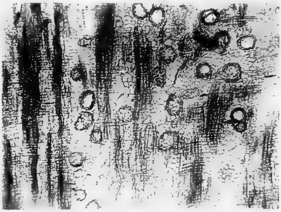

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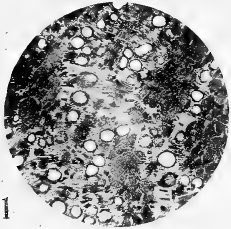

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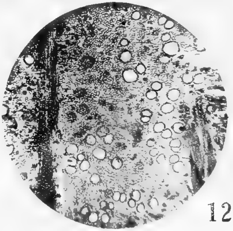
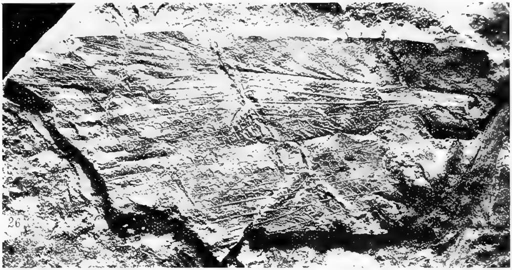
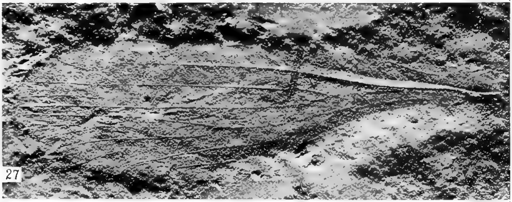


12

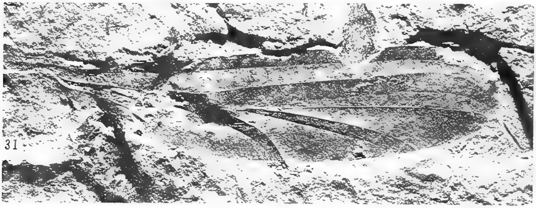
7-10. *Eucalyptus Macarthuri*. 11-12. *E. Smithii*.

1-2 Stalagmitic ferruginous deposits. 3-7. Twigs, fruit and leaf with ferruginous coatings. (All figures x $\frac{4}{5}$.)

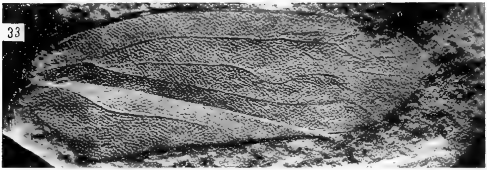
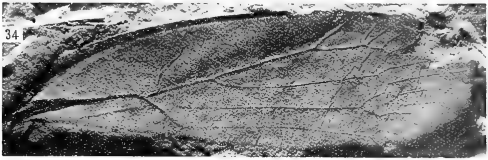
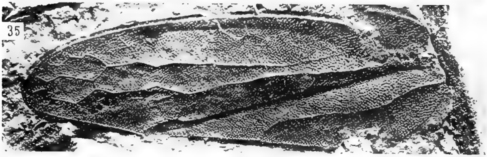
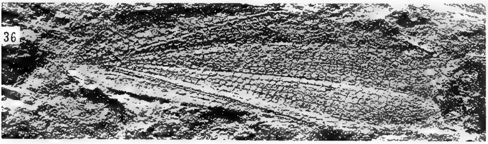




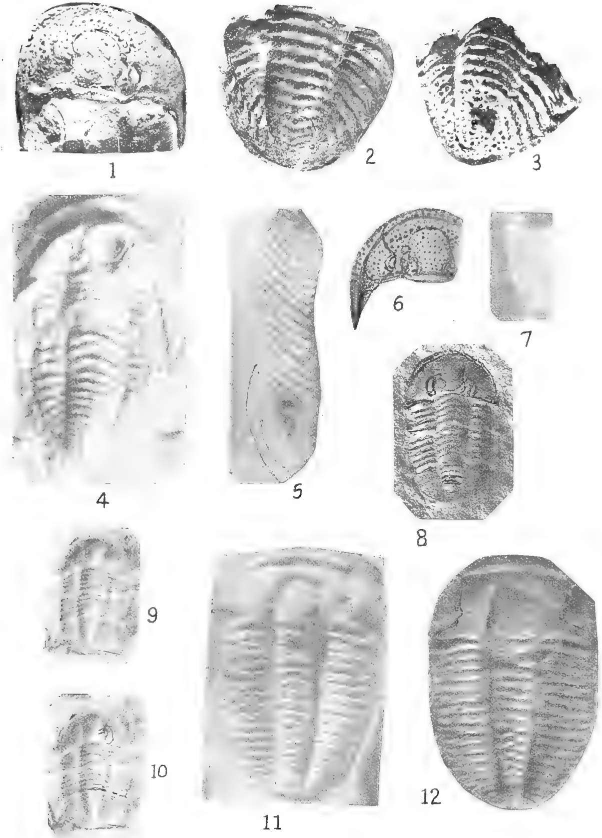
26. *Mesorthopteron locustoides.*
27. *Triassomantis pygmaeus.*
28. *Triassolocusta leptoptera.*
29. Burrow of Coleopterons larva.



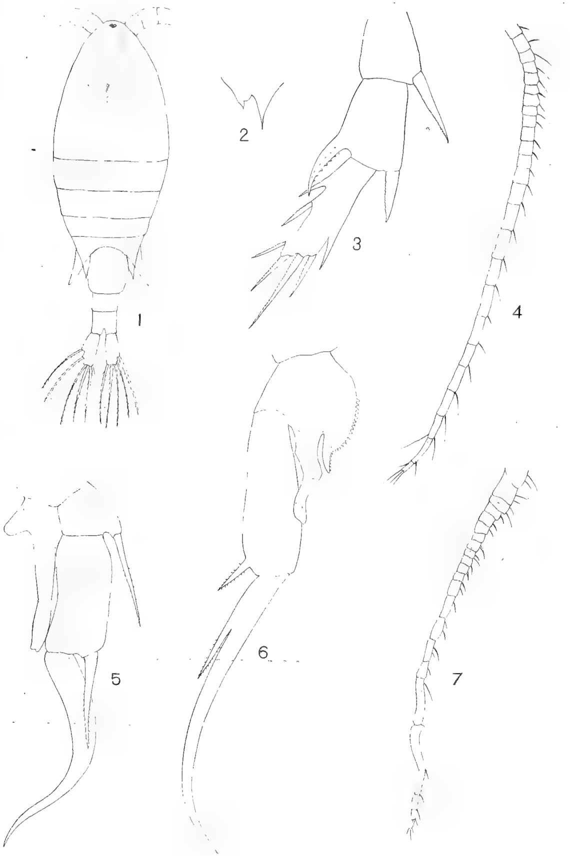
30. *Mesophlebia antinodalis*. 31. *Triassagrion australiense*.
32. *Triassopsychops superba*.


33. *Apheloscyta mesocampta.* 34. *Mesocixiodes termioneura.*
35. *Ipsviciopsis elegans.* 36. *Polycytella triassica.*
37. *Chiliocycla scolopoides.*

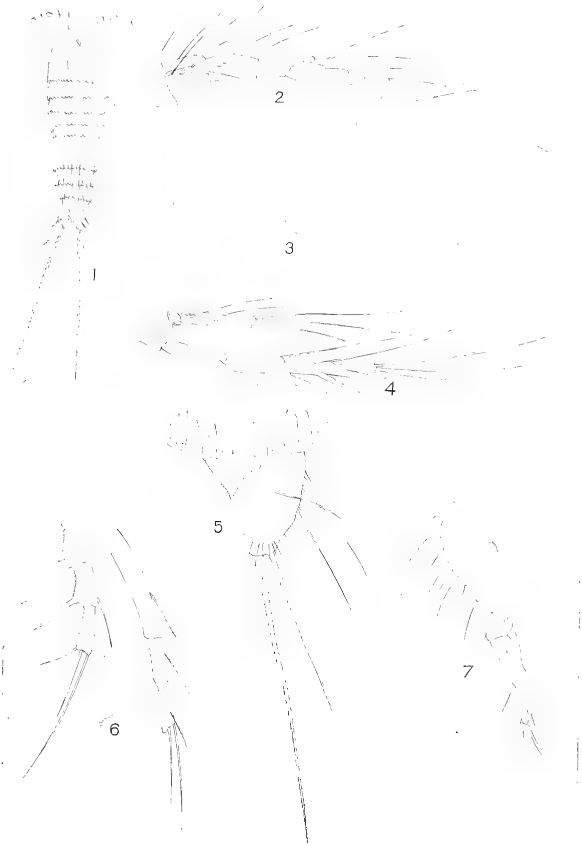


1-7. *Cordania gardneri* 8-10. *Phillipsia convexicaudatus.*
11-12. *Ptychoparia merrotskii.*

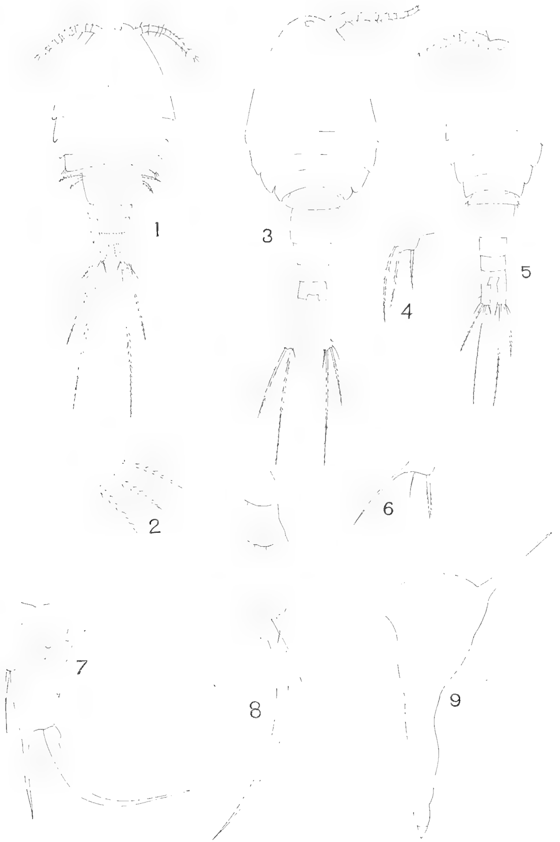


Boeckella coronaria.

1–2, 4–6. *Boeckella fluvialis.* 3. *Moraria longiseta.*



Moraria longiseta.



1–2. *Platycyclops phaleratus.* 3–4. *P. affinis.*
5–6. *P. fimbriatus.* 7–9. *Boeckella robusta.*

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES.

WEDNESDAY, 29TH MARCH, 1922.

The Forty-seventh Annual General Meeting, together with the Ordinary Monthly Meeting, was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, 29th March, 1922.

ANNUAL GENERAL MEETING.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

The Minutes of the preceding Annual General Meeting (30th March, 1921) were read and confirmed.

PRESIDENTIAL ADDRESS.

It is customary for the address delivered by the President of this Society at the Annual Meeting to be in two sections. One deals with a scientific subject, and in this age of specialization it is becoming increasingly difficult for the occupant of the Chair to choose a subject which will be of general interest and so appeal to members other than those working in his own particular branch of study. The other is a report on the affairs of the Society for the year and on any matters of general scientific importance in which the Society may be concerned.

The Australian National Research Council, following on the resolutions carried at the meeting of the Australasian Association for the Advancement of Science in January, 1921, held two meetings during the year, the first in Sydney during May and the second in Melbourne during August. At the first meeting the membership was increased nearly to the full number and at the second meeting important questions of policy were discussed and a number of committees appointed to deal with various matters appertaining to Australian Science e.g.

Proposed Soil Survey of Australia, Proposed Federal Geological Survey, Solar Radiation Station, Gravity Survey of Australia, Effects of freezing on Meat, etc. It was also decided that the Council should undertake the publication of a quarterly abstract of papers by scientific workers in Australia.

The concluding Part of Volume xlvi. of the Society's Proceedings was issued on 23rd December, the whole of the papers thus being issued during the year in which they were read. That this was possible is due in a large measure to the efforts of our printers.

The complete volume (536 + xxii. pp., 46 Plates and 188 Text-figures) contains thirty-seven papers, seven of which were contributed by members of the Society's research staff.

During the year the Rules of the Society were revised and a new issue printed, copies of which have been distributed to each member.

Some years ago the Postal Department refused to continue to allow the Proceedings of Scientific Societies to be transmitted through the post as books, and the Societies, as a result, had to face a very much heavier postage rate than formerly. Regulations revising the postal definition of a book have recently been gazetted, and in consequence of this the Council has decided upon certain alterations in the publication of the Proceedings. In future five Parts will be issued annually instead of four; Part i. will contain the proceedings at the Annual Meeting, Parts ii.-iv. the papers read at the Ordinary Monthly Meetings, and Part v. the abstracts of Proceedings, list of members, donations and exchanges, etc.

Mention was made a year ago of the difficulties that were being experienced in carrying on the publication of the International Catalogue of Scientific Literature. Although no official reports of the negotiations have been received, we learn through the Zoological Society of London that efforts to proceed with this important work have been unsuccessful. This will make it a matter of considerable difficulty for the research worker to keep in touch with the work of his contemporaries in foreign countries. Zoologists, however, are fortunate in this respect. The Zoological Society undertook to prepare and issue the Zoology volume for the years 1915-1920 inclusive at its sole financial risk, pending the resumption of the Catalogue; and now, with the approval of the Royal Society, it hopes to continue the issue of the Zoological Record from 1921 onwards as a separate undertaking.

Exchange-relations with Societies and Institutions are again very flourishing, the receipts for the Session amounting to 1874 additions to the library as against 1603 last year. During the year the publications of the following Societies and Institutions have been added to the list obtained in exchange for the Society's Proceedings:—Société Géologique et Minéralogique de Bretagne, Botanical Survey of South Africa, Bombay Bacteriological Laboratory, Real Academia de Ciencias y Artes de Barcelona, and Botanic Gardens, Cluj, Roumania.

We are also fortunate in having received a large number of the publications of the Carnegie Institution of Washington, which Institution has also expressed its willingness to send the Society such of its future publications as come within the scope of the Society's work.

We also have to acknowledge our gratitude to Mr. G. I. Playfair, a member of the Society, for a valuable donation to the library consisting mainly of books and reprints dealing with Algae, Diatoms and other lowly forms of plant life. A list of this donation has been published in the Proceedings (1921, pt. 4, p. 531).

By the loss of the S.S. Canastota during the year between Sydney and

New Zealand the Society lost a large parcel of Proceedings sent as exchanges to Societies and Institutions in the United States of America. The parcels were insured by the Public Library of N.S.W., through which they are transmitted to the Smithsonian Institution for distribution in America. The insurance, however, did not cover the actual value of the publications and the loss falls most seriously on the Society's stock of Proceedings for 1920, part 4, of which over 30 copies were lost. This is only the second occasion on which large parcels of the Society's publications have been lost in this way (the previous one was by the wreck of the S.S. China in 1898) and we may, therefore, perhaps consider ourselves as not unfortunate in this respect.

I would ask members to keep in mind the resulting deficiency in the Society's stock of Proceedings for 1897, part 3 and 1920, part 4, should they ever have an opportunity of aiding in making it good.

For some years the Commonwealth Institute of Science and Industry has had in preparation a catalogue of the scientific and technical periodicals in the chief libraries of the Commonwealth. This catalogue, which should be of considerable value to everyone interested in scientific research, is now complete in the form of a card catalogue, and steps are being taken to endeavour to publish it so that it will be most readily available to research workers. Pending publication the Institute has expressed its willingness to furnish any information contained in the Catalogue, and this will no doubt prove a boon to many research workers.

During the year the names of ten Ordinary Members were added to the roll and four members resigned. In addition, four names have been removed from the list, making the number of Ordinary Members now on the roll 161. We are fortunate in being able to record the fact that during the past year our list of members has not been reduced by death.

Ordinarily, in a scientific Society the small membership should occasion grave concern, but with us, owing to the benefactions of Sir William Macleay, a large income from members' subscriptions is not a necessity. Still I am of opinion that our membership is not nearly as large as it should be, and that the number of persons in New South Wales interested in Natural History is at least 250 and I would urge our members to try to increase our membership at least to that number. If you will glance at the accounts to be presented by the Honorary Treasurer to-night you will see that the amount paid in subscriptions for the year 1921 amounts to only £141/15/-, whilst the income from investments amounts to £1,248/19/5. I have often wondered how many of our members examine the Balance Sheets and Statements of Income presented annually by the Honorary Treasurer. A brief examination of these will show the strong position to which the Society has grown during the past few years and indicate the amount of work that must be performed by our Honorary Treasurer, Mr. J. H. Campbell. The outstanding feature of these accounts is that we owe our strong position to the late Sir William Macleay for amounts given during his life and bequeathed by his will.

By the death of Dr. Robert Logan Jack in November last, at the age of 76, another of the pioneers of Australian Geology has passed away. Born in Scotland in 1845, Dr. Jack was appointed Government Geologist for Northern Queensland in 1877, after having served 10 years on the Scottish Geological Survey. He was soon appointed Government Geologist for the whole State, a position which he filled till 1899, when he resigned. It is for the geological work done during this period that Dr. Jack's name will live in the records of Australian

Science. His most notable production was the "Geology and Palaeontology of Queensland and New Guinea," published in 1892 in conjunction with Robert Etheridge Junior, a work which was largely responsible for the award to the joint authors of Clarke Memorial Medals by the Royal Society of New South Wales in 1895.

Last year an important step was taken by our University in the institution of a lectureship in Entomology—a step in which I am particularly interested. Mr. A. J. Nicholson, M.Sc., who has been appointed to this important position, reached Sydney towards the end of last year and we have already had the pleasure of welcoming him to our meetings. He comes to us from the Birmingham University where he was very successful as an extramural lecturer. After graduating in 1915, he served for the remainder of the war with the Artillery. He held a Research Scholarship under the Board of Agriculture in 1919 and was demonstrator in Zoology in the University of Birmingham. During 1921, after his appointment to Sydney, he visited the chief Institutions and Universities where Entomology is studied in the United States. He has thrown himself with enthusiasm into the study of our insects and has already made several important entomological trips since his arrival, on one of which I was of the party and had the opportunity of making his further acquaintance.

We offer our heartiest congratulations to Mr. J. J. Fletcher on the award to him by the Royal Society of New South Wales of the Clarke Memorial Medal—a fitting recognition of his distinguished services to Natural History in Australia.

To Mr. R. J. Noble, a distinguished graduate in Agriculture of the University of Sydney, we offer congratulations on being the first to receive the Ben Fuller Scholarship, a travelling scholarship in Agricultural Science, one of the conditions attached to the award of which is that the Scholar shall return and give New South Wales the benefit of the experience gained abroad.

We also offer cordial congratulations to Sir Hugh Dixson, Kt., on the honour conferred on him by His Majesty the King; Professor T. Harvey Johnston, on his appointment as Professor of Zoology in the University of Adelaide; Mr. E. C. Andrews, who has taken over the permanent Honorary Secretaryship of the Australasian Association for the Advancement of Science from Mr. J. H. Maiden, who for many years has carried on the work of that office with marked success; Mr. G. H. Hardy, on his appointment as Walter and Eliza Hall fellow in Economic Biology in the University of Queensland.

One of the most notable exhibits that have been made before us was that at the September meeting of two young live platypus collected by Mr. Harry Burrell. We take this opportunity of extending our hearty congratulations to Mr. Burrell on the success which has attended his efforts in this field of collecting.

The Council has, during the year, discussed matters in connection with the Macleay Collections and the Macleay Museum, and has informed the Senate of he University of Sydney that in its opinion the Collections are not easily acessible to members of the Society, as they should be under the conditions atched to Sir William Macleay's gift. The Senate referred the matter to the Committee of Management of the Museum for report and we await their further reply.

In December the Royal Society of New South Wales fittingly commemorated the centenary of the foundation of the first scientific society in Australia, the Philosophical Society of Australasia, and members paid a visit to Kurnell where the president and members of the original Society erected a brass tablet to mark the landing of James Cook and Joseph Banks.

One of the aims of the Royal Zoological Society of New South Wales is the issue of a series of handbooks on various branches of the Natural History of New South Wales. The first of these, The Fishes of New South Wales, has just been completed and the Society is to be congratulated on having thus far succeeded in its objective.

The year's work of the Society's research staff may be summarised thus:—

Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, contributed two papers "The High Temperature Organism of Fermenting Tan-bark, Part i.," and "Note upon the Extraction of Acids from Cultures," which appeared in the Proceedings for 1921, Part 1. During his year's leave of absence he visited England and took advantage of the opportunity of visiting a number of the laboratories in which work similar to his own is being carried on. At the Lister Institute, where he spent some weeks, most of the staff were working on Vitamines, Professor Martin was investigating the feeding properties of pure proteids and Professor Harden was working with the enzymes and co-enzymes of yeast and with hexose phosphates, while there were also workers investigating bacteriological problems connected with leather. He also visited the laboratories of the Imperial Institute, University College, and of the Metropolitan Board of Water Supply. At Rothamsted there were over thirty research workers, mostly engaged in research on soils and vegetable products. In the Biochemical Laboratories at Cambridge University Dr. Greig-Smith was specially interested in the work of Dr. Peters on the growth of Protozoa in bacteria-free fluids. He also had the opportunity of visiting, at Long Ashton, near Bristol, the Agricultural and Horticultural Research Station of the National Fruit and Cider Institute, one of the few institutions in England where research in industrial bacteriology is being carried on. We have pleasure in welcoming him back fresh from his tour of these famous research institutions and wishing him a successful year's research.

Since his return he has had under further examination the high-temperature organism that ferments tan-bark, and has also been working to obtain a synthetic fluid in which the bacterium will grow freely so that its fermenting capabilities can be studied. He also has under observation, some bacteria isolated from Eucalyptus nodules sent by Mr. Musson from Bowral.

Dr. J. M. Petrie, Linnean Macleay Fellow of the Society in Biochemistry, completed his investigation of the poisonous principle of *Erythrophloeum Laboucherii* from the Northern Territory, the results being published in Part iii. of the year's Proceedings. Further work on *Heterodendron* has been directed towards the investigation of the cyanogenetic glucoside contained in the uncrystallisable residues in the hope of isolating the very active principle. Towards the end of the year some success was achieved in this direction, minute crystals being obtained which evolved hydrocyanic acid when tested with emulsin. The work is now being repeated with a greater amount of material. Experimental work on Cyanogenesis in plants has been continued and a number of plants have been examined and tested, among them being several varieties of Sorghum. A number of plants received from Central Australia were tested both chemically and physiologically but the results showed nothing of special interest. Dr. Petrie proposes in addition to his current researches, to commence some work on the natural colouring substances of plants, such as the wattle blossom, etc.

Miss Vera Irwin-Smith, Linnean Macleay Fellow of the Society in Zoology, has devoted much of her time to the examination, in the laboratory, of anatomical preparations of Stratiomyiidae in continuation of her studies in the lifehistories of Australian Diptera Brachycera; during the year two papers of this series have appeared in the Proceedings, and another one is in course of preparation. Field collection of dipterous larvae for rearing was continued and resulted in the addition of some 70 specimens to those already under observation in the families Leptidae, Asilidae, Therevidae, Bombylidae, Muscidae, Anthomyidae and Tachinidae. Unfortunately, the proportion of losses in rearing these specimens was considerable. In continuation of her work on Nematodes Miss Smith is now studying species of the genus Physaloptera, especially those parasitic in Reptiles. Three papers on this subject have been completed, the first of them appearing in Part 4 of the Year's Proceedings; the other two will appear in the Proceedings for the coming year.

Miss Marjorie I. Collins, Linnean Macleay Fellow of the Society in Botany, continued her observations on the mangrove and saltmarsh vegetation in the neighbourhood of Sydney, paying special attention to the Cabbage Tree Creek area, Port Hacking; the results of this work have appeared in Part iii. of the year's Proceedings. Following the same line of work, Miss Collins spent some time in the Broken Hill District for the purpose of investigating the Plant Ecology of an arid region, as a preliminary step in establishing the relationship between rainfall and soil conditions and plant grouping and distribution in the drier parts of the State. She was able to collect and make notes on the flora for over 100 miles North of Broken Hill and also on the sandy plains between the ranges and the South Australian border and between Broken Hill and the Darling River. The field work thus accomplished now involves a considerable amount of work in the laboratory, particularly in the identification and investigation of the material collected.

Miss Marguerite Henry, Linnean Macleay Fellow of the Society in Zoology, has devoted her time largely to the collection of material and the examination and description of the Cladocera. She has obtained numerous collections from many localities in New South Wales, and also from New Zealand and South Australia. Experiments have been carried on in raising Entomostraca from dried mud in aquaria; a mud from New Zealand which had been in a dried state for over seven years yielded large numbers of Ostracods. The examination of the Cladocera has been completed and the results embodied in a paper which will appear in Part ii. of the Proceedings for 1922. Miss Henry is proceeding with the examination of the next group—the Copepoda.

Dr. Walkom has during the year contributed two short papers on Australian fossil plants to the Proceedings: (i.) On the Occurrence of *Otozamites* in Australia, with Descriptions of Specimens from Western Australia and (ii.) On a Specimen of *Noeggerathiopsis* from the Lower Coal Measures of New South Wales. In addition he prepared an account of some seeds found in association with *Glossopteris* in Queensland and which may be the megasporangia of that genus, the paper being read at the meeting of the Geological Society of London on 4th May, 1921; he also completed his examination and description of the Glossopteris flora of Queensland, the manuscript of which has now been in the hands of the Queensland Geological Survey for some time. Dr. Walkom has in view a re-examination of the Tenison-Woods' collection of Australian fossil plants in the Macleay Museum. The original descriptions were published in our Proceedings in 1883, and it is very desirable that such an important collection should be examined in the light of recent advances in palaeobotany. To enable drawings to be made of some of the more important specimens, the University of Sydney has generously made available a grant from the McCaughey Research Fund.

Seven applications for Linnean Macleay Fellowships, 1922-23, were received in response to the Council's invitation of 26th October, 1921. I have now the pleasure of making the first public announcement of the Council's re-appointment, for another year from 1st April, 1922, of Dr. J. M. Petrie, Miss V. Irwin-Smith, Miss Marjorie I. Collins, and Miss Marguerite Henry to Fellowships in Biochemistry, Zoology, Botany and Zoology respectively. On behalf of the Society I have pleasure in wishing them a successful year's research.

The Necessity for a Zoological Survey of Australia.

Our fauna, as well as our flora, is a national asset and as such we should have as complete a knowledge of it as possible. The subject of a co-ordinated investigation of the fauna was discussed by Section D. of the Australasian Association for the Advancement of Science in Melbourne in 1921, and the following resolution carried:—"That in order to carry out immediately a co-ordinated Investigation into the Land and Freshwater Fauna and the Flora of Australia and Tasmania, the Societies and Institutions in the various States . . . be requested to co-operate in the work and to take such steps as they may deem most advisable for the carrying out of this work, more especially in securing in each State the active assistance of specialists in different branches of Botany and Zoology." A committee was appointed and the Scientific Societies throughout Australia were circularised, but so far no active steps have been taken to give effect to the resolution, nor have suggestions been made as to how such a survey might be carried out. Professor Sir Baldwin Spencer published a short but important paper on the subject in the Victorian Naturalist for February, 1921. Mr. W. W. Froggatt also has urged the necessity for the establishment of a bureau of biological survey in Australia (Aust. Zoologist, ii., Pt. 1, 1921, p. 2).

Future generations of Australian scientists may reasonably expect to find the best collections of the Australian fauna in their own Museums but in view of the attention paid to the collection of Australian specimens by foreign institutions within the past few years it is doubtful whether their expectations will be realised unless some active steps are taken to make our own collections as complete and representative as they should be. The British Museum authorities have also been considering the possibility of sending a collecting expedition to Australia and in a letter to the High Commissioner for Australia which was forwarded to the Council of this Society for comment they mention the foreign expeditions and add that "in view of the fact that with the advance of settlement many of the unique animals are becoming rare, it is evident that unless steps are taken and are taken soon, the finest collections of the Australian fauna will be found in Museums outside the British Empire."

In the case of Geology and Botany the State has recognised the need for systematic surveys. Each of the Australian States has its Geological Survey and there is no need for me to recall to you the many eminent scientists who have been associated with these Departments nor the excellent work which has been carried out. Each State also has its Botanic Gardens with an associated Herbarium where specimens and information have been accumulated regarding the plants and where a more or less complete survey of the Plants is available.

Zoology on the other hand has not been so provided for. There are, in New South Wales, two public institutions which might have been expected to assist in such a Zoological Survey—the Australian Museum and the Taronga Zoological Park—but I fear that as the governing bodies of both these Institutions are composed of men who, with a few well known exceptions, are not zoologists, they fail to appreciate the necessity for such work.

It is true, however, that the matter has not been entirely neglected, for a large amount of valuable information has been collected and made available by private individuals each working at his own particular group as a hobby. What is capable of accomplishment is demonstrated by the fact that I have been able, during the past twenty five years, to gather together the finest collection of Australian butterflies in the World. Other private individuals have been able to do the same in their own special groups. The Entomological Branches of the Department of Agriculture, whose work must be concerned primarily with the economic side of the subject, have done excellent work in several of the States, but the field is far too extensive for the limited staffs employed.

In order to bring some constructive criticism on the question of a Zoological Survey, I would suggest that immediate steps be taken by the Commonwealth Government to institute a Federal Museum, one of the chief objects of which would be the gathering together of specimens of Australian animals as well as of accurate information concerning their distribution. When Canberra is ready for occupation as the Federal Capital such a Museum will be a necessity and as the accumulation of material is a slow process no time should be lost in making a beginning. Extensive accommodation would not be necessary for some time to come as it is not suggested that the collections would be on view until the Museum is properly established but they should be available for purposes of study. A small beginning has already been made in this direction for I understand that the Australian Museum is housing temporarily the fishes obtained by the illfated Federal Trawler. I also venture to assert that in the event of such a Museum being inaugurated, numerous private individuals would willingly donate portions of their collections to form the nucleus of what ultimately would be a fine display of our native fauna.

In the absence of any such scheme as the above we would have to look to our State Museums for a co-ordinated Zoological Survey. Much would be possible in this direction by concerted action on their part. In the early days, the Museum staffs were small and of necessity composed of general naturalists rather than specialists; with increasing collections, staffs were increased and there was opportunity for specialization. Even now, however, a single man has often to cover far too wide a field to do really good work in any one branch. I would suggest to the authorities of the various Australian Museums that in future care should be taken not to duplicate the appointment of a specialist in any one branch. For example, there are entomologists in four of the Museums and it could be easily agreed that no two of them should be specialists in the same group. There would then be in Australia specialists in four different insect groups and there should be no difficulty in arranging for each to determine the species of his own special group for all four Museums. By mutual arrangement, a similar scheme might well be made to apply to the whole of the Zoologists in our Museums. At the present time the members of the Museum Staffs constitute only a small proportion of the naturalists in Australia, there being many private individuals who have taken up the study of special groups as a hobby. I would suggest that the authorities of the Museums might make much more use of these private individuals than has been done in the past.

The number of new animals awaiting discovery in Australia is very far from exhausted, though, of course, this is chiefly amongst the lower forms of animal life. One would think that after such entomologists as Meyrick, Helms, Turner and Goldfinch had visited Mt. Kosciusko very few moths would be left undiscovered on that Plateau, but we find that Goldfinch secured over twenty undescribed species during a week's visit there last December and his collecting was confined entirely to the Digger's Creek Valley. On this same trip I secured two new records of butterflies for the Plateau, and though I have made many new discoveries during visits to this district during the months of December, January, February, and March and have partially surveyed the Plateau as far as the butterflies are concerned, I have not by any means yet exhausted it even for such a well known group. I would welcome an extended entomological survey of this district carried out on thoroughly systematic lines, for a wealth of new discoveries is indicated, and many of these would be of great help in elucidating the Physiography of Australia in times past. The curious net-veined midges (*Blepharoceridae*) found there last November by Dr. Tillyard and Mr. Nicholson are of great interest, especially as they are not capable of life at any distance from swiftly running water. Further specimens of a most interesting Dragonfly with affinities to a Chilian species have also been taken there by Mr. Goldfinch and myself. The investigation of the insect fauna at an elevation of 4000 ft. and over is of great importance, for there the remnants of the older species are to be found. In the past, in order to accomplish the greatest amount of work in the shortest possible time, I examined our coastal areas, for butterflies, as species, though not necessarily individuals, were more plentiful there, and as a result I have now a fairly clear idea of the distribution of the butterflies along the coast of Eastern Australia; but the case of the mountain ranges, to which I have turned my attention during the last few years, is far different, though here the species are fewer and individuals more plentiful. Our knowledge is still far from complete, many of the higher levels being difficult of access; I propose later on in the year to prepare an account of the butterfly fauna of our alpine regions as we now know it.

An Account of Some Breeding Experiments with the Satyrine Genus Tisiphone.

During the past few years I have been carrying out a series of breeding experiments with the Satyrine genus *Tisiphone* using the races *abeona* and *morrisi* mainly with the idea of proving or disproving whether a third race, *T. abeona joanna,* was a natural hybrid. For the scientific portion of my address I propose to give a short account of the course of these experiments and some of the results to date.

Tisiphone joanna Butler was described in 1866 (*Enodia joanna,* Ann. Mag. Nat. Hist., 1866, p. 286) and from that date until 1913 no specimens of it appear to have been taken in Australia, nor had I been able to find any in Australian collections. In October, 1913, on a trip to Port Macquarie with Mr. C. Hedley, I secured over one hundred specimens of this form and have figured some of them (Aust. Zoologist, i. pt. 1, 1914, Pl. 1; The Butterflies of Australia, Pl. 39). In October, 1914, I captured another long series, and on two other occasions (January and March, 1918) further specimens were obtained. The tremendous variation in these specimens is shown by the series on Plate ii., all from the very limited area within eight miles of Port Macquarie, where, out of some 300 specimens, no two were exactly alike. Some showed a close resemblance to the broad, orange-banded southern form, others a similarity to the narrow, white-banded northern form, and I came to the conclusion that at Port Macquarie there existed a natural hybrid that had had neither the time nor the opportunity to become stabilised. There are no barriers on either side of Port Macquarie to prevent an occasional specimen of either the southern or northern form entering the area.

The distribution of Tisiphone *in Eastern Australia.*

The Genus Tisiphone *Hübner.*

I have already shown (Australian Zoologist, i., pt. 1, 1914) that *Tisiphone* Hübner is the generic name that must be applied to these butterflies, which have been placed by various authors at different times under *Enodia, Xenica* or *Epinephile.* The genus is confined to the Coast and the Main Dividing Range of Eastern and South-eastern Australia. In my opinion it consists of two species only—*T. helena* from an altitude of 1000 ft. and over in the Cairns District, Queensland and *T. abeona* which extends, with six subspecies, from Southern Queensland into Victoria. No collections have yet been made in the Main Divide between Cairns and Rockhampton and I anticipate that further species or subspecies will yet be discovered to link up the dark *abeona* with the paler coloured *helena.* In order that the results of my experiments may be understood it is necessary here to give a brief review of the subspecies of *Tisiphone abeona* and their distribution. The map (Plate i.) shows the various areas in which the subspecies of *T. abeona* have been taken. The food plants of the genus are various species of *Gahnia,* commonly called Sword grass or cutty grass.

T. abeona albifascia Waterhouse. (Plate ii., fig. 816.)

This is the race that occurs in Victoria and on the coast in the south of New South Wales; it differs only in degree from the typical form found near Sydney, having broader and (especially in the female) paler orange markings on the forewings above and much broader white markings beneath. We might expect that this form of a butterfly that ranges into Queensland would only occur near sealevel in Victoria, but this is not the case, for, though it has been taken at Lorne and Wilson's Promontory, it is also found at an elevation of 2300 feet at Mt. Macedon. It has not been recorded from the Victorian Alps, nor from Mt. Kosciusko, and must certainly be absent from the latter locality for I have myself searched for it there in the months of December, January, February and March. This race grades into the typical race and it is not possible to draw the exact line of separation between the two. I consider all my specimens from Eden to belong to *albifascia* whilst all those from Ulladulla belong to typical *abeona.*

T. abeona abeona Donovan. (Plate ii., fig. 815.)

The type locality of this butterfly must have been near Sydney for, though only described in 1805, Donovan remarks that it was not very unfrequently received amongst other insects from the vicinity of Port Jackson and that a painting of it existed amongst the drawings of William Jones of Chelsea when Fabricius visited England prior to 1793. It is strange that Fabricius omitted to describe this handsome species when describing others from Jones' drawings. This form is very common on the coast from Ulladulla to Newcastle and also occurs in the Blue Mts. as far as Mt. Victoria, but is absent from the coastal plain between Penrith and Sydney. It is not subject to any great variation though I have a few interesting aberrations amongst many hundreds of specimens that have passed through my hands.

T. abeona aurelia Waterhouse.

This is a further and brighter extension of the typical form. It is somewhat variable, a few specimens showing a narrow orange band on the hindwing above. It occurs on the coast from north of the Hunter River to Camden Haven. Though this race approaches closely to typical *abeona* it can always be distinguished from it by the very much brighter and more prominent ring to the subtornal ocellus on the forewing above, a character common to all the races occurring north of the estuary of the Hunter River. For this character then the extensive river flats near the mouth of the Hunter form a sufficient barrier, for probably at no time did the foodplant grow here.

T. abeona joanna Butler. (Plate ii., figs. 794-814, 818.)

I have endeavoured to secure information as to the place of capture of the type of this subspecies, but without much success. Mr. N. D. Riley of the British Museum writes that the type is apparently one of two specimens received from the Entomological Club in 1844 and bears a small label *Linn. Soc. N. Holland.* The specimen was obviously collected some time, probably some years, before 1844. Dr. Jackson, General Secretary of the Linnean Society of London, searched their records and though he found an entry in 1833 of a collection of insects from N. Holland presented by Alexander Macleay, he considers that these particular insects formed a portion of those sold by his Society in 1863. However, considering localities available about 100 years ago, I have very little doubt that the type was caught at Port Macquarie and, if not actually caught by Alexander Macleay, reached England through his instrumentality. Besides the type, five other specimens are in the British Museum (four of which are from the Hewitson Collection) but they do not show such great variations as I have found. Until 1913, when I obtained over one hundred specimens at Port Macquarie, from which the specimens figured on Plate ii. were taken, this form was unknown in Australia. In the spring of 1914, I traversed the coast line from Coff's Harbour to Ulladulla, collecting over 500 specimens of *Tisiphone* and about the same time I received a large number of specimens from between Clarence Heads and Coff's Harbour from Mr. F. A. Heron, and from south of Ulladulla from Mr. H. W. Simmonds. The limits of this variable race (*joanna*) I would give as about 10 miles radius from Port Macquarie, for at Camden Haven two specimens only had paler bands, and from Crescent Head the specimens, though not quite typical *morrisi*, were cream and only in one or two cases showed an orange tint. The variability of the race suggested that *joanna* was a natural hybrid and caused me to try the experiment of crossing the broad orange-banded form and the narrow cream-banded form.

T. abeona morrisi Waterhouse. (Plate ii., fig. 817).

This form I first met with on my first collecting trip to the Richmond River, and for a long time I considered that the name *joanna* might be applied to it and distributed it under that name. It has a wide range along the coast from Southport, S. Queensland to the Macleay River and it is only at Crescent Head that the influence of the southern orange subspecies begins to be felt, for here an occasional orange tint is seen in the pale markings. It occurs on a spur of the Main Divide at Ebor (4000 feet) where Dr. Tillyard captured some particularly large specimens, on the Divide itself near Hanging Rock, and again at the southern end of the Mt. Royal Range where recently I captured a number of specimens at an elevation of about 5000 ft. The last locality is very important, as it is in a latitude nearly 100 miles south of the southernmost locality for the race on the sea-coast. I have searched for it without success in the Range near Murrurundi and Messrs. Goldfinch and Lyell were unable to see it at Mt. Gregson somewhat further west.

T. abeona rawnsleyi Miskin.

This race, which is generally smaller than *morrisi,* in most specimens lacks any pale markings above; there is, however, in some specimens an incomplete pale narrow band on the hindwing above, a character of more frequent occurrence and more pronounced in the female than in the male. My specimens are from the neighbourhood of Landsborough, Nambour and Eumundi in S. Queensland. At Mooloolah I found larvae very common in July, 1919, and brought a number to Sydney which I successfully reared.

The accompanying map (Plate i.) shows at a glance the positions on the East Coast of Australia where the various races are known to occur. As far as the coast is concerned this region has been very well surveyed and over the greater part of it I have myself collected. The distribution of *rawnsleyi* has not yet been fixed with any great exactitude. It probably occurs further north than at present recorded, and the break in the almost continuous distribution of the collective species *abeona* at the mouth of the Brisbane River needs further investigation. This should not be a difficult task for an entomologist resident in or near Brisbane. From Southport, Q., south to Gabo Island little remains to be done from the point of view of distribution, for I do not think I have gaps in the records greater than 50 miles and such gaps, except perhaps that at the mouth of the Hunter River, are caused by advancing civilization clearing and using the localities in which the foodplant grew in the past. On the Victorian coast the gaps are greater owing to less extensive collecting and the western limit of the range of *albifascia* has not yet been definitely determined.

In the Main Dividing Range the races *rawnsleyi, joanna* and *aurelia* have not yet been found, and I doubt if these, with the possible exception of *rawnsleyi,* exist there. The three localities where *morrisi* occurs are marked A on the map and further investigation will link up these localities and extend the range of this race much further. The capture of this form on the Mt. Royal Range some two years ago by Mr. J. Hopson is very important and adds still further confirmation to my suggestion that the Cassilis Gap has formed a barrier for a great length of time and allowed the development in times past of the northern and southern forms. The typical race *abeona* and also *albifascia,* as will be seen from the map, have only been taken at localities of fairly easy access,—places that are near tourist resorts. The intervening portions of the Mountains require further investigation.

The method of conducting the experiment.

As far back as 1914 I was able to get fertile eggs from a pairing of *abeona* and *morrisi,* but these eggs had to be obtained by dissection from the female, as I did not seem able to get the female to lay them. The larvae that hatched did not live long, for they disappeared, no doubt victims to a spider. I then had to consider the best means of overcoming the various difficulties that presented themselves, the chief being obtaining sufficient growing plants in my garden, successful pairing, laying of eggs by the female on the foodplant, and protecting the larvae from parasites and enemies. In the main I have succeeded in overcoming these difficulties. The food plant (several species of *Gahnia*) grows either in swamps near the sea-coast, or inland in the bed of creeks and so must be well supplied with water. When picked it very quickly shrivels up and dies, crushing any larvae that may be hiding in the tufts. By keeping the tufts in moist sand in a jar, I have kept it alive for over a week, but this is by no means so satisfactory as having growing plants. Aided by Mr. J. W. Allgood, gardener, I have now at least 50 growing plants and we have found that the best time to remove the plants from the bush is in the early spring or early autumn when they are beginning to shoot. I have had little success in moving plants in the winter. Pairing now is not difficult provided the day is bright and sunny and I usually place a large wire cage over a plant growing in a tin and have the cage in as open a spot as possible. I have at times had pairing take place in a large glass jar. The length of time of pairing in cases I have watched has not exceeded 23 minutes which, no doubt, accounts for the few times this species has been seen paired in the bush. After pairing is noticed, the male is removed and killed, and during the following two days from 16-32 eggs are laid by the female, usually on the food plant, but occasionally on the wire of the cage. The tin is then removed to one of the specially built wire gauze cages, which are about 3 feet high and 2 feet 6 inches wide on each side, with a door at one of the sides and are all numbered. My early cages were single, being built round already growing plants of sword grass. Later the Senate of the University of Sydney generously made available a special grant from the McCaughey Research Fund, for which I take this opportunity of expressing my thanks and I was enabled to erect a series of cages, which for economy were built back to back, the ground being specially prepared, and now, after 12 months, the plants are in splendid condition. By this means the available number of cages has been more than doubled. These cages, being made of the wire gauze used for fly windows, have protected the larvae from both dipterous and hymenopterous parasites and have prevented the larvae from wandering. The growing sword grass is protected from the ravages of the larva of a moth, which feeds on the young shoots of the sword grass, causing it to die. The greatest trouble at present is the presence of spiders, which find the cages suitable places to live in and which, when very young, can easily pass through the mesh of the wire gauze. When inhabited, the cages must be examined almost daily and the spiders killed. The larvae pass through their transformation and the pupae are transferred inside to compartments bearing numbers corresponding with the cages from which they were taken.

A trip in July, 1919, with Mr. G. M. Goldfinch to Southern Queensland was undertaken both to obtain larvae of *rawnsleyi,* in which we were successful, and to find larvae of *morrisi* at Southport which, however, we failed to do. I had, however, a number of pupae of *abeona* from Sydney and also of *rawnsleyi,* and as a male of *rawnsleyi* and a female of *abeona* emerged close together I paired them and secured fertile eggs from which I reared three males and two females. I made two pairings of these in the autumn of 1920 and secured two small families which I have in my collection. These results were not altogether satisfactory, as the parents that produced the second generation were brother and sister. I also secured a pairing of *abeona* male with *rawnsleyi* female, this female being reared from a fertile egg laid in the paper envelope by a female caught by Mr. R. Illidge at Mooloolah in October, 1919. These preliminary experiments, however, gave me sufficient information to set about the larger experiment carried out since.

Tisiphone joanna—A Natural Hybrid.

Experimental proof.

In October, 1920, I spent three days at Urunga, at the mouth of the Bellinger River, and there secured a few pupae of *morrisi* and a large number of larvae. These I brought home and reared a number of them to perfect insects. Before this, I had secured a large number of larvae of *abeona* from near Sydney, some of which I had in one of my cages and others I had on marked plants in a gully near my home to be used if required. When suitable specimens emerged on the same day and the weather was right for pairing, a pair was introduced into a cage in the sunshine. In this way I secured ten sets of fertile eggs, in five cases the male parent was *abeona* with a *morrisi* female and in the other five the male parent was *morrisi* with an *abeona* female. In some cases I had to keep the specimens alive for a few days by artificial feeding in order to have the sex I required, and in one case only I had to bring in a wild *abeona* male caught near my home, as I had no freshly-emerged specimen. From these ten families I secured in the autumn of 1921 exactly one hundred first generation hybrids. From these first generation specimens, despite very adverse weather conditions, I was able to secure ten fresh pairings, in no case mating brother and sister. The weather during the winter of 1921 was not at all conducive to success, and the larvae of the first generation had so eaten down the food plants during the previous summer, that I at one time feared that I should rear only two or three specimens of the second generation. Some families failed entirely to give me any butterflies, but two were very successful; it was abundantly indicated that I should have more plants in reserve and not try to rear two broods in the one cage in any one year. I am now in a much stronger position for the plants in the new set of cages are growing well and are in much better condition than the older ones which were not grown under such favourable conditions. Of second generation specimens I secured in all thirty butterflies from which I was only able to make two successful pairings; these, however, have given me during the last six weeks twelve butterflies of the third generation.

A detailed examination of these three generations of hybrids has been so far impossible, as sufficient time has not yet been available, so this must be postponed until a later date; nor can all the families obtained and their parents be figured, for coloured plates would be necessary and the cost would be very great. I have given figures of six specimens of the first generation, six of the second and three of the third, choosing as far as possible specimens that agree as nearly as possible with those figures of *joanna* in "The Butterflies of Australia," the coloured plate appearing in that work being repeated here as Plate ii. A comparison of the hybrids figured on Plate iii. with the figures of *joanna* on Plate ii. gives the following results:—fig. 1, a first generation male, approaches fig. 808; fig. 2, also a first generation male of the same family as fig. 1, is not represented on Plate ii. but is of a somewhat similar type to many caught specimens; fig. 3 is a remarkable first generation female; this type appeared in quite half the first generation families, but was very rarely caught at Port Macquarie; fig. 4, a first generation male, approaches figs. 805, 809 and 811 and specimens somewhat like this are not uncommon at Port Macquarie; fig. 5, another first generation male of the same family as figs. 3 and 4, represents the general type of first generation males occurring in the ten first generation families, though usually the band on the hindwing above is quite absent; it somewhat resembles fig. 801, more especially on the forewing, and is not uncommon at Port Macquarie; fig. 6, is a first generation female of the type of fig. 5. The second generation hybrids are shown in figs. 7-12 and are all from the same family; fig. 7, a male, is close to fig. 805 and fig. 8, also a male, agrees with fig. 795; fig. 9 is a female agreeing fairly well with fig. 803 and also approaches the typical *morrisi*; fig. 10 is a male agreeing with fig. 809; fig. 11 is a female agreeing with fig. 3 of the first generation and is somewhat like fig. 812; fig. 12 is a male very like fig. 811; fig. 8 is the male parent of all the third generation hybrids I have reared. The third generation hybrids are shown in figs. 13-15; fig. 13, a male, is almost identical with fig. 800; fig. 14, a female, approaches fig. 798, but has the hindwing band much reduced; fig. 15, a male, approaches fig. 811. In making a comparison between the hybrids I have reared and specimens of *joanna* caught at Port Macquarie, it must be remembered that the comparison between males is easier than between females, for I have reared nearly an equal proportion of the sexes whilst, as is usual, I have only been able to catch about one female to every five males, even though I searched for the former more thoroughly. I have therefore a much smaller number of females of *joanna* with which to compare my hybrid females.

It is not contended that I have been able to obtain amongst my hybrids a specimen identical or even nearly so with every specimen of the 300 specimens of *joanna* obtained by myself at Port Macquarie or those caught there by Messrs. Lyell and Wylde. The number of hybrids reared is only about one third of the number of specimens of *joanna* available for comparison and by far the greater number are of the first generation. It is improbable that at the present time an equivalent of the first generation hybrid ever occurs. When the experiment is continued beyond three generations a greater similarity with existing specimens will no doubt be reached. The above comparison with a careful examination of the coloured plates proves my contention that the race *joanna* at Port Macquarie is a natural hybrid resulting from the crossing of the broad orange-banded southern form with the narrow white-banded northern form.

It has not been possible to give figures of the parents of the families, for, as they have to be kept in the cages sometimes as long as four days, they naturally become worn and ragged. This happens especially with the females, as they are left until I consider all their eggs are laid; the males are killed as soon as I am satisfied that pairing has taken place.

I propose as soon as possible to continue these experiments to a much greater number of generations and also to see what will be the results by pairing somewhat similar specimens of *joanna* from Port Macquarie and also the results from widely different specimens.

The Relation of Tisiphone to the Physiography of Eastern Australia.

Those who have studied Australian physiography agree that the events of the ultimate and penultimate chapters of the development of Eastern Australia present the following sequence. At a period roughly dated as Pliocene, peneplanation of this area was in an advanced stage; the shore stood farther eastwards, trespassing upon what are now the Tasman and the Coral Seas, the watershed was lower than at present and lay further westward, whilst the land continued south to Tasmania and beyond and north to New Guinea.

To this epoch of terrestrial stagnation there succeeded what Mr. E. C. Andrews has called appropriately the "Kosciusko cycle." Then the coast re-treated westward, the coastal mountain range rose higher, Torres and Bass Straits opened. Synchronous with these events occurred a glacial phase which has written its story in moraines across the face of Kosciusko. Movement of the coast range re-organised the river system and exposed different rocks on the surface. Changes in climate played on each organism and the vegetation, as Mr. R. H. Cambage has described so clearly in the case of the Eucalypts, responded to the change of environment. Specific differentiation in both fauna and flora then proceeded rapidly.

The palaeontological record shows so far no fossil butterflies earlier than the Tertiary, but in the Oligocene of both Europe and North America we find fossils of even the more developed groups and, included amongst these, several fossil Satyrids. Present day Satyrids are of world-wide distribution and there is every possibility that as early as the Miocene they had a similar distribution and that the ancestral forms of our present Satyrids were then in Australia.

It is reasonable to suppose that, before the great uplifting movement at the end of the Pliocene, the ancestor of *Tisiphone* was present in Eastern Australia. I consider that first of all the genus became restricted to the higher elevations where moisture was more abundant. At the low-lying portion of the main divide known as the Cassilis Gap, the conditions became unsuited for its existence and it disappeared. This barrier then produced a discontinuous distribution and allowed the ancestral *Tisiphone* to develop independently to the north and to the south, gradually producing what we now know as broad orange banded forms in the south and narrow white banded forms in the north. The southern form now occurs almost up to the southern end of the Cassilis Gap and, though no form has been taken near the northern end of the Gap, the white banded form occurs at the southern end of the Mt. Royal Range almost in the same latitude. As time progressed the two forms were able to reach the coast, the southern probably first, and finding suitable conditions moved northward and southward, meeting in the small area of Port Macquarie and thus were able, in fairly recent times, to reunite and form the very complex race *joanna* there. Tasmania, though possessing the foodplant, does not possess any *Tisiphone,* which may possibly have died out or was not in a position to pass along the land connection at what is now Bass Straits. This would point to *Tisiphone* belonging rather to the earlier of the newer Papuan invasions from the north than to the older Satyrid fauna occurring in South-eastern Australia and now represented by such genera as *Heteronympha* and *Xenica.*

Though these experiments were started with the definite object of proving *Tisiphone joanna* a natural hybrid, which I claim to have shown, many other interesting problems have presented themselves, but sufficient time has not been available for their complete study and so they must be left to some future occasion. The great question of heredity stands first, but I have not had sufficient time to make the thorough examination necessary, nor do I consider that the number of specimens obtained, particularly in the second and third generations, is enough to enable sound conclusions to be drawn. I propose, therefore, with the increased facilities at my disposal and the experience I have already obtained, to repeat the experiment of obtaining ten families of hybrids from *abeona* and *morrisi* and aim at getting a much larger number of specimens of the second and third generations and even carrying on the experiments to further generations. Though the coastal strip from Twofold Bay to Caloundra has been carefully and thoroughly collected—the only point of investigation being the nature and extent of the barrier separating *morrisi* and *rawnsleyi*—the Main Divide has been imperfectly worked as will be seen from the map (Pl. i.); the various gaps require to be filled, a task that will take many months, for, unlike the seacoast where the sword grass is fairly continuous, in the mountains it occurs in small isolated patches more particularly at the higher elevations.

In conclusion, other than those already mentioned, I have to thank Mr. C. Hedley for many suggestions over a number of years and our Secretary Dr. Walkom who has been of great assistance to me all through the last year.

In illustration of his remarks Mr. Waterhouse exhibited a case of butterflies showing all the subspecies of *T. abeona* with a map giving their distribution; a case containing about 80 specimens of *joanna* from Port Macquarie showing all the general types of variation so far caught; a case showing the parents and two large families of hybrids of the first generation, one having *abeona* as the male parent and the other *morrisi* as the male parent, also all the second and third generation hybrids obtained; a case showing the preliminary experiments with *abeona* and *rawnsleyi* and all the hybrids obtained.

EXPLANATION OF PLATES I.–III.

Plate i.

Map of Eastern Australia from near Maryborough, Q. to Lorne, Vic., showing the distribution of the subspecies of *Tisiphone abeona* on the coast, and the localities on the Main Dividing Range where some of the subspecies have been captured.

Plate ii. (Reprinted from "The Butterflies of Australia.")

Figs. 794-814 and 818 show a number of variations of *T. abeona joanna*, all except fig. 801 caught within ten days of one another in Oct.–Nov., 1913, and all from within eight miles of the Port Macquarie Post Office.

Fig. 801.—Reared from an egg laid by the female shown in fig. 807; emerged from pupa in March, 1914.

Fig. 815.—*T. abeona abeona*, under side. Blue Mts. in October.

Fig. 816.—*T. abeona albifascia*, under side. Macedon, Vic. in January,

Fig. 817.—*T. abeona morrisi*, upper side. Richmond R. in October.

Plate iii.

Hybrids between *abeona* and *morrisi*.

Figs. 1–6.—First generation, Figs. 3, 4 and 5 are from the same family.

Figs. 7–12.—Second generation. All from the same parents; fig. 8 shows the male parent of all the third generation hybrids reared in these experiments.

Figs. 13–15.—Third generation.

Figs. 3, 6, 9, 11 and 14 are *females*, the remainder *males*.

Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheets for the year 1921, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that it be received and adopted, which was carried unanimously.

No nominations of other Candidates having been received, the President declared the following elections for the ensuing Session to be duly made:—

President: Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S.

Members of Council (to fill six vacancies): Messrs. R. H. Cambage, F.L.S., Prof. H. G. Chapman, M.D., B.S., T. Storie Dixson, M.B., Ch.M., E. W. Ferguson, M.B., Ch.M., J. J. Fletcher, M.A., B.Sc., and A. F. Basset Hull.

Auditor: Mr. F. H. Rayment, F.C.P.A.

On the motion of Sir Edgeworth David a cordial vote of thanks to the retiring President was carried by acclamation.

Linnean Society of New South Wales.

GENERAL ACCOUNT. Balance Sheet at 31st December, 1921.

LIABILITIES.

	£ s. d.	£ s. d.
Capital: Amount received from Sir William Macleay during his lifetime		14,000 0 0
Further sum bequeathed by his Will		6,000 0 0
		20,000 0 0
Contingencies Reserve		950 0 0
Commercial Banking Coy. (Peace Loan A/c.)		144 1 7
Income A/c. at 31st December, 1921		49 1 5
		£21,143 3 0

ASSETS.

	£ s. d.	£ s. d.
Society's Freehold		105 0 0
Investments—War and Peace Loans	10,795 0 0	
N.S.W. Treasury Bills	4,000 0 0	
Loan on Mortgage	6,200 0 0	
		20,995 0 0
Cash: Current A/c.	31 3 0	
Savings Bank	2 0 0	
In hand	10 0 0	
		43 3 0
		£21,143 3 0

INCOME ACCOUNT, Year ended 31st December, 1921.

	£ s. d.	£ s. d.
To Salaries, Wages, and Retired Allowance		1,060 0 0
„ Printing Publications	706 16 0	
„ Illustrations	181 13 10	
		888 9 10
„ Rates	55 4 10	
„ Insurance (Fire)	16 4 4	
		71 9 2
„ Postage and Transport	104 14 6	
„ Printing (Sundries) and Stationery	28 18 6	
„ Audit Fee	5 5 0	
„ Gas	5 2 4	
„ Maintenance Sir Wm. Macleay's Grave	1 10 0	
„ Telephone	12 0 1	
„ Insurance (Workmen's Compensation)	5 2 9	
„ Furniture and Repairs	17 19 0	
„ Bank Charges	1 8 0	
„ Petty Cash	28 14 7	
		210 14 9
„ Library		59 11 0
„ Honour Roll		3 16 0
„ Contingencies Reserve		200 0 0
„ Balance from 1920		6 19 3
„ „ to 1922		49 1 5
		£2,550 1 5

	£ s. d.	£ s. d.
By Subscriptions: 1921	141 15 0	
„ Do. Arrears	23 2 0	
„ Do. In advance	9 2 0	
		173 19 0
„ Entrance Fees		10 10 0
„ Interest on Investments		1,284 19 5
„ Sales (including 100 copies of Proceedings purchased by Government of N.S. Wales)		208 14 11
„ Fellowships A/c. (Surplus income transferred)		821 18 1
„ Bacteriology A/c. (Rent and Maintenance)		50 0 0
		£2,550 1 5

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,
Auditor.

1st February, 1922.

Sydney, 20th January, 1922.

J. H. CAMPBELL,
Hon. Treasurer.

LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1921.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	35,000	0	0	Investments: War and Peace Loans	17,805	0	0
Surplus Income capitalised	9,000	0	0	N.S.W. Stock and Treasury Bills	2,615	0	0
				Loans on Mortgage	23,580	0	0
	£44,000	0	0		£44,000	0	0

INCOME ACCOUNT, Year ended 31st December, 1921.

	£	s.	d.		£	s.	d.
To Salaries of Linnean Macleay Fellows	1,500	0	0	By Interest on Investments	2,437	13	1
„ Fellows Subsidies	15	15	0				
„ Capital A/c.	100	0	0				
„ General A/c.	821	18	1				
	£2,437	13	1		£2,437	13	1

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,
Auditor.

1st February, 1922.

Sydney, 20th January, 1922.

J. H. CAMPBELL,
Hon. Treasurer.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1921.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	12,000	0	0	War Loan				14,400	0	0
Accumulated Income capitalised	2,000	0	0	Cash: Current A/c.	35	19	8			
Income A/c. at 31st December, 1921	446	9	3	Savings Bank	4	9	7			
				In hand	6	0	0			
								46	9	3
	£14,446	9	3					£14,446	9	3

INCOME ACCOUNT, Year ended 31st December, 1921.

	£	s.	d.		£	s.	d.
To Salary	500	0	0	By Balance from 1920	299	5	0
,, Expenses and Petty Cash	7	5	4	,, Interest on Investments	704	9	7
,, General A/c. for Rent, Rates, &c.	50	0	0				
,, Balance to 1922	446	9	3				
	£1,003	14	7		£1,003	14	7

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Auditor.

1st February, 1922.

Sydney, 20th January, 1922.

J. H. CAMPBELL,
Hon. Treasurer.

ABSTRACT OF PROCEEDINGS.

ORDINARY MONTHLY MEETING.

29th March, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

PAPERS READ.

1. The *Loranthaceae* of Australia. Part i. By W. F. Blakely.

2. Notes on Nematodes of the genus *Physaloptera*, with special reference to those parasitic in Reptiles. Part ii. A review of the *Physaloptera* of Lizards. By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

3. A Monograph of the Freshwater Entomostraca of New South Wales. Part i. *Cladocera.* By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

The Donations and Exchanges received since the previous Monthly Meeting (30th November, 1921), amounting to 69 Vols., 447 Parts or Nos., 67 Bulletins, 14 Reports and 2 Pamphlets, etc., received from 110 Societies and Institutions and 5 private donors were laid upon the table.

ORDINARY MONTHLY MEETING.

26th April, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Messrs. Oscar Werner Tiegs, M.Sc., University of Adelaide, Adelaide, S.A., Alexander John Nicholson, M.Sc., Zoology Department, The University, Sydney, Owen Meredith Moulden, M.B., B.S., Broken Hill, N.S.W., Frederick Athol Perkins, B.Sc. Agr., Department of Agriculture, Sydney, Patrick Dismond Fitzgerald Murray, B.Sc., London, England, and Ian Mackerras were elected Ordinary Members of the Society.

The President announced that the Council had elected Professor H. G. Chapman, M.D., B.S., Messrs. J. J. Fletcher, M.A., B.Sc., W. W. Froggatt, F.E.S., and A. G. Hamilton to be Vice-Presidents; and Mr. J. H. Campbell, M.B.E., to be Honorary Treasurer for the current session, 1922-23.

The Donations and Exchanges received since the previous Monthly Meeting (29th March, 1922), amounting to 13 Vols., 51 Parts or Nos., 1 Bulletin, 2 Reports and 4 Pamphlets, etc., received from 36 Societies and Institutions and 5 private donors were laid upon the table.

PAPERS READ.

1. Australian *Coleoptera*: Notes and new species. No. ii. By H. J. Carter, B.A., F.E.S.

2. A new genus of Australian *Cixiidae* (Homoptera). By F. Muir.

3. New Gyrodactyloid Trematodes from Australian Fishes, together with a reclassification of the superfamily Gyrodactyloidea. By Professor T. Harvey Johnston, M.A., D.Sc., and O. W. Tiegs, M.Sc.

The discussion on the subject of the Presidential Address was contributed to by Dr. Anderson, Messrs. Blakely, Dr. Ferguson, Fletcher, Goldfinch, A. G. Hamilton, Hull, Le Souef and Dr. Walkom, the President replying to various questions raised.

NOTES AND EXHIBITS.

Mr. T. Steel exhibited a young *Hyla coerulea* having two bots of the frog bot-fly (probably a species of *Batrachomyia*), one on each shoulder.

Mr. W. F. Blakely exhibited from the National Herbarium, *Cenchrus pauciflorus* Benth., one of the North American sandburrs or "Burr grasses," which has been received for the first time from three widely different localities during the last four months, namely, Narrabri (Stock Inspector Brigg), Manildra district (A. H. T. Sherwin), Kelso (E. Ray). It is alleged to have been introduced into the two latter districts in "Sudan Grass" seed. There is another specimen in the Herbarium labelled Western Australia (Dr. F. Stoward, 1916). Wherever the Burr Grasses have become established they are spoken of as "vile weeds"—the burr-like involucres are a serious menace to man and beast. This species is described and figured by Agnes Chase, who has revised the North American species of Cenchrus (Cont. United States Nat. Herb., xxii., pt. i, 1920, p. 67). It is closely allied to *C. tribuloides* L., from which it is distinguished by its smaller, finely pubescent burrs, in contradistinction to the larger and densely woolly burrs of *C. tribuloides*.

Mr. Fred Turner exhibited specimens of *Euphorbia lathyris* Linn., received from Mr. R. Baird, Multagoona, Darling River. The exhibitor had never collected this plant west of the Darling R., nor had he previously received it from that part of the State. According to Dr. Robert Bentley the seeds are "purgative and yield by expression a very active cathartic oil." The plant is recorded in Turner's "Catalogue of Introduced Plants" (Agric. Gaz. N.S.W., i., p. 304). Mr. Turner also stated that *Saponaria calabrica* Guss. recorded as new for the State (These Proc., 1921, p. 349) was listed in Australian seedsmen's catalogues and cultivated in gardens as a border plant more than forty years ago.

ORDINARY MONTHLY MEETING.

31st May, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Mr. Robert Henry Anderson, Botanical Assistant, Dept. of Agriculture, Sydney, was elected an Ordinary Member of the Society.

The President, on behalf of members, offered hearty congratulations to Mr. R. T. Baker on the award to him by the Royal Society of New South Wales of the Clarke Memorial Medal, and also to Mr. H. G. Smith on the award to him of the David Syme Research Prize by the University of Melbourne.

The President announced that Mr. J. H. Maiden, I.S.O., F.R.S., acting on the advice of his medical advisers, had resigned from the Council, and expressed, on behalf of members, the regret felt at Mr. Maiden's resignation and the greatest appreciation of his interest in the Society and all its work during his thirty five years of office as a Member of Council.

The Donations and Exchanges received since the previous Monthly Meeting (26th April, 1922), amounting to 9 Vols., 130 Parts or Nos., 7 Bulletins, 9 Reports and 3 Pamphlets, etc., received from 61 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. The Geology and Petrography of the Clarencetown-Paterson District. Part i. By G. D. Osborne, B.Sc.

2. Descriptions and biology of some North Australian Termites. By G. F. Hill, F.E.S.

3. A Second Bird Census. By Professor J. B. Cleland, M.D.

NOTES AND EXHIBITS.

Mr. W. F. Blakely exhibited from the National Herbarium, *Erucastrum incanum* (L.) Koch., (Sinapis incana L., Brassica adpressa L.), an introduced cruciferous plant from the Mediterranean region, of which there appears to be no previous record for the Commonwealth. Several plants were found in the railway enclosure opposite Marrangaroo Siding (Dr. E. C. Chisholm and W. F. Blakely, 8-5-1922). It is a straggling hispid plant with long wiry branches, and a few narrow stem-leaves; the very thin appressed fruiting branches vary from 6 inches to 2 feet long; pods 6-12 mm. long, 2-4-seeded. It is closely allied to *Brassica* from which it differs mainly in the one-seeded beak; ovate or oblong seeds; and in the truncate cotyledons. It is figured in Ill. Brit. Fl. fig. 83. From an agricultural viewpoint the plant appears to be an undesirable one.

Mr. E. Cheel drew attention to a work entitled "Nomenclatorial Notes: chiefly African and Australian," by G. Claridge Druce (Second Supplement to Botanical Society and Exchange Club Report for 1916, pp. 601-653) which had a very important bearing on the naming of Australian plants. The names of some of the commonest of local plants are affected, including *Angophora lanceolata, Baeckea crenulata, Westringia rosmarinifolia,* and *Scaevola hispida.*

Dr. E. W. Ferguson exhibited a specimen of the head of a fowl infested with fleas. The flea *Echidnophaga gallinacea,* popularly known as the Sticktight Flea, is well known as a pest of poultry in other parts of the world, but does not appear to have been recorded as a pest in N.S. Wales. In Western Australia the flea has been causing extensive trouble among poultry and domestic animals during the past eighteen months. The fleas attack principally the combs and wattles of the birds and often settle in large masses on the host. Unlike most fleas, the Sticktight flea settles down in a suitable spot and, deeply inserting its rostrum, remains in the one place for days or weeks. Chickens are most often attacked, but other animals, including dogs, cats, ducks, tame pets and rats, may act as hosts. Man may be attacked, but apparently not freely. The eggs are dropped from the adult female and the larvae hatch out and develop in the dust of chicken coops, fowl-houses, etc. The flea is not known to carry any disease, but may cause considerable loss among young poultry.

Mr. A. F. Basset Hull exhibited a copy of Handbook No. 1 (The Fishes of New South Wales) published by the Royal Zoological Society of N.S.W.

Mr. A. R. McCulloch gave an interesting account of Lord Howe Island, illustrating his remarks with a number of lantern slides.

ORDINARY MONTHLY MEETING.

28th June, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

The President announced that the Council had elected Mr. E. C. Andrews to be a Member of the Council in place of Mr. J. H. Maiden, resigned.

Letters were read from Messrs. R. T. Baker and H. G. Smith, returning thanks for congratulations; and from Mr. J. H. Maiden returning thanks for Members' appreciation of his services as a member of the Council. Mr. Baker, who was present, also expressed his appreciation of Members' congratulations.

Professor Haswell forwarded a report of the Council of the Ray Society in which an appeal is made for new subscribers to enable the Society to continue work on its present scale. The Secretary will be pleased to furnish any further information available to intending subscribers.

The Donations and Exchanges received since the previous Monthly Meeting (31st May, 1922), amounting to 11 Vols., 64 Parts or Nos., 10 Bulletins, 5 Reports and 4 Pamphlets, etc., received from 47 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. The *Loranthaceae* of Australia, Part ii. By W. F. Blakely.
2. Some New Permian Insects from Belmont, N.S.W., in the Collection of Mr. John Mitchell. By R. J. Tillyard, M.A., D.Sc., F.L.S., F.E.S.
3. A new Gasteropod (fam. *Euomphalidae*) from the Lower Marine Series of New South Wales. By John Mitchell.
4. Notes on Nematodes of the genus *Physaloptera*. Part iii. The *Physaloptera* of Australian Lizards. By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.
5. Studies in Symbiosis. i. The Mycorhiza of *Dipodium punctatum* R.Br. By J. McLuckie, M.A., D.Sc.

NOTES AND EXHIBITS.

Mr. Fletcher showed a complete plant, 3¼ inches high, a dwarf form of *Darwinia taxifolia*, in flower, from Lane Cove, by way of contrast to some flowering specimens from a plant 8 feet high, exhibited, some years ago, by Mr. Cheel from the Hawkesbury River.

Mr. A. F. Basset Hull gave a short account of his recent expedition to the Archipelago of the Recherche, Western Australia, and exhibited a collection of Chitons (Polyplacophora) taken along the coast of the Great Australian Bight and on the Islands; and a series of land shells (*Bothiembryon* spp.) illustrating the local variation from the mainland type *B. inflatus*, the shells from each island visited being distinguishable, in fact some have been separately named by malacologists. Reference was also made to the wanton destruction of seals on the islands of the Archipelago

Mr. E. Le G. Troughton exhibited (by permission of the Director of the Australian Museum) two skins of a rare native rat, *Rattus mondraineus* (described in 1921 by Mr. Oldfield Thomas from two specimens), secured by the recent expedition to the Recherche Archipelago; also two skulls of the White-necked Hair Seal, *Eumetopias albicollis*, from the same source; one specimen displayed an irregularity in dentition, not infrequent in seals, due to the failure of the sixth molar to develop.

Mr. W. F. Blakely submitted the following examples of homoplasy (referred to in These Proc., xlvii., 1922, pp. 17, 18): 1. *Lyonsia eucalyptifolia* and *Eucalyptus Stuartiana*; 2. *Exocarpus aphylla* and *Acacia exocarpioides*; 3. *Notothixos cornifolius* and *Exocarpus latifolius*; 4. *Stephania hernandifolia* and *Macaranga Tanarius*; 5. *Epacris rigida* and *Leptospermum epacridioides*; 6. *Dodonaea* *boroniaefolia* and *Boronia microphylla*; 7. *Cryptocarya patentinervis* and *Acer philippinum*; 8. *Santalum obtusifolium* and *Gaiadendron ligustrina.*

Mr. A. S. Le Souef exhibited a live specimen of *Conilurus conditor,* the house-building rat, specimens of which were procured on the Nullarbor Plains and have since bred in Taronga Park.

ORDINARY MONTHLY MEETING.

26th July, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

The President announced that Mr. R. T. Baker, having retired from active participation in scientific work, had resigned from the Council of the Society and expressed, on behalf of members, appreciation of Mr. Baker's services to the Society as a member of Council for twenty-five years.

The President also announced the death, on 23rd July, of Mr. J. E. Carne, late Government Geologist of N.S.W., who had been a member of the Society since 1899, and a member of Council from 1913-1921.

The Donations and Exchanges received since the previous Monthly Meeting (28th June, 1922), amounting to 7 Vols., 100 Parts or Nos., 6 Bulletins, 5 Reports and 1 Pamphlet, etc., received from 49 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. Description of New Australasian Blattidae, with a Note on the Blattid Coxa. By A. Eland Shaw, M.R.C.S., F.E.S.

2. A remarkable new Gall-thrips from Australia. By H. H. Karny, Ph.D. (*Communicated by W. W. Froggatt, F.L.S.*).

3. A New Australian Termite. By G. F. Hill, F.E.S.

4. Notes on Australian Tabanidae, Part ii. By E. W. Ferguson, M.B., Ch.M., and G. F. Hill, F.E.S.

5. Studies in Symbiosis, ii. The Apogeotropic Roots of *Macrozamia spiralis* and their physiological Significance. By J. McLuckie, M.A., D.Sc.

NOTES AND EXHIBITS.

Mr. J. J. Fletcher called attention to Mr. Kinghorn's illustration of, and remarks on, an Indian Bulbul (*Otocompsa emeria*) in the Australian Museum Magazine for July, 1922; and reported that he had recently noticed one doing exactly what a Fan-tailed Cuckoo had done a few days before—alight on a stake in the garden a few yards from a wall covered with Virginian Creeper, fly up and catch a caterpillar of the Vine Moth, and return to the stake to finish his repast.

Dr. C. Anderson, Australian Museum, exhibited portions of the lower jaw of *Diprotodon,* found by Mr. Edward Saunders on Cuan Creek, about 14 miles west of Scone. The bones, which are remarkably fresh, were discovered at the base of a bank of gravel and earth about 25 feet high, which is being undercut by the creek. We are indebted to Canon F. Cadell, of Scone, for calling attention to this find.

Mr. W. W. Froggatt exhibited (1) a *Loranthus,* parasitic on a Black Cypress Pine (*Callitris* sp.) growing on a ridge about seven miles from Scone, which is thickly infested with the Indian Wax-Scale *Ceroplastes ceriferus.* This loranth is killing out a number of these cypress pines, and a great number of the loranths are thickly infested with the wax-scale, though there is not a single wax-scale on the foliage or twigs of the Cypress. It looks as if this was a case where birds must have carried the scale from some other host plant.—(2) Also a remarkable gall (*Sphaerococcus leaii*) on the Belah (*Casuarina Cambagei*) from Trangie, N.S.W., described from Casuarinas in Western Australia, but not previously found in Eastern Australia.

ORDINARY MONTHLY MEETING.

30TH AUGUST, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

The President, on behalf of members, offered the congratulations of members to Dr. W. R. Browne on having attained the degree of Doctor of Science in the University of Sydney.

A bronze example of the Medal struck on the occasion of the one hundred and fiftieth Anniversary of the foundation of the Royal Academy of Belgium was received from that Institution.

The President announced that the Naturalists' Society of N.S.W. would hold an exhibition of wild flowers and fauna in St. James' Hall, Phillip Street, on Thursday and Friday, 7th and 8th September, afternoon and evening.

The Donations and Exchanges received since the previous Monthly Meeting (26th July, 1922), amounting to 7 Vols., 116 Parts or Nos., 14 Bulletins, 4 Reports and 2 Pamphlets, etc., received from 58 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. A new species of *Mordellistena* (Coleoptera, Mordellidae) parasitic on Termites. By G. F. Hill, F.E.S.
2. Description of a new Phasma belonging to the genus *Extatosoma*. By W. W. Froggatt, F.L.S.
3. On *Astacocroton*, a new type of Acarid. By Professor W. A. Haswell, M.A., D.Sc., F.R.S.
4. A new Nematode Parasite of a Lizard. By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.
5. Revision of Australian Lepidoptera: Saturniadae, Bombycidae, Eupterotidae, Notondontidae. By A. J. Turner, M.D., F.E.S.

NOTES AND EXHIBITS.

Mr. W. F. Blakely exhibited from the National Herbarium specimens of *Acacia juncifolia* Benth., an imperfectly known species, recently collected on Ramornie Station, Copmanhurst District (W. F. Blakely and D. W. C. Shiress), the first definite locality for the species in this State. Bentham described the phyllodia as "slightly flattened with a scarcely prominent nerve on each side." In a fresh state the Ramornie specimens were filiform, perfectly terete, with 4 very fine nerves, and 1-2 microscopic lines between them, two of the nerves were slightly more prominent than the others. When dry, the phyllodia shrivelled to such an extent as to appear slightly compressed or subtetragonous-terete, more or less channelled, while the nerves are scarcely distinguishable from the longitudinal wrinkles of the phyllodia. This specimen is almost identical with one from Balonne River, a cotype, and very similar to the following Queensland specimens:—Crow's Nest (Dr. F. H. Kenny), Eight Mile Plain (F. M. Bailey), near Miles (Miss E. J. Adams), Eidsvold (Dr. T. L. Bancroft). Var. *planifolia* Benth., from Warialda (J. H. Maiden and J. L. Boorman), has broader and more compressed phyllodia than any of the preceding, but it also has the 4 very fine nerves which are apt to be overlooked, as in the rest of the specimens, unless critically examined. The seeds of this species are mottled.

Mr. E. Cheel drew attention to a number of seedling plants of an upright blackberry (*Rubus* sp.) cultivated at Hill Top via Picton, very badly infested with "Rust Disease" probably caused by *Phragmidium* sp. but further material is required to work out the species definitely.

Mr. G. A. Waterhouse exhibited specimens of *Argynnina hobartia cyrila* reared from eggs laid in captivity by females caught at Narrabeen; also a pair of the same butterfly caught last December at Mt. Kosciusko, constituting a new record for the locality.

Mr. J. J. Fletcher exhibited a number of lantern slides showing the germination of various species of *Loranthus*.

ORDINARY MONTHLY MEETING.

27th September, 1922.

Mr. J. J. Fletcher, M.A., B.Sc., Vice-President, in the Chair.

Mr. Leith Fuller Hitchcock, Assistant Biologist, Prickly Pear Laboratory, Sherwood, Queensland, was elected an Ordinary Member of the Society.

A letter was read from Dr. W. R. Browne, returning thanks for congratulations.

The Chairman announced that the regulations governing the Linnean Macleay Fellowships had been revised and that the Council is prepared to receive applications for four Fellowships tenable for one year from 1st March, 1923, from qualified Candidates. Applications should be lodged with the Secretary, who will afford all necessary information to intending Candidates, not later than Wednesday, 1st November, 1922.

The Donations and Exchanges received since the previous Monthly Meeting (30th August, 1922), amounting to 10 Vols., 51 Parts or Nos., 2 Bulletins, 4 Reports and 2 Pamphlets, etc., received from 51 Societies and Institutions and 1 private donor were laid upon the table.

PAPERS READ.

1. Chemical Notes—General. By T. Steel.

2. A Note on Protein Precipitation in Grasses. By Margaret H. O'Dwyer, B.Sc.

3. Further Report on the Nutritive Value of Certain Australian Grasses. By Margaret H. O'Dwyer, B.Sc.

4. The *Loranthaceae* of Australia (contd.), Part iii. By W. F. Blakely.

5. The Occurrence of Oil-Glands in the Barks of Certain Eucalypts. By M. B. Welch, B.Sc., A.I.C.

NOTES AND EXHIBITS.

Mr. W. F. Blakely exhibited from the National Herbarium: (1) An example of albinism in *Pultenaea daphnoides* Wendl. Three plants, ranging from 3-5 feet high were found in a gully about 2½ miles due East of Hornsby railway station. The leaves and calyces are similar to the typical form. Standard white except for 10-12, fine, radiating, light purple-brown lines at the base.

Wings white with a light purple-brown streak on the lower margin. Keel dark purple-brown shading to black; (2) A large flowering variety of *Lasiopetalum rufum* R.Br., from Berowra (W. F. Blakely and D. W. C. Shiress) which differs from the normal form in the larger leaves, and large, showy, flesh-coloured flowers. Mr. Blakely also exhibited a beautiful hand painting of *Loranthus alyxifolius* F.v.M., on its host *Alphitonia excelsa* Reiss., by Mrs. C. F. Tindal, Ramornie. Flowers and buds various shades of old blood red (Plate 103, Dauthenay, Repertoire de Couleurs). Anthers saffron yellow (Plate 48). The adventitious roots are similar in appearance to the branches of the parasite, and they possess, also, the same general tone as the bark of the host.

Mr. E. Cheel exhibited a fresh flowering specimen of *Callistemon,* having flowers of a rich reddish plum colour (*see* Dauthenay's Repertoire de Couleurs. Pl. 174 (4) given as "Deep Carmine Violet"). The plant is one taken from a batch of seedlings raised from seeds of a creamy-white flowering form of *C. lanceolata* var. *lilacina* Hort., originally raised from seeds received from Berlin in 1913 (*see* These Proceedings, 1916, p. 219 and 1917, p. 512). It is interesting to note that specimens have been collected at Gosford in a natural state, and forwarded to the National Herbarium for identification, having identical coloured filaments and anthers, as one of the forms raised from the seeds obtained from Berlin.

The specimens collected at Como (*see* These Proceedings, 1903, p. 884) belong to this series rather than to the typical *C. rugulosus* DC (C. coccineus F.v.M.) which is an interior species.

Mr. N. B. Friend exhibited a specimen of picramic acid, $C_6H_2(NO_2)_2NH_2.OH$, prepared by him in the laboratory of the Royal North Shore Hospital, by reduction of picric acid.

Professor T. T. Flynn sent, for exhibition, a photograph that is practically unique in depicting the actual process of parturition in an Australian marsupial, *Potorous tridactylus.* The organs are shown from the dorsal side and the embryo is lying on its left side in the left lateral canal. The photograph shows that in this case parturition takes place through the lateral canals and not through a median passage as Fletcher and Stirling have shown in the case of twelve species of *Macropus.*

ORDINARY MONTHLY MEETING.

25th October, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

The President announced that since the last meeting two members of the Society had died, viz., Messrs. C. O. Hamblin, B.Sc., who had been a member since 1915, and G. I. Playfair, who was elected a member in 1908.

Candidates for Linnean Macleay Fellowships, 1923-24, were reminded that Wednesday, 1st November, was the last day for lodging applications with the Secretary.

The Donations and Exchanges received since the previous Monthly Meeting (27th September, 1922), amounting to 1 Vol., 118 Parts or Nos., 2 Bulletins, 1 Report and 2 Pamphlets, etc., received from 45 Societies and Institutions and 1 private donor were laid upon the table.

PAPERS READ.

1. Mesozoic Insects of Queensland. No. 9. By R. J. Tillyard, M.A., D.Sc., F.E.S., F.L.S.

2. Some Australian Moths from Lord Howe Island. By A. J. Turner, M.D., F.E.S.

3. Notes on Nematodes of the genus *Physaloptera*. Part iv. The *Physaloptera* of Australian Lizards (contd.). By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

4. The Geology and Petrography of the Clarencetown-Paterson District. Part ii. By G. D. Osborne, B.Sc.

NOTES AND EXHIBITS.

Mr. E. Cheel sent for exhibition fresh flowering specimens of *Callistemon pallidus* (Bonpland) DC. The seeds from which the plant was raised, now cultivated at Ashfield, were collected on Mount Jellore in May, 1916; the plant is now 9 feet high, having flowers of a creamy-white colour. Although the plant is seven years old, it is the first time it has flowered. Plants almost identical with those on Mount Jellore are to be found at Jenolan Caves, Mount Seaview, and Mount Nelligen in this State, and Buffalo Ranges in Victoria. It is also quite common in Tasmania, and has previously been listed as a synonym under *C. salignus* DC., but is quite distinct.

Mr. W. F. Blakely exhibited from the National Herbarium fruiting specimens of *Acacia subtilinervis* F.v.M., a rare species for N.S.W., from near Nowra (Dr. F. A. Rodway). The pods do not appear to have been described before. When very young they are minutely scurfy; mature pods linear, glabrous, flat or the valves slightly convex over the seeds, margins nerve-like, 5—6 cm. long, 4 mm. broad; seeds placed longitudinally, oblong, 4 mm. long; areolae oblong, about half the length of the seed; funicle white, slightly dilated, with 2 or 3 folds at the end of the seed.

It is also represented in the Herbarium from Clyde Mountain (W. Bauerlen) and Yowaka via Pambula (H. W. Smith).

Mr. J. Ramsay, by invitation, showed a number of lantern slides illustrating the results of timber cutting in the National Park.

ORDINARY MONTHLY MEETING.

29th November, 1922.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Dr. Frederick George Hardwick, B.D.S., D.D.Sc., Molesworth Street, Lismore, N.S.W., was elected an Ordinary Member of the Society.

The President announced that the Council had re-appointed Dr. J. M. Petrie, Miss M. I. Collins, B.Sc., and Miss M. Henry, B.Sc., to Linnean Macleay Fellowships in Bio-chemistry, Botany and Zoology respectively for one year from 1st April, 1923.

The Donations and Exchanges received since the previous Monthly Meeting (25th October, 1922), amounting to 4 Vols., 752 Parts or Nos., 5 Bulletins, 5 Reports, and 4 Pamphlets, etc., received from 47 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. Descriptions of two new Trilobites and note on *Griffithides convexicaudatus* Mitch. By John Mitchell.

2. A Monograph of the Freshwater Entomostraca of New South Wales. Part ii. Copepoda. By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

3. New or little-known species of Australian Tipulidae (Diptera). i. By C. P. Alexander, Ph.D. (*Communicated by Dr. E. W. Ferguson*).

4. The Effect of Suspended Respiration on the Composition of Alveolar Air. By H. S. Halcro Wardlaw, D.Sc.

5. On Australian Anthicidae (Coleoptera). By Arthur M. Lea, F.E.S.

6. A Contribution to the Parasitism of *Notothixos incanus* (Oliv.) var. *subaureus*. By J. McLuckie, M.A., D.Sc.

7. The Phylogenetic Significance of the Marsupial Allantoplacenta. By Professor T. Thomson Flynn, D.Sc.

NOTES AND EXHIBITS.

Professor T. W. Edgeworth David exhibited a microslide of chert of Lower Permian age collected by Dr. W. R. Browne and himself from strata of the Lower Marine Series from about 1½ miles N.N.E. of Eelah, near West Maitland. It contains spore cases, perfectly resinous and translucent, some of which appear to contain microsporangia. The chert is largely a very fine volcanic tuff re-distributed in water.

Mr. W. M. Carne exhibited a specimen of a wild oat, *Avena sterilis*, from Richmond not previously recorded as a weed in this State. There are no Australian specimens in the National Herbarium. This species is believed to be the origin of most of the oats now cultivated in this State. These varieties have largely replaced those of the cooler parts of the world which are derived from *Avena fatua* L.

Professor T. Thomson Flynn exhibited an intracranial cast of the whale *Prosqualodon davidis* from the Miocene Beds at Wynyard, Tasmania. The cast shows a well developed olfactory peduncle, low development of the cerebral hemisphere, well formed optic chiasma and other primitive features.

Mr. E. Cheel exhibited specimens of the common "Knot-Grass" (*Polygonum aviculare* L.), infested with a rust fungus *Uromyces polygoni* (Pers.) Fckl., collected at Ashfield in December, 1920, and each successive year during the months of November and December. It is recorded by McAlpine (Agric. Gaz. N.S.W., vii., 1896, 301) from near Melbourne but has not been recorded previously for this State so far as can be ascertained.

He also exhibited specimens of a common fungus *Schizophyllum commune* received from Mr. D. G. Stead, who states that he collected it at the Public Market at Teluk Anson, Perak, F.M.S. It is used commonly as "Makan" (food), in preparation for which it is cooked (boiled) as an ordinary vegetable and is eaten with rice, cocoanut, etc. Sold throughout the Malay Peninsula.

Mr. J. H. Maiden sent for exhibition specimens of *Linnea borealis* L. var. *americana* collected by Mr. C. Hedley on the Klondyke Gold-field, Alaska, U.S.A., at the end of July, 1922.

Miss V. Irwin Smith exhibited a collection of parasitic nematodes from a chicken and a goat hitherto unrecorded in Australia from these hosts. They were all obtained in Sydney, two species from the chicken and six species from the goat.

From the chicken, a young cockerel of the breed known as Rhode Island Red, seven specimens of *Acuaria* (*Cheilospirura*) *hamulosa* Diesing, six females and one male, were collected from a nodule projecting externally from the gizzard.

Numerous perforations, made by the parasites, led from the nodule into the interior of the gizzard, through one of which a worm was projecting into its cavity. This worm has only been recorded from Brazil, Italy and France. Numerous badly preserved specimens of a species of *Capillaria* were collected from the intestine of the same cockerel. They are unlike the species hitherto recorded in this State, and appear to approach most nearly to *Capillaria* (*Thominx*) *collare* Linstow.

The six species from the goat were *Haemonchus contortus* Rud., *Ostertagia circumcincta* Stadelm, *Trichostrongylus extenuatus* Raill., and *T. instabilis* Railliet, from the stomach, and *Chabertia ovina* Fabr., and *Trichuris ovis* Abildg., from the intestine.

These are all well known in other parts of the world as parasites of cattle, sheep, and goats, and most of them have been recorded already in Australia either from cattle or sheep; but the parasites of goats have not hitherto received any attention here and this is the first record made from this host.

Mr. W. F. Blakely exhibited from the National Herbarium the following new weeds for the State: (1) *Silene quinquevulnera* L. * (Caryophyllaceae). "Five-wounded Catchfly." Distinguished from *S. gallica* by the smaller flowers, and the dark crimson spot in the centre of each petal. It is common from Milton in the South, to Walcha in the North. It is also found in Victoria and Western Australia. Determined by Mr. W. M. Carne. (2) *Cleome spinosa* Jacq. (Capparidaceae). "Prickly Spider Flower" of South America. A garden escape which has become naturalised on the North Coast and in Queensland. Taree (J. Dowsett); Camden Haven River (J. Franks), with white flowers. (3) *Chamaesyce prostrata* (Ait.) Small (Euphorbia prostrata Ait.). "Spurge." This small North American species was found at Petersham by Mr. A. R. Woodhouse. It is also common in the Pacific Islands, and it is now recorded for the following islands for the first time. Jaluit, Marshall Islands (Dr. Schachnee); Nauru and Ocean Islands (Mrs. R. D. Rhone); Upolu, Samoa (Dr. B. Funk). (4) *C. thymifolia* L. (E. thymifolia L.). "Thyme-leaved Spurge." A native of the tropics generally. On gravel walk Botanic Gardens (E. Cheel). (5) *C. Preslii* (Guss) Arth. (E. Preslii Guss). "Upright Spotted Spurge" or "Slobber Weed" of North America. Abergeldie, Ashfield (R. D. Dixson). Its acrid milky juice is credited with causing "slobbers" in grazing animals. (6) *Datura ferox* L. (Solanaceae). "Thorn Apple," Balldale (C. H. Shipard); Klondyke, Barmedman, (H. A. Smith); Binneguy (G. P. Darnell Smith). A native of Spain; it is said to possess similar properties to *D. stramonium.* Determined by Mr. E. Cheel. (7) *Martynia diandra* Glox. (Martyniaceae). "Small Devil's Claw." Warialda (H. R. Goodall). It is an undesirable plant from tropical America. (8) *Cnicus benedictus* L. (Compositae). "Blessed Thistle." From an oat crop at Forest Hill near Wagga Wagga (G. C. Sparks). This Asiatic plant is a naturalised alien in many parts of the world. In America its leaves and flowering tops form the principal ingredient in "bitter tonics."

* *Silene quinquevulnera* is not a new record for the State, having been previously exhibited by Dr. Cleland (see These Proceedings, xlii., 1917, 104).—Ed.

DONATIONS AND EXCHANGES.

Received during the period 30th November, 1921, to 29th November, 1922.

(*From the respective Societies, etc., unless otherwise mentioned*).

ADELAIDE.

Australasian Antarctic Expedition, 1911-1914.—Scientific Reports, Series C. vi., pts. 4—5; viii., 2 (1922).

Department of Mines: Geological Survey of S. Australia.—Annual Report of Director of Mines and Government Geologist for 1920 (1921); Bulletin No. 9 (1922); Mining Review for Half-year ended 31st December, 1921, No. 35 (1922).

Public Library, Museum, and Art Gallery of South Australia.—Records of the S.A. Museum, ii., 2 (1922).

Royal Society of South Australia.—Transactions and Proceedings, xlv. (1921).

ALBANY.

New York State Library.—Annual Report of the New York State Museum, lxx., 1916 (2 vols.); lxxi., 1917 (2 vols.) (1919); lxxii., 1918 (Vols. 2—3) (1920).

AMSTERDAM.

Nederlandsche Entomologische Vereeniging.—Entomologische Berichten, vi., 121—124, 126, 127 (1921—1922); Tijdschrift voor Entomologie, lxiv., 3—4 (T.p. & c.) (1921).

ANN ARBOR.

American Microscopical Society.—Transactions, xl., 3—4 and Index (1921); xli., 1—2 (1922).

University of Michigan: Museum of Zoology.—Occasional Papers, Nos. 70—75; Index for Nos. 62—90; 91—103 (1919-1921).

AUCKLAND.

Auckland Institute and Museum.—Annual Report, 1921-22 (1922).

BALTIMORE.

Johns Hopkins University.—University Circular, N.S. 1920, Nos. 2—8 (1920); 1921, 1—6 (1921); 1922, 1 (1922).

BARCELONA.

Real Academia de Ciencias y Artes de Barcelona.—Boletin, iv., 5—6 (1921-1922); Memorias, xvi., 6—14 (T. p. & c.) (1921); xvii., 1—15 (1922); Nomina del Personal Academico, 1921-22.

BASEL.

Naturforschende Gesellschaft.—Verhandlungen, xxxii., 1920-21 (1921).

BATAVIA.

Koninklijke Natuurkundige Vereeniging in Nederl.-Indie.—Natuurkundig Tijdschrift voor Nederlandsch-Indie, lxxxi., 3 (T. p. & c.) (1921); lxxxii., 1—2 (1922).

BERKELEY.

University of California.—Memoirs, v. (1921); Publications.—Botany, T. p. & c. for Vols. i.—iv. (1903-1915); v., 17 (1922); vii., 11—14 (1922); ix. (complete) (1921); xi., 1 (1922); Geology, xii., 5 (T. p. & c.) (1919-1921); xiii., 1—8, 10 (1921-1922); xiv., 1—4 (1922); Physiology, v., 13 (T. p. & c.) (1912-1922); Zoology, xx., 8—13 (1922); xxi., 6—8 (1921-1922); xxiv., 1—2 (1922).

BERLIN.

Deutsche Entomologische Museum.—Deutsche Entomologische National-Bibliothek, Jahrgang 1—2, 1910-1911 (1910-1911); Entomologische Mitteilungen, i. (1912)-x. (1921) (complete); xi. (1922); Nos. 1—4 (1912-1922); Entomologische Monatsblatter, i.-ii. (complete) (1876, 1880); Supplementa Entomologica, Nos. 1—8 (1912-1919).

BIRMINGHAM.

Birmingham Natural History and Philosophical Society.—Annual Report for 1921; List of Members, 1922 (1922).

BOMBAY.

Bombay Bacteriological Laboratory.—Annual Report for Year 1920 (1922).

BOSTON.

American Academy of Arts and Sciences.—Proceedings, lvi., 1—11 (T. p. & c.) (1921); lvii., 1—10 (1921-1922).

Boston Society of Natural History.—Memoirs, viii., 3 (1919); Proceedings, xxxv., 4—6 (T. p. & c.) (1917-1920).

BREMEN.

Naturwissenschaftlicher Verein.—Abhandlungen, xxv., 2 (1922); 55th and 56th Jahrebericht (1922).

BRISBANE.

Department of Agriculture and Stock.—Queensland Agricultural Journal, xvi., 6 (T. p. & c.) (1921); xvii., 1—6 (T. p. & c.) (1922); xviii., 1—5 (1922).

Field Naturalists' Club of Queensland.—"The Queensland Naturalist," ii., Nos. 4—6; iii., 1—4 (1920-1922).

Geological Survey of Queensland.—Publication, No. 270 (1922).

Royal Society of Queensland.—Abstract of Proceedings, 31/10/21 (1921); 11/4/22; 28/4/22; 31/5/22; 26/6/22; 31/7/22; 31/8/22; 26/9/22; 30/10/22 (1922); Proceedings, xxxiii., 1921 (1922); Report of Council for 1921 (1922).

BROOKLYN, N.Y.

Botanical Society of America.—American Journal of Botany, viii., 8—10 (T. p. & c.) (1921); ix., 1—7 (1922).

Brooklyn Institute of Arts & Sciences.—Cold Spring Harbor Monographs ix. (1921).

BRUSSELS.

Academie Royale de Belgique.—Bulletin de la Classe des Sciences, 1921, 4—12 (T. p. & c.) (1921); 1922, 1—2 (1922); "L'Academie Royale de Belgique depuis sa Fondation," 1772-1922 (1922).

Academie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.—Annuaire, 88th Année, 1922 (1922).

Société Royale de Botanique de Belgique.—Bulletin l.; liv. (1921).

Société Royale Zoologique et Malacologique de Belgique.—Annales, li., 1920 (1921).

BUDAPEST.

Musée National Hongrois.—Annales, xvi., 2 (T. p. & c.) (1918); xvii. (1919); xviii., 1920-21 (1921).

BUENOS AIRES.

Museo Nacional de Historia Natural.—Anales, xxx., 1918 (1920).

Sociedad Argentina de Ciencias Naturales.—Revista "Physis," v., 19 (1921).

BUFFALO.

Buffalo Society of Natural Sciences.—Bulletin, xiii., 2 (1921).

CAEN.

Société Linnéenne de Normandie.—Bulletin, 7th Ser., iii., 1920 (1921).

CALCUTTA.

Geological Survey of India.—Memoirs, T. p. & c. for xl., pts. 1—3 (1912-1921); T. p. & c. for xliii., pts. 1—2 (1913-1916); xlviii. (1922); Palaeontologia Indica, N.S., vi., Mem. No. 2 (1922); Records, liii., 2—3 (1921-1922); liv., 1 (1922).

Indian Museum.—Memoirs, v., 9—10 (1921-1922); Records, viii., 13 (1922); T. p. & c. for xviii. (1921); xxi., 1; xxii., 2—5 and Appendix; xxiii., 1; xxiv., 1, 3 (1921-1922).

CAMBRIDGE, England.

Cambridge Philosophical Society.—Proceedings, xx., 4 (T. p. & c.) (1921); xxi., 1—2 (1922); Transactions, xxii., 23—25 (1922).

CAMBRIDGE, Mass.

Museum of Comparative Zoology at Harvard College.—Annual Report of the Director, 1920-1921 (1921); Bulletin, lvii., 6 (1922); lxv., 2—4 (1921-1922).

CAPE TOWN.

Royal Society of South Africa.—Transactions, x., 2 (1922).

South African Museum.—Annual Report for year ended 31st December, 1921 (1922); Annals, xviii., 3—4 (1921).

CHRISTCHURCH, N.Z.

Canterbury Museum.—Records, ii., 2 (1922).

CHRISTIANIA.

Videnskaps Selskapet i Christiania.—Fordhanglinger, Aar 1920; Skrifter i Matematisk-naturvidenskabelig Klasse, 1920 (2 vols.) (1921).

CINCINNATI.

Lloyd Library.—Bulletin, Nos. 21—22 (1921-1922).

CLUJ, Roumania.

Gradina Botanica.—Bulletin, i., 2 and Appendix, 3 (T. p. & c.) (1921); ii., 1—2 (1922); Contributions Botaniques, i., 1—2 (1921-1922).

COLOMBO.

Colombo Museum.—Spolia Zeylanica, T. p. & c. for xi.; xii., 45 (1921-1922); "The Snakes of Ceylon," by Frank Wall (1921).

COLUMBUS, Ohio.

American Chemical Society.—Journal of Industrial and Engineering Chemistry, xiii., 10—12 (T. p. & c.) (1921); xiv., 1—10 (1922).

Ohio Academy of Science and Ohio State University Scientific Society.—Ohio Journal of Science, xxii., 1—7 (1921-1922).

Ohio State University.—Bulletin, xxvi., 16 (1922).

Ohio State University: Ohio Biological Survey.—Bulletins, 10, 12 (1921).

COPENHAGEN.

Zoological Museum of the University.—Publications, Nos. 19—25 (1921-1922); The Danish Ingolf-Expedition, v., 9 (1921).

DUBLIN.

Royal Dublin Society.—Scientific Proceedings, N.S. xvi., 14—39 (T. p. & c.) (1920-1922); xvii., 1—10 (1922).

Royal Irish Academy.—Proceedings, T. p. & c. for xxxv., Section B. (1919-1920) and General (1918-1920); xxxvi., Section B., No. 1 (1921).

DURBAN.

Durban Museum.—Annals, iii., 2 (1921).

EAST LANSING, Mich.

Michigan Agricultural College Experiment Station.—Bacteriological Section, Report of the Bacteriologist, 1919-1920 (1920); 1920-1921 (1921); Technical Bulletin, Nos. 49, 52 (1920-1921).

EDINBURGH.

Royal Society of Edinburgh.—Proceedings, xli., 2 (T. p. & c.), Session 1920-1921 (1921); xlii., 1—2, Session 1921-1922 (1922); Transactions, lii., 4 (T. p. & c.), Session 1920-1921 (1921).

FRANKFURT ON MAIN.

Senckenbergische Naturforschende Gesellschaft in Frankfurt a.M.—Abhandlungen, xxxv., 3; xxxvi., 4 (T. p. & c.); xxxvii., 1—4 (1920-1921); Bericht, No. 51, 1—4 (1921); 52, 1 (1922).

GEELONG.

Geelong Field Naturalists' Club.—"The Geelong Naturalist," Second Series, vii., 1 (No. 49) (1922).

GENEVA.

Société de Physique et d'Histoire Naturelle de Génève.—Compte Rendu, xxxviii., 3 (T. p. & c.) (1921); xxxix., 1—2 (1922); Mémoires, xxxix., 6—7 (1921-1922).

GRANVILLE.

Denison University.—Journal of the Scientific Laboratories, xix., pp. 147—224 (No. 3); pp. 225—329 (No. 4) (T. p. & c.) (1920-1921).

HALIFAX.

Nova Scotian Institute of Science.—Proceedings and Transactions, xv., 1, Session 1918-1919 (1922).

HELSINGFORS.

Societas pro Fauna et Flora Fennica.—Acta, 45, 1—2 (1916-1921); 47—50 (1920-1921); Meddelanden, 46, 1919-1920; 47, 1920-1921 (1921).

Société des Sciences de Finlande.—Bidrag, T. p. & c. for 79; 80, 1—2 (1921); Oversikt, lxi., 1918-1919, C; lxii., 1919-1920, A; lxiii., 1920-1921, A. (1921).

HOBART.

Forestry Department.—Annual Report for Year ended 30th June, 1921 (1st Report) (1921).

Royal Society of Tasmania.—Papers and Proceedings for the Year 1921 (1922).

Tasmanian Field Naturalists' Club.—Easter Camp, 1922 (1922).

HONOLULU, T.H.

Bernice Pauahi Bishop Museum.—Memoirs, viii., 3—4 (1922); Occasional Papers, vii., 12—14 (T. p. & c.); viii., 2, 3, 5 (1921-1922).

INDIANAPOLIS.

Indiana Academy of Science.—Proceedings, 1919-1921 (1921-1922).

ITHACA, N.Y.

Cornell University.—28 theses presented for the degree of Doctor of Philosophy (mostly reprints from scientific publications) (1904-1922).

JAMAICA PLAIN.

Arnold Arboretum.—Journal, ii., 4 (T. p. & c.) (1921); iii., 1—2 (1921-1922).

JOHANNESBURG.

South African Association for Advancement of Science.—South African Journal of Science, xviii., 1—4 (T. p. & c.) (1921-1922).

LA PLATA.

Museo de La Plata.—Obras Completas y Correspondencia Cientifica de Florentino Ameghino, Vols. i.-iii. (1913-1915); Revista, xxv. (1921).

LAUNCESTON.

Department of Mines: Geological Survey of Tasmania.—"The Progress of Geological Research in Tasmania since 1902," by Loftus Hills (1921) (Reprint from Papers and Proceedings, Royal Society of Tasmania, 1921); Underground Water Supply Paper No. 2 (1922).

LIEGE.

Société Géologique de Belgique.—Annales, xlii., 4 (T. p. & c.) (1921); xliii., 3—4 (T. p. & c.) (1921-1922); xliv., 1—2 (1921-1922); Publications Relatives au Congo Belge et aux Régions Voisines, Annex T. xliv., 1, 1920-1921 (1922).

LONDON.

British Museum (Natural History).—Catalogue of the Fossil Bryozoa—The Cretaceous Bryozoa, by Dr. W. D. Lang, Vol. iii., pt. 1; Economic Series No. 12; Handbook of the British Lichens, by A. L. Smith (1921).

Entomological Society.—Transactions, 1919 (complete) (1919-1920); 1920, 1—2 (1920); 1921, 1—5 (T. p. & c.) (1921-1922).

Geological Society.—Quarterly Journal, lxxvii., 3—4 (T. p. & c.) (1921); lxxviii., 1—3 (1922); Geological Literature added to the Library during Year ended 31st December, 1920 (1921); Year ended 31st December, 1921 (1922); List, April, 1922 (1922).

Linnean Society.—Journal, Botany, xlv., 304 (T. p. & c.) (1922); xlvi., 305—306 (1922); Zoology, xxxiv., 230 (T. p. & c.) (1922); xxxv., 231—232 (1922); List, 1921-1922 (1922); Proceedings, 133rd Session, 1920-1921 (1921); Transactions, 2nd Series, Zoology, xviii., 1 (1922).

Ministry of Agriculture and Fisheries.—Journal, xxviii., 7—12 (T. p. & c.) (1921-1922); xxix., 1—7 (1922).

Royal Botanic Gardens, Kew.—Bulletin of Miscellaneous Information, 1921 (1921); Hooker's Icones Plantarum, Fifth Ser., i., 4 (T. p. & c.) (1922) (Presented by the Bentham Trustees).

Royal Microscopical Society.—Journal, 1921, 4 (T. p. & c.) (1921); 1922, 1—3 (1922).

Royal Society.—Philosophical Transactions, Series B, ccxi., Nos. B. 385—387 (1922); Proceedings, Series B, xcii., Nos. B. 647—648 (T. p. & c.) (1921); xciii., Nos. B. 649—655 (T. p. & c.) (1922); xciv., Nos. B. 656—657 (1922).

Zoological Society.—Abstract of Proceedings, Nos. 220—231 (1921-1922); Notices re Meetings (2) (1922); Proceedings, 1921, 4 (T. p. & c.) (1922); 1922, 1—2 (1922); Proceedings, Index, 1911-1920 (1922).

LYON.

Société Botanique de Lyon.—Annales, xli., 2 (1921).

MADRID.

Junta para Ampliacion de Estudios.—Catalogue of Publications, 1921-1922; Fauna Iberica, Himenopteros fam. Encirtidos (1921); Trabajos del Museo Nacional de Ciencias Naturales, Serie Geologica No. 28 (1922); Serie Zoologica No. 43—45 (1921-1922).

Real Sociedad Espanola de Historia Natural.—Boletin, xxi., 4—10 (T. p. & c.) (1921); xxii., 1—5 (1922); Memorias, xi., 5—6 (1921); xii., 2—3 (1921-1922).

MAINE, U.S.A.

Maine Agricultural Experiment Station.—Bulletins, 238, 242, 244, 251, 256, 259, 263—265, 267, 270, 273, 276, 282, 296 (1915-1921); Entomology Nos. 80, 82, 88, 90 (1915-1917).

MANCHESTER.

Conchological Society of Great Britain and Ireland.—Journal of Conchology, xvi., 8—9 (1922).

Manchester Literary and Philosophical Society.—Memoirs and Proceedings, lxiv., 2 (T. p. & c.), 1919-1920; lxv., 1, 1920-1921, (1921).

MANILA, P.I.

Bureau of Science of the Government of the Philippine Islands.—Philippine Journal of Science, xix., 1—6 (T. p. & c.) (1921); xx., 1—6 (T. p. & c.) (1922); xxi., 1—4 (1922).

MASSACHUSETTS.

Tufts College.—Tufts College Studies, v., 2 (1921).

MELBOURNE.

Australasian Journal of Pharmacy, N.S. ii., 23—24 (1921); iii., 25—34 (1922). (*From the Publisher*).

Commonwealth Bureau of Census and Statistics.—Official Yearbook, No. 14, 1921.

Commonwealth Institute of Science and Industry.—First Annual Report of Director from the Period from the Date of his Appointment (18th March, 1921) to the 30th June, 1922 (July, 1922); Bulletin, No. 22 (1922).

Department of Agriculture of Victoria.—Journal, T. p. & c. for xix; xx., 1—10 (1922).

Field Naturalists' Club of Victoria.—"Victorian Naturalist," xxxviii., 8—12 (T. p. & c.) (1921-1922); xxxix., 1—7 (1922).

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LIST OF MEMBERS, 1922.

Ordinary Members.

1905 Allen, Edmund, c/o Chief Engineer for Railways, Brisbane, Q.
1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College St., Sydney.
1921 Anderson, Miss Grace, B.Sc., Park Avenue, Gordon.
1922 Anderson, Robert Henry, B.Sc.Agr., Botanic Gardens, Sydney.
1899 Andrews, Ernest Clayton, B.A., F.G.S., Geological Survey, Department of Mines, Sydney.
1912 Aurousseau, Marcel, B.Sc., c/o Geo-Physical Laboratory, Carnegie Institution of Washington, Washington, D.C., U.S.A.
1913 Badham, Charles, B.Sc., M.B., Bureau of Microbiology, 93 Macquarie Street, Sydney.
1888 Baker, Richard Thomas, The Avenue, Cheltenham.
1919 Barnett, Marcus Stanley, c/o Colonial Sugar Refining Co., Ltd., O'Connell Street, Sydney.
1907 Benson, Professor William Noel, B.A., D.Sc., F.G.S., University of Otago, Dunedin, N.Z.
1920 Blakely, William Faris, Botanic Gardens, Sydney.
1912 Breakwell, Ernest, B.A., B.Sc., Agricultural High School, Yanco, N.S.W.
1914 Bretnall, Reginald Wheeler, "Dardanella," Bowral, N.S.W.
1912 Brewster, Miss Agnes, Girls' High School, Sydney.
1900 Broelemann, Henry W., Boite 22, a Pau (Basses-Pyrenees), France.
1919 Broughton, Miss Eileen Marjorie, B.Sc., "Riverview," Glenfield, N.S.W.
1921 Brown, Horace William, Grey Street, Glen Innes, N.S.W.
1911 Browne, William Rowan, D.Sc., Geology Dept., University of Sydney.
1920 Burkitt, Arthur Neville St. George Handcock, M.B., B.Sc., Medical School University of Sydney.
1921 Burns, Alexander Noble, Prickly Pear Laboratory, Sherwood, Brisbane, Q.
1910 Burrell, Harry, 19 Doncaster Avenue, Kensington.
1910 Burrell, Mrs. Harry, 19 Doncaster Avenue, Kensington.
1912 Cadell, Miss Myall, "Wotonga," Belgium Avenue, Roseville.
1899 Cambage, Richard Hind, L.S., F.L.S., Park Road, Burwood.
1901 Campbell, John Honeyford, M.B.E., Royal Mint, Sydney.
1905 Carne, Walter Mervyn, Government Botanist, Perth, W.A.
1890 Carson, Duncan, c/o Winchcombe, Carson, Ltd., Bridge St., Sydney.
1903 Carter, H. J., B.A., F.E.S., "Garrawillah," Kintore St., Wahroonga.
1912 Cayzer, Albert, B.Sc., University of Queensland, Brisbane, Q.
1904 Chapman, Professor Henry G., M.D., B.S., Medical School, University of Sydney.
1921 Chase, Miss Eleanor Emily, B.Sc., Zoology Department, The University, Sydney.
1899 Cheel, Edwin, Botanic Gardens, Sydney.
1920 Clarke, Harry Flockton, c/o Colonial Sugar Refining Co., Ltd., Rarawai Mill, Ba River, Fiji.
1901 Cleland, Professor John Burton, M.D., Ch.M., The University, Adelaide, S.A.
1916 Collins, Miss Marjorie Isabel, B.Sc., Macleay Museum, The University, Sydney.
1908 Cotton, Leo Arthur, M.A., D.Sc., Geology Dept., University of Sydney.
1900 Crago, W. H., M.D., 185 Macquarie Street, Sydney.

1920 Danes, Dr. Jiri Victor, Consul-General of the Czechoslovak Republic, 40 Bayswater Road, Darlinghurst.
1885 David, Sir Tannatt William Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., University of Sydney.
1883 Deane, Henry, M.A., F.L.S., M.Inst.C.E., "Campsie," 14 Mercer Road, Malvern, Melbourne, Victoria.
1916 Deer, Miss Margaret, B.A., B.Sc., 37 Milson Road, Watersleigh.
1913 Dixon, Jacob Robert L., M.R.C.S., L.R.C.P., Medical School, University of Sydney.
1887 Dixson, Sir Hugh, K.B., J.P., "Abergeldie," Summer Hill.
1881 Dixson, Thomas Storie, M.B., Ch.M., 215 Macquarie Street, Sydney.
1921 Dodd, Alan Parkhurst, Prickly Pear Laboratory, Sherwood, Brisbane, Q.
1920 Dwyer, Rt. Rev. Joseph Wilfrid, Bishop of Wagga, Wagga Wagga, N.S.W.

1920 Elston, Albert H., F.E.S., 50 Lefevre Terrace, North Adelaide, S.A.
1914 Enright, Walter John, B.A., West Maitland, N.S.W.

1908 Ferguson, Eustace William, M.B., Ch.M., Bureau of Microbiology, Macquarie Street, Sydney.
1908 Finckh, Herman E., "Hermes," 100 Raglan Street, Mosman.
1881 Fletcher, Joseph J., M.A., B.Sc., Woolwich Road, Woolwich.
1908 Flynn, Professor Theodore Thomson, D.Sc., University of Tasmania, Hobart, Tas.
1920 Friend, Norman Bartlett, 42 Pile Street, Dulwich Hill.
1911 Froggatt, John Lewis, B.Sc., Dept. of Agriculture, Brisbane.
1886 Froggatt, Walter Wilson, F.L.S., Agricultural Museum, George St. North, Sydney.
1920 Furst, Herbert Charles, "Hermsley," Tupper Street, Marrickville.

1912 Goldfinch, Gilbert M., "Lyndhurst," Salisbury Road, Rose Bay.
1899 Grant, Robert, 24 Edward Street, Woollahra.
1911 Greenwood, William Frederick Neville, c/- Colonial Sugar Refining Co., Ltd., Lautoka, Fiji.
1910 Griffiths, Edward, B.Sc., Dept. of Agriculture, 136 Lower George St., Sydney.
1901 Gurney, William B., F.E.S., Dept. of Agriculture, George St. North, Sydney.

1911 Hacker, Henry, Queensland Museum, Bowen Park, Brisbane, Q.
1909 Hall, E. Cuthbert, M.D., Ch.M., George Street, Parramatta.
1919 Hall, Leslie Lionel, 51 Macquarie Street, Sydney.
1897 Halligan, Gerald H., F.G.S., 97 Elphin Road, Launceston, Tasmania.
1899 Hamilton, Arthur Andrew, Botanic Gardens, Sydney.
1885 Hamilton, Alexander Greenlaw, "Tanandra," Hercules Street, Chatswood.
1922 Hardwick, Frederick George, B.D.S., D.D.Sc., Molesworth Street, Lismore, N.S.W.
1917 Hardy, G. H. Hurlestone, The University, Brisbane, Q.
1905 Harrison, Launcelot, B.Sc., B.A., Zoology Dept., University of Sydney.
1879 Haswell, Professor William Aitcheson, M.A., D.Sc., F.R.S., "Mimihau," Woollahra Point.
1911 Haviland, The Venerable Archdeacon F. E., The Rectory, Coonamble, N.S.W.
1891 Hedley, Charles, F.L.S., Australian Museum, College St., Sydney.
1920 Henry, Marguerite, B.Sc., "Derwent," Oxford St., Epping.
1909 Henry, Max, D.S.O., M.R.C.V.S., B.V.Sc., Coram Cottage, Essex Street, Epping.
1913 Hill, Gerald F., F.E.S., P.O. Box 301, Townsville, North Queensland.
1916 Hinder, Miss Eleanor Mary, B.Sc., "Taverham," Bridge End Street, Wollstonecraft.
1916 Hindmarsh, Miss Ellen Margaret, B.Sc., Medical School, The University of Sydney.
1922 Hitchcock, Leith Fuller, Prickly Pear Laboratory, Sherwood Brisbane, Q.
1918 Hopson, John, Jr., "Dalkeith," Eccleston, N.S.W.

1907 Hull, Arthur Francis Basset, Box 704, G.P.O., Sydney.
1892 Hynes, Miss Sarah, B.A., "Isis," Soudan Street, Randwick.

1912 Irby, Llewellyn George, Forest Branch, Lands Dept., Hobart, Tasmania.

1912 Jackson, Sidney William, M.R.A.O.U., Belltrees, via Scone, N.S.W.
1917 Jacobs, Ernest G., "Goulburnia," Banks Street, Ashfield.
1903 Jensen, Harald Ingemann, D.Sc., Queensland Geological Survey, George St., Brisbane, Q.
1907 Johnston, Professor Thomas Harvey, M.A., D.Sc., University of Queensland, Brisbane, Q.

1921 Kennedy, John A., M.B., Ch.M., 423 Marrickville Road, Dulwich Hill.

1913 Lawson, Professor A. Anstruther, D.Sc., F.R.S.E., Botany Dept., University of Sydney.
1892 Lea, Arthur M., F.E.S., 241 Young Street, Unley, Adelaide, S.A.
1915 Le Plastrier, Miss Constance Emily Mary, "Carinyah," Provincial Road, Lindfield.
1910 Le Souef, A. S., C.M.Z.S., Zoological Gardens, Taronga Park, Mosman.
1911 Longman, Heber A., Queensland Museum, Bowen Park, Brisbane, Q.
1891 Lower, Oswald B., F.E.S., Bartley Crescent, Wayville, S.A.
1893 Lucas, A. H. S., M.A., B.Sc., Sydney Grammar School, College St., Sydney.

1922 Mackerras, Ian Murray, "Beechworth," Stanton Road, Mosman.
1911 Mackinnon, Ewen, B.Sc., Commonwealth Institute of Science and Industry, 314 Albert Street, East Melbourne.
1883 Maiden, J. Henry, I.S.O., F.R.S., F.L.S., Botanic Gardens, Sydney.
1905 Mawson, Sir Douglas, B.E., D.Sc., The University, Adelaide, S.A.
1902 May, W. L., Forest Hill, Sandford, Tasmania.
1919 McCarthy, T., Bertram Street, Mortlake.
1907 McCulloch, Allan Riverstone, Australian Museum, College Street, Sydney.
1907 McDonnough, Thomas, L. S., "Iluka," Hamilton Street, Randwick.
1917 McKeown, Keith Collingwood, Office of the Water Conservation and Irrigation Commission, Leeton, N.S.W.
1919 McLuckie, John, M.A., D.Sc., Botany Dept., The University, Sydney.
1884 Mitchell John, 10 High Street, Waratah, N.S.W.
1922 Moulden, Owen Meredith, M.B., B.S., Broken Hill.
1904 Murdoch, R., Wanganui, New Zealand.
1920 Musgrave, Anthony, Australian Museum, College St., Sydney.
1888 Musson, Charles T., "Calala," Nelson Road, Gordon.

1913 Newman, Leslie John William, "Walthamstowe," Bernard St., Claremont, Perth, W.A.
1922 Nicholson, Alexander John, M.Sc., Zoology Dept., The University, Sydney.
1920 Noble, Robert Jackson, B.Sc. Agr., Carrington Street, Homebush.
1912 North, David Sutherland, c/- Colonial Sugar Refining Co., Ltd., O'Connell St., Sydney.

1920 O'Dwyer, Margaret Helena, B.Sc., Bio-chemistry Dept., Imperial College of Science, South Kensington, London, S.W.7, England.
1910 Oliver, W. Reginald B., F.L.S., F.Z.S., Dominion Museum, Wellington, N.Z.
1921 Osborne, George Davenport, B.Sc., Geology Dept., The University, Sydney.

1922 Perkins, Frederick Athol, B.Sc.Agr., Post Office, Stanthorpe, Queensland.
1904 Petrie, James Matthew, D.Sc., F.I.C., Medical School, University of Sydney.
1921 Phillips, Montagu Austin, F.L.S., 57 St. George's Square, London, S.W., England.
1920 Pincombe, Torrington Hawke, B.A., Russell Road, New Lambton, N.S.W.
1916 Pinkerton, Miss Ethel Corry, B.Sc., Ashford Street, Ashfield.
1918 Priestley, Henry, M.D., B.Sc., Medical School, University of Sydney.
1910 Pulleine, Robert Henry, M.B., 3 North Terrace, Adelaide, S.A.

1919 Scammell, George Vance, 18 Middle Head Road, Mosman.
1922 Shaw, Alfred Eland, M.R.C.S., L.R.C.P., F.E.S., Hospital for the Insane, Goodna, Queensland.
1918 Sherrie, Miss Heather, B.Sc., Ben Boyd Road, Neutral Bay.
1887 Sloane, Thomas G., Moorilla, Young, N.S.W.

1909 Smith, G. P. Darnell, D.Sc., F.I.C., F.C.S., Agricultural Museum, George St. North, Sydney.
1899 Smith, Henry George, F.C.S., "Dunbourne," Shirley Road, Roseville.
1898 Smith, R. Greig, D.Sc., Linnean Hall, Elizabeth Bay.
1916 Smith, Miss Vera Irwin, B.Sc., F.L.S., "Cora Lynn," Point Road, Woolwich.
1898 Stead, David G., "Boongarre," Pacific St., Watson's Bay.
1886 Steel, Thomas, "Rock Bank," Stephen Street, Pennant Hills.
1905 Stokes, Edward Sutherland, M.B., Ch.M., Dept. of Water Supply and Sewerage, 341 Pitt Street, Sydney.
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1920 Taylor, Augustus Selwyn, J.P., Asst. Govt. Geologist, Entebbe, Uganda, British East Africa.
1907 Taylor, Frank H., c/- Box 137, G.P.O., Sydney.
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(1922)

(a) GENERAL INDEX.

(*b*) BIOLOGICAL INDEX.

Synonyms are printed in *italics*; new names in SMALL CAPITALS.

(Issued 21st April, 1922.)

Vol. XLVII.
Part I.

No. 185.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1922

PART I. (pp. i.-xx.)

CONTAINING THE PROCEEDINGS OF THE ANNUAL MEETING

WITH THREE PLATES

[Plates i.-iii.]

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Corrigenda.—Proceedings, 1921, Part 4.

P. 511, line 19—for *A. piceus* Ol., read *A. laevigatus* F.

lines 34-35—for *Acacia farnesiana* L. read *Acacia Farnesiana* Willd.

Plate xxxiv. and Explanation on p. 412—Figs. 2 and 3 *should read* Fig. 2, male subimago; Fig. 3. female imago.

(*Issued 16th June, 1922.*)

Vol. XLVII.
Part 2.

No. 186.

THE PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES

FOR THE YEAR

1922

PART II. (*pp. 1-198.*)

CONTAINING PAPERS READ IN

MARCH-MAY.

WITH TWENTY-THREE PLATES

[Plates iv.-xxvi.]

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(*Issued 15th September, 1922.*)

Vol. XLVII.
Part 3.

No. 187.

THE

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OF THE

LINNEAN SOCIETY

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(*Pages 199-390, and Plates xxvii.-xxxviii.*)

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PROCEEDINGS, 1922, PART 3.

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Page xi., line 7. *For* forewing, *read* hindwing.

(Issued 15th December, 1922.)

Vol. XLVII.
Part 4.

No. 188.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

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Corrigenda.

Page 429, lines 31-2, *for* *E. Gullicki* Baker, *read* *E. Gullicki* Baker and Smith.

Page 431, line 2, *for* from, *read* to.

———— 5, *for* 2 mm., *read* 0.3 mm.

———— 6, *for* averaged 0.015 mm., *read* measured 0.06 mm.

Page 433, 3rd line from bottom, *for* section *read* sections.

(*Issued 15th February, 1923.*)

Vol. XLVII.
Part 5.

No. 189.

THE PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES

FOR THE YEAR

1922

PART V. (Pages xxi.-lxxi.)

ABSTRACT OF PROCEEDINGS, DONATIONS AND EXCHANGES, LIST OF MEMBERS AND INDEX.

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