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Index to Volume XII.

INDEX TO SUBJECTS.

INDEX TO AUTHORS.

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Edited by

GILBERT WHITLEY, F.R.Z.S.

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THE AUSTRALIAN ZOOLOGIST

Vol. XII. Part 1.

REVISION OF THE LIOTIIDAE OF NEW SOUTH WALES.

By CHARLES F. LASERON, F.R.Z.S.

(Figures 1-49.)

INTRODUCTION.

The original intention of this paper was to review the family of the Liotiidae alone, but it has been extended to include a number of other species, the classification of some of which is uncertain. The exact limitations of the Liotiidae are not yet well defined. The minute size of many species, and the fact that when living material is obtained specimens are only procured when this has been dried out, makes the study of the animal and even the operculum very difficult. The Orbitestellidae have been recognised as a different family, and many authors use Cyclostremidae as another distinct group. Apart from these there are other groups whose systematic position can only be guessed, and ultimately it will probably be found that the complete classification is very complex. An immediate necessity, however, is to catalogue and figure such species as exist on the coast, as a preliminary for the deeper study of phylogeny and ecology.

Even in taxonomy comparatively little has been done in New South Wales. Charles Hedley in his Check List allowed 24 species under Liotiidae and one *Orbitestella*. Of these, seven species described by Hedley himself have been excellently described and figured and their future recognition presents no difficulty. Species named by Angas are also satisfactory, as is Brazier's *Liotella pulcherrima*. Of the others, most are Tasmanian and Southern Australian species, whose extended range to New South Wales is often open to considerable doubt. This applies particularly to the several species proposed by the Rev. J. E. Tenison Woods. It is unfortunate that these were invariably unfigured, the descriptions were entirely inadequate, confined to a few lines of Latin with omission of many essential characters, and without access to the types recognition is almost impossible. This has led to much confusion. For instance, Professor Tate and W. L. May have identified and figured two different species as *Liotella annulata* Ten. Woods, one from South Australia, the other from Tasmania, while that recorded as *annulata* from New South Wales, while resembling the Tasmanian form, seems different from either.

Tasmanian species which appear on the New South Wales list were mostly identified by Hedley from deep sea dredgings by the "Thetis" and other expeditions. Even these cannot be taken as certain. The shells are so minute, that unless a species is a striking novelty, a general resemblance has been sufficient to cause workers to extend the range from one State to another. When every species, known or unknown, is drawn, differences in detail are revealed, showing that many are quite different from those with which they have been identified, and others, though tentatively retained under their former names, may yet prove to be distinct species.

Of the other species described in this paper, some show relationship with Queensland species, themselves as yet undescribed. The field here is enormous. Practically the only work done in Queensland on minute shells is that by the late Charles Hedley, and that mainly from two localities only—the Hope Islands and Masthead Island. There are literally hundreds of species, more or less related to the Liotiidae, which are as yet entirely unstudied, the great majority of which need new specific and in many cases new generic names. It is hoped that this attempt to systematise the group in New South Wales, practically synonymous with the Peronian Zoogeographical Province, will stimulate the desire to do likewise in Northern Australian waters.

MAY 17 1954

Practically all the material in this paper has been collected by my son John and myself in the last twenty years. I am deeply indebted to Mr. Tom Iredale, who throughout has taken the greatest interest in the work, has ever been ready with useful advice, and who has given freely of his own great knowledge and experience. All the types, as well as specimens illustrated, are being presented to the Australian Museum, where they will be kept as a separate unit and thus be available for future reference.

As in my other papers, the reference Hedley 466, or May 365, denotes the number indicating a species in the papers by Charles Hedley and W. L. May, respectively: "A Check List of the Marine Fauna of New South Wales, Part I," Supplement to Jour, Roy. Soc., N.S.W., Vol, LI, 1917, and "A Check List of the Mollusca of Tasmania," Govt. Printer, Hobart, 1921 and 1923.

Family LIOTIIDAE.

Genus LIOTINA, Fischer, 1885.

Liotina, Fisher, Man, de Conch. 1885, p. 831. Type, *L. gervillei* Defr. (Eocene fossil, Europe).

Liotina botanica Hedley. Figures 1, 1a.

Hedley 466.

This is the largest and also the commonest of the New South Wales species. It has been excellently described and figured by Hedley, and there is little to be added to his description. It is common on beaches right along the coast, and we have found it alive under rocks in pools at Long Reef, north of Sydney. The specimen figured is from this locality, and its major diameter is 6.5 mm., comparing with 7 mm. in the type. As the operculum has not yet been described, the opportunity is taken to note the following characters. It is circular with a central depressed nucleus, multi-spiral, the spirals very numerous and close together, and covered with minute raised tubercles. It is thick, with an outer, thin translucent and apparently horny layer both on the external and internal surfaces, between which is a thick, granular (? crystalline) layer.

It is a very constant species, easily recognised by its form, sculpture and prominent varix surrounding the aperture, and there is no other species with which it can readily be confused.

Liotina saxa, sp. nov. Figures 2, 2a.

Shell large for the group, massive, depressed turbinate, yellowish. Protoconch small and naticoid in a flat summit. Whorls 4, increasing rapidly, angular at the periphery, flattened above, sutures deep. The sculpture consists primarily of a strong concentric keel at the periphery, a lesser keel below this, another fainter keel below this and a fourth keel on the base. There are also two faint keels above, between the shoulder of the whorl and the suture. The transverse sculpture consists of broad, rounded costae, fading on the base, about 12 on the body whorl, and rising into prominent protuberances where they cross the keels. Secondary transverse sculpture consists of very fine, sharp, closely-packed ridges, covering both the main costae and the spaces between, and continuous from the suture downwards across the base and on to the walls of the umbilicus. Aperture rounded and entire, oblique, its margin broadened by a thick varix. Umbilicus large and deep, the funicle and sides with sharp vertical ridges. Height 5 mm., maximum diameter 7 mm., minimum diameter 5.5 mm.

Locality:—14 fathoms off Long Reef (type); also 2 specimens 30-35 fathoms off Crookhaven.

Remarks:—The nearest relation of this species seems to be *L. densilineata* Tate, but it differs in details of the sculpture and in the umbilicus.

Liotina scalaris Hedley.

Hedley 467.

Originally recorded as *Liotia tasmanica* Ten. Woods, var. *scalaris* Hedley, this is a deep water species from the continental shelf. I have not seen specimens, but from a figure published by T. Iredale, 1936, it has a higher spire and is much more rugose than *L. saxa*, though the general features of the sculpture are similar.

Genus PSEUDOLIOTIA Tate.

Trans. Royal Soc. S. Aust., xxii., 1898, p. 71.

Genotype *Liotia micans* Adams.

Tate's description of *Pseudoliotia* is as follows: "Shell something like *Liotia*, shell thick and porcellaneous, aperture oblique, operculum horny and multispiral. Recalls *Molleria*, which is differentiated by a calcareous operculum."

Various authors, including Iredale, Hedley and May, have since regarded *Pseudoliotia* as a synonym of *Liotia*, but the Australian species usually regarded as true Liotias are tropical forms, larger and with more elevated spires. *Pseudoliotia* forms apparently a natural group, of which two species occur in southern Australia, and similar, if not exactly the same, species in Queensland and northern Australia as far as Darwin. Tate's genus may therefore be left until further data determine its exact systematic position.

Pseudoliotia micans Adams. Figures 3, 3a.

Pseudoliotia speciosa Angas. Figures 4, 4a.

Hedley 464.

Though these are two distinct species, they are better discussed together, as there has been some confusion about their identity, and Hedley in his Check List synonomizes *speciosa* under *micans*. Both seem to have a wide geographical range; just how wide is not yet correctly known. The type locality of *micans* is South Australia, and both the Tasmanian and New South Wales specimens cannot be distinguished from those from South Australia. P. *speciosa* was described from Sydney Harbour, and extends northwards. Two similar if not identical species are found in Queensland, and two more in Darwin, but the exact identity of these northern forms has not yet been determined. When found together, *micans* and *speciosa* can be readily separated by their size, which is very constant, the specimen of *micans* figured from Little Manly having a maximum diameter of 3.2 mm, that of *speciosa* from North Harbour being 2.1 mm. This difference does not seem great, but it actually represents the comparative difference between a florin and a sixpenny piece, and is very apparent to the eye. The sculpture is very close, but *speciosa* has rather fewer cross ribs, it is flatter, the aperture is much more oblique, and the funicle or rib within the umbilicus is not nearly so prominent. Both species are common in shell sand on the beaches around Sydney, both inside and outside the harbour.

Genus LODDERIA Tate.

Trans. Roy. Soc. South Australia, xxiii, 1899, p. 215.

Genotype: *Lodderia lodderae* Petterd.

A genus related to *Liotia*, depressed turbinate in shape, aperture circular, oblique, with a prominent varix, peristome complete, the sculpture confined to a number of plain spiral keels, umbilicus deep. Operculum white and thick, with a central nucleus, multi-spiral.

Lodderia lodderae Petterd. Figs. 5, 5a..

Hedley 462.

Petterd's name has for a long time been accepted for the New South Wales shell, and gives the species an extensive range, South Australia, Victoria, Tasmania and New South Wales. Tasmanian specimens agree very well with the New South Wales species, but I have not been able to compare them with those from the type locality. Locally the species is a distinctive one, the strong concentric keels and absence of transverse sculpture making its recognition easy. It is common from many localities, mainly on the outer beaches. The specimen figured was living in dead Teredo tubes in a piece of driftwood at Long Reef, north of Sydney, its maximum diameter 1.7 mm., its minimum diameter 1.3 mm.

Genus LODDERENA Iredale.

Proc, Linn. Soc. N.S.W., xlix, 1924, p, 233,

Genotype *Liotia minima* Ten. Woods.

The genotype is included in both the New South Wales and Tasmanian check lists as *Lodderia,* and Iredale gives no generic description beyond stating that it should be separated as a distinct genus. If this be accepted, the main differences between the two are that the aperture is more prolonged and the concentric keels are finer and relieved by transverse puckerings adjacent to the sutures and on the base where they make the margin of the umbilicus plicate. The varix surrounding the very oblique aperture is very strong.

Lodderena minima Ten. Woods. Figs. 6, 6a.

Hedley 463.

This is another of Tenison Woods' species, which was unfigured and with an original description insufficient for recognition. Hedley identified it from the New South Wales coast after comparison with specimens from Western Port, Victoria, supplied by J. H. Gatliff, and figured and described the New South Wales shell. This is a very distinctive though minute shell, and the characters as given for the genus *Lodderena* should make its recognition easy. It is not uncommon in shell sand from various localities, mainly on the outer beaches. The specimen figured was dredged in North Harbour, its texture diameter .8 mm., its minimum diameter about .6 mm.

Genus PARTUBIOLA Iredale.

Rec. Aust. Mus. XIX, 1936, p. 286.

Genotype *Partubiola blancha* Iredale.

Iredale combined his generic and specific descriptions, but the features which may be taken as generic are the small, discoidal shell, which is thin and translucent, the sculpture of numerous concentric ridges, the wide umbilicus, the slightly oblique aperture and incomplete peristone, a band of callus on the body whorl linking the anterior and posterior extremities of the inner margin. The systematic position of this genus is uncertain. The simple nature of the shell gives no clue to its true relationship. It may be linked to the Liotiidae; on the other hand, when the animal and operculum become known it may have affinities at present unsuspected.

Partubiola blancha Iredale. Figs. 7, 7a.

Reference as for the genus.

The specimen figured came from 30-35 fathoms off Crookhaven, its maximum diameter 3.7 mm., which is smaller than the type. Otherwise it agrees fairly well, though the concentric ridges on the central portion of the body whorl are very faint and practically obsolete. Above this they are well defined, and steplike to a sharp edge, beyond which the whorl is depressed to the suture, bearing three more faint ridges. The type came from Sydney Harbour dredgings, and it may be that further material will show that more than one species occurs.

Genus MICRODISCULA Thiele.

Deutsch Sud. Pol. Exped. Vol. 12, 1912, p 199.

Genotype *M. vanhoffeni* Thiele.

This genus was proposed for small shells from the Antarctic and Subantarctic generally resembling the European *Skenea* but with a different radula. The general features are a thin, transparent shell, with depressed spire, just visible from in front, wide umbilicus and incomplete peristome. Certain Australian shells fit this description, and W. L. May has used it for *Cyclostrema charopa* Tate, which has a slightly higher spire than the genotype. May's figure does not, however, agree with that of Tate, and it is probable that the Tasmanian species is distinct. Three species from New South Wales might also be placed here, though their ultimate verification will depend on the discovery of the animal and comparison of its radula with the true *Microdiscula.*

Microdiscula vitrea, sp. nov. Figs. 8, 8a.

Shell small, thin, colourless and transparent, discoidal, the low spire just visible when viewed laterally. Protoconch minute, naticoid, mature whorls three, rapidly expanding, rounded, depressed above making a distinct hollow to the suture. Surface smooth except for faint growth lines, and a few faint concentric lirae adjoining the suture. Umbilicus wide and deep, the coiling of the earlier whorls clearly visible. Aperture not quite perfect in the type, but slightly oblique, rounded, the peristome nearly complete, except for a short gap where it is replaced by a narrow band of callus on the body whorl, outer and inner margins thin. Height, about 1.5 mm., maximum diameter 4.1 mm., minimum diameter 3,5 mm.

Locality: North Harbour, Port Jackson.

Remarks: In spite of the simple nature of the shell, there is no Australian shell yet described with which it can be confused. Others undoubtedly exist, and it is hoped that the description of one species will stimulate search for others, and for data to shed light on their true relationship.

Microdiscula pellucida, sp. nov. Figs. 9, 9a.

Shell small, thin, colourless and transparent, discoidal, summit of spire just visible from the side. Protoconch minute and simple, mature whorls three, rapidly increasing, regularly rounded, sutures deep. Sculpture none, except for faint growth lines, surface shining. Umbilicus wide and deep, round, the curvature of the earlier whorls visible within. Aperture wide and rounded, margins thin, peristome almost complete, adhering to the body whorl over a very short distance. Height slightly over 1 mm., maximum diameter 2.5 mm., minimum diameter 1.8 mm.

Locality: Kurnell, Botany Bay, in shell sand.

Remarks: Generally resembles *M. vitrea*, but smaller and with quite different proportions, being much higher in relation to its diameter.

Microdiscula fragilis, sp. nov. Figs. 48, 48a, 48b.

Shell small, white, thin and translucent, discoidal, the spire depressed, its tip just visible when viewed laterally. Protoconch apparently naticoid, slightly tilted and immersed. Mature whorls three, rounded, the earlier whorls just level above with the body whorl, the tip of the spire slightly above, sutures moderately impressed. Surface smooth and shining, the sculpture confined to faint growth lines. Aperture round, its upper margin just below the body whorl, slightly oblique, margins thin, the peristome incomplete, a thin layer of callus connecting it across the body whorl. Umbilicus round, wide and deep. Maximum diameter 1.8 mm., minimum diameter 1.4 mm.

Locality: Abundant in shallow water dredgings, Port Hacking, New South Wales.

Remarks: This is the smallest of the three species here discussed under *Microdiscula*. It is not quite so flat as *M. vitrea*, and is flatter than *M. pellucida*, and there are differences in the aperture, hard to describe, but best understood by comparison of the figures. The three species have distinct contours when viewed laterally.

Genus BROOKULA Iredale.

Proc. Malac. Soc., x., 1912, p. 119.

Genotype *B. stibarochila* Iredale.

This is a large and on the whole well defined genus, and its usage is uniform by conchologists both in Australia and New Zealand. Typically the species have broadly conical, elevated spires, they are minute, often under 1 mm. in height, umbilicate, the peristome complete but hidden by the overhang of the body whorl, and the sculpture consists of strong transverse ribs, between which are fine and concentric threads. Occasionally the sculpture is ill-defined and even nearly obsolete, but close examination always reveals its presence even if at first sight the shells seem practically smooth. There is also variation in the height of the spire. Some species are more depressed, and in a few, such as *johnstoni* Beddome, a stage is reached where different authors have placed it either under *Brookula* or *Liotella*.

Two species of *Brookula* have been allowed in Hedley's Check List, *B. angeli* Ten, Woods, and B. *crebresculpta* Tate. Both were collected by J. Brazier off Bottle and Glass Rocks, Port Jackson. For various reasons both identifications are open to doubt. When it was made in 1900 the wealth of minute species on the coast was not realised, and a general resemblance was often taken as sufficient identificatio. *Brookula angeli*, first described as a Rissoa, is another of Tenison Woods' wretched species, unfigured and inadequately described. Hedley figured a specimen sent to him as authentic by C. E. Beddome,[1] but W. L. May in his Tasmanian Check List figures quite another species, with far fewer ribs, and certainly more like one of the New South Wales forms

[1] Proc. Linn. Soc. N.S.W. xxv, 1900, p. 503, pl. 25, f. 14,

Tryon in his Manual figures as *angeli* still another species. Later in this paper the N.S.W. species generally known as *angeli* has been given a new name to avoid perpetuating this confusion of identity. *B. crebresculpta* Tate is a South Australian species which has been adequately figured and described, but in twenty years of collecting we have not seen it in New South Wales, and while its record cannot be altogether expunged, some further confirmation is needed before it can be finally accepted. Of the other Tasmanian species none is quite identifiable with those of New South Wales, neither are the one or two so far described from Queensland. This necessitates new specific names for all the New South Wales forms which are here described.

Brookula obscura, sp. nov. Fig. 10.

Shell minute, white, thin, translucent, broadly conical. Protoconch naticoid followed by three mature whorls, increasing regularly, body whorl large. Whorls regularly rounded, sutures deep. Sculpture not prominent, the transverse ribs nearly obsolete and only visible at some angles, the spiral lirae continuous, fine and closely spaced, continuing on the base. Umbilicus narrow but deep. Aperture rounded outer margin thin, inner margin straighter and slightly reflected, peristome comlete, but posterior portion hidden from in front by the overhang of the body whorl. Height 1.3 mm.

Localities: Not uncommon in shell sand on the outer beaches. Type from Port Stephens, also many specimens from Manly Ocean Beach.

Remarks: Though of typical shape, the obscure transverse sculpture and continuous spiral lirae remove it from most other species of the group, though in my opinion not sufficiently to justify generic separation. These features should make its future recognition easy.

Brookula jacksonensis, sp. nov. Fig. 11.

Shell minute but large for the genus, thin, white and translucent, conical. Protoconch naticoid, prominent and slightly tilted. Mature whorls four, increasing regularly, rounded, sutures deep. Sculpture very prominent, consisting of narrow, elevated, rounded, transverse costae, about 16 to the whorl, conspicuously white against the translucent surface of the whorl, continuous on to the base and into the umbilicus. The spaces between the costae are much wider than the costae themselves, and are crossed by numerous fine spiral lirae. Umbilicus narrow but deep. Aperture rounded, with simple outer margin, inner margin slightly reflected, peristome complete, but its posterior portion hidden from in front by the overhang of the body whorl, the whole aperture anteriorly produced. Height 1.5 mm.

Locality: Manly Beach (type); not uncommon in shell sand here and on other outside beaches.

Remarks: This approaches closely to *B. nepeanensis* Gatliff, a Victorian species also recorded from Tasmania. It is, however, rather narrower and with an extra whorl, and the transverse costae are rather more numerous.

Brookula augeria, sp. nov. Fig. 12.

Shell minute, broadly conical, thin, white. Protoconch naticoid, prominent. Mature whorls three, increasingly regularly, rounded, with deep sutures. Sculpture prominent, on the body whorl about 12 broad, rounded and elevated transverse costae; on the two earlier whorls the costate are smaller, numerous and close together. The costae are continuous on the base and bend upwards into the umbilicus. The spiral lirae are strong and are continuous, overriding the transverse costae. Umbilicus narrow and deep. Aperture rounded, in the type the outer margin expanded by the latest of the main costae, inner margin slightly reflected, the peristome complete, adherent posteriorly to the body whorl whose overhang makes it invisible in front. Height 1.2 mm.

Locality: 40-50 fathoms off Twofold Bay.

Remarks: This species is very close to *B. jacksonensis*, of which it may be considered the deepwater representative. It differs by having one whorl less, by being relatively broader, by having fewer costae on the body whorl, and by the crowding of the costae on the earlier whorls. It also resembles the figure given by May of *B. angeli* Ten. Woods, but for reasons already given this name has been discarded as from New South Wales.

Brookula turbinata sp. nov. Fig. 13.

Shell minute, white turbinate with a low spire. Protoconch prominent, naticoid, smooth, the costae of the adult sculpture appearing quite suddenly. Mature whorls three, rounded, sutures deep. Sculpture well defined, consisting of numerous, sharp, narrow, elevated transverse costae, about 20 on the body whorl, narrower than the intercostal spaces, continuous on the base and ascending into the umbilicus. Numerous spiral lirae cross the spaces between the costae. The umbilicus is moderately wide, round and deep. Aperture rounded, slightly angulated posteriorly, peristome complete, separate from the body whorl, but slightly hidden by the overhang of the body whorl when viewed from in front, margins thin. Height .9 mm.

Localities: 40-50 fathoms, Twofold Bay (type); another specimen from shell sand, Port Stephens.

Remarks: This is a beautiful little species, easily recognised by its shape and its sharply defined, regular sculpture. It is the first of several species showing progressively a reduction in the height of the spire, a corresponding increase in the size of the umbilicus and a complete development of the peristome, until the border line of *Brookula* and *Liotella* is reached.

Brookula orospatia, sp. nov. Fig. 14.

Shell minute, conical white. Protoconch prominent, naticoid and smooth, adult sculpture appearing gradually. Mature whorls three, rounded, sutures deep. The transverse sculpture is distinct but not prominent, the costae are narrow, about 22 on the body whorl, not elevated and not so well defined as shown on the figure, particularly on the base where they become faint before they finally ascend into the umbilicus. The spiral lirae are fine, numerous and well defined, particularly on the base. Umbilicus narrow and deep. Aperture rather elongate, the peristome adherent in its posterior portion to the body whorl, the outer margin thin and rounded, the inner margin nearly straight, the anterior margin bent back and extended. Height 1.3 mm.

Locality: 40-50 fathoms, Twofold Bay.

Remarks: The weak transverse sculpture separates this from most of the New South Wales species with high spires, but the shape of the aperture with its reflected anterior margin is the most conspicuous specific character.

Brookula sp. Fig. 34.

A single specimen of what is apparently a different species of *Brookula* was sorted from dredgings from 6-9 fathoms, Sow and Pigs Reef, Port Jackson, and is here figured for future reference. Further material is needed before a new specific name is proposed. In form this specimen generally resembles *B. turbinata,* but is nearly smooth, only traces of transverse sculpture appearing on the upper whorls and similar traces of concentric sculpture here and there. The indefinite sculpture may be partially due to wear, but the characters of the aperture are sufficiently distinctive to suggest that ultimately this must be still another species to add to the New South Wales list. The height of the specimen is about 1 mm.

Brookula finesia, sp. nov. Fig. 15.

Shell minute, turbinate with a low spire, white. Protoconch naticoid of two whorls, smooth. Mature whorls three, increasing regularly, rounded, sutures deep. Sculpture well defined, the transverse costae sharp, narrow and very numerous, close together, in width about equal to the intercostal species, continuous on the base and ascending into the umbilicus. The spiral sculpture is not prominent, consisting of fine lirae just visible between the costae. Aperture round, slightly oblique, peristome nearly entire, joined for a very narrow space posteriorly to the body whorl, umbilicus relatively wide, circular and deep. Height of shell 1.3 mm., maximum diameter of base 1.6 mm.

Locality: 30-35 fathoms off Crookhaven.

Remarks: This is a very beautiful and distinctive little species, the turbinate shape and sharp, finely-packed costae being useful features for future recognition. Systematically it seems on the border line between *Brookula* and *Liotella,* and might indeed be placed in either genus, the spire in height intermediate between the two with the rounded deep umbilicus and the aperture approaching the typical *Liotella.* Its nearest ally is *B. densilaminata* Verco, which has a slightly higher spire, but is otherwise very similar.

Brookula tumida, sp. nov. Fig. 16.

Shell minute, conical, white. Protoconch naticoid and smooth. Mature whorls three, rounded, the centre whorl swollen, relatively large, making the spire higher than normal and giving a distinct facies to the contour, the sutures deep. Sculpture not prominent, the transverse costae few and ill-defined, fading at the periphery, the spiral lirae continuous, very fine and not at all conspicuous. On the type the transverse costae become more conspicuous on the back of body whorl and near the aperture, where they consist of broad, low, rounded folds. Aperture rounded, peristome not quite complete, the inner margin slightly flattened and slightly reflected anteriorly. Umbilicus narrow, little more than a deep slit. Height 1.6 mm.

Locality: 40-50 fathoms, off Twofold Bay.

Remarks: This approaches close to *B. obscura*, already described in this paper, which is the common shallow water species near Sydney, and the opinion might possibly be held that it is but a deep water variety of that species. It is, however, relatively higher in proportion to its width, and the tumid median whorl gives it a distinct facies. There is no known Tasmanian species with which it can be compared.

Genus LIOTELLA Iredale.

Trans. New Zealand Inst., xvii, 1914, p. 442.

Genotype *Liotia polypleura* Hedley.

Iredale proposed *Liotella* for shells without a thickened peristome which are more or less loosely coiled, and having a multispiral operculum, with a central nucleus. To this may be added that the spire is depressed, the umbilicus wide and deep, the whorls are rounded and the sculpture consists of strong transverse ribs, with the spiral sculpture confined to fine lirae between the ribs or nearly or entirely obsolete. Among the species placed under *Liotella* there is considerable variation in the height of the spire; some species have the spire so elevated as to approximate to a depressed *Brookula*, others have it so depressed that the summit is quite flattened and the shell is coiled nearly within the one plane. Within these limits *Liotella* seems to form a natural genus whose recognition is comparatively easy.

Liotella princeps, sp. nov. Figs. 17, 17a.

Shell minute, depressed turbinate, spire laterally visible, white. Protoconch minute, smooth, but details not observable. Mature whorls three, rounded, sutures very deep, the whole loosely coiled, becoming slightly uncoiled towards the aperture. Sculpture prominent and well defined, consisting of numerous, sharp, well-raised transverse costae, 11 of which are visible on the front portion of the body whorl when viewed in profile. The intercostal spaces are about twice the width of the costae themselves. There is no trace of spiral sculpture, and the intercostal spaces are smooth. The costae are continuous from the sutures round the whorl and ascend vertically into the umbilicus. Aperture round, the peristome complete, the body whorl slightly uncoiled with the aperture pointing slightly downwards. Umbilicus round, well defined and deep. Major diameter 1.3 mm., minimum diameter .9 mm.

Locality: 15-25 fathoms, off Crookhaven.

Remarks: This is probably the species recorded by C. Hedley from the "Thetis" Expedition as *Cyclostrema johnstoni* Beddome, and included in the Check List as *Liotella* (No. 460). Unfortunately, *johnstoni* is another rather unsatisfactory species, as the original description was short and unaccompanied by a figure. Both May and Tate later figured *johnstoni*, but their figures do not quite agree, and it is probable that May's figure from a Tasmanian shell is the correct species. May shows a shell with a rather higher spire than ours, brown in colour, and, in fact, he places it under *Brookula*. Amongst New South Wales species, the slight uncoiling of the body whorl, and the downward pointing aperture, should prove ready recognition points.

Liotella littoralis, sp. nov. Fig. 18.

Shell minute, depressed turbinate, spire laterally visible, white. Protoconch naticoid, smooth. Mature whorls three, rounded, sutures deep. Sculpture strong and well defined, consisting of numerous elevated sharp costae, continuous from the sutures across the whorls and into the umbilicus, the intercostal spaces about $1\frac{1}{2}$ times the width of the costae, spiral sculpture absent. Fourteen costae are visible on the front portion of the body whorl when viewed laterally. Aperture rounded, peristome entire, separate from the body whorl, but not pointing downwards as in *L. princeps*. Umbilicus round, wide and deep. Maximum diameter 1 mm., minimum diameter .7 mm.

Localities: Shell sand, Port Stephens (type); Manly Ocean Beach; not uncommon on outer beaches.

Remarks: This is closely allied to *L. princeps*, but has a slightly deeper body whorl, the costae are rather more numerous and more closely placed, and the aperture does not point downwards.

Liotella parvirota, sp. nov. Figs. 19, 19a.

Shell minute, discoidal, coiled in nearly one plane so that the spire is slightly below the rim of the body whorl, and there is little difference in appearance between the lower and the upper surface of the shell; white. Protoconch minute, smooth, apparently a short, conical cap. Mature whorls three, round, the sutures deeply indented, the body whorl becoming separate just before the aperture. Aperture round, peristome complete and separate from the body whorl. Sculpture consisting of fine, sharp, well-elevated costae, far apart, only seven visible on the body whorl when viewed from in front, continuous round the whorls, from the sutures above to the sutures visible within the wide umbilical cavity. Faint traces of spiral lirae appear under high magnification in the intercostal spaces. Maximum diameter .8 mm., minimum diameter .6 mm.

Localities: Reclamations Bayview, Pittwater (type); not uncommon in shell sand on the outer beaches, Port Stephens, Manly Beach, and Shellharbour.

Remarks: This is possibly the species recorded as *L. annulata* Ten. Woods, by Hedley from the "Thetis" Expedition. Beyond knowing that the type of *annulata* came from Tasmania, there is no certainty as to what that species is. Both May and Tate figured different species as *annulata*, and Tryon in his Manual rejected the species as indecipherable. Under the circumstances it has been thought better to give the New South Wales species a new name rather than perpetuate one which will ever be open to doubt. There should be no difficulty in recognising the species in the future. It is probably the smallest of the local species; the flat, almost symmetrical coiling is distinctive, as is the wide distance separating the sharp, well-defined costae.

Liotella compacta Petterd was figured as *annulata* by Tate, but seems to be the young of *Liotia mayena* Tate.

Liotella pulcherrima Brazier. Figs. 20, 20a.

Hedley 461.

This beautiful little species is one of the most distinctive on the coast, and is easily recognisable by its flat, discoidal shape, not quite so symmetrical as *L. parvirota*, and the fineness of its sculpture, the costae being very numerous, fine, and closely packed. Unlike most other Liotellas, spiral sculpture is very defined, consisting of very fine lirae crossing the spaces between the costae but not overriding them, so the shell is hardly cancellate as stated by the author. The specimen figured is from Manly Ocean Beach, its maximum diameter 1.3 mm., its minimum .9 mm.

Liotella capitata Hedley.

Hedley 457.

I have not seen this species and am unable to provide an illustration, but Hedley's figure and description are adequate, and there should be no difficulty in its rcognition should it ever be found again. The type was a single specimen found in the great depth of 800 fathoms, 35 miles east of Sydney, right on the edge of the continental shelf, a locality only accessible to a properly equipped, deep sea dredging expedition. For reference it may be noted that it is rather similar to *L. patonga*, described in this paper, but differs chiefly in the rather higher spire, the more steeply descending aperture, and the crowding of the costae on the penultimate whorl.

Liotella patonga, sp. nov. Figs. 32, 32a, 32b.

Shell minute, subdiscoidal, the spire just visible when viewed laterally, white. Protoconch minute, apparently rather conical and elongate. Mature whorls three, rounded, sutures deep, slightly uncoiled towards the aperture which is turned slightly downwards. The sculpture is well defined, consisting of broad, elevated, widely separated transverse costae, only seven visible on the body whorl when viewed from in front, more prominent on the periphery and thinning towards the sutures on top and the umbilicus below. Aperture round, separate, turning slightly downwards, umbilicus wide, round and deep. Maximum diameter 1.2 mm., minimum diameter .8 mm

Localities: Patonga, Broken Bay, in shell sand (type); also on Manly Ocean Beach.

Remarks: This is the closest in relationship to *L. capitata* Hedley, and together they form a link between Liotellas with a depressed turbinate shape as *L. princeps*, and those which are discoidal as *L. parvirota*.

Liotella gravicosta, sp. nov. Figs. 33, 33a

Shell minute, suborbicular, spire just visible when viewed laterally, white. Protoconch undetermined. Mature whorls three, rounded, sutures deep. Sculpture strong and well defined, consisting of numerous, broad, well-elevated, rounded costae, 11 visible on the body whorl when viewed from in front, about equal in width to the intercostal spaces, continuous from the sutures round the whorls and ascending into the umbilicus, spiral sculpture absent. Aperture just below the previous whorl, not oblique, large, irregularly rounded, flattened above and obliquely flat on the inner margin, peristome complete and free from the body whorl, umbilicus large, rounded and deep. Maximum diameter .9 mm., minimum diameter .7 mm.

Locality: 55 fathoms, off Montagu Island.

Remarks: This has coarser sculpture than any of the other Australian species, and the broad, prominent costae, the form of the shell and the flattened upper margin of the aperture are good recognition points.

Genus LIOCARINIA gen. nov.

Genotype *Liotia disjuncta* Hedley.

Mem. Australian Mus., iv, 1903, p. 336, f. 66.

Shell with the general characters of *Liotella*, the shell loosely coiled, the aperture becoming separate and without a varix. It differs from *Liotella* in that the whorls are not rounded but strongly keeled, the genotype having a strong spiral keel at the periphery and another at the base of the whorl, between which the space is slightly concave, the transverse ribs descending vertically. The species described as *Omalaxis radiata* Hedley from the Masthead Islands, Queensland, will also come here.

Liocarinia disjuncta Hedley. Figs. 41, 41a (after Hedley).

Hedley 459.

This beautiful, distinctive little shell was collected by the "Thetis" Expedition from 41-50 fathoms, off Cape Three Points, on the continental shelf. Hedley's full description and excellent figures should make its future recognition beyond doubt.

Genus CIRSONELLA Angas.

P.Z.S., 1877, p. 38.

Genotype *Cirsonella australis* Angas.

The description given by Angas is "shell minute, globosely turbinate, smooth, narrowly umbilicated; aperture circular, peritreme continuous, slightly thickened." To this can be added that the operculum is brown, apparently horny, large, not retracted into the shell, thick, with a central nucleus and multispiral. The aperture also is oblique. Angas placed it provisionally in the Trochidae, but it probably needs a separate family and may not be far removed from the Liotiidae. Iredale's genus *Lissotesta* almost comes here, but may be retained to designate somewhat smaller shells of thinner texture and with the peristome incomplete.

Cirsonella australis Angas. Figs. 27, 27a.

Hedley 449 (*Cirsonella weldii* Ten. Woods).

Hedley synonomised *C. australis* under *C. weldii*, the type locality of which is Tasmania. As usual with Tenison Woods' species, no figure was provided, and the description is insufficient for identification. Tate and May[2] figured as *weldii* a shell with similar general characters to the Sydney shell, but with a more depressed spire. In view of this, and as Angas' figure is good and his description clear, I think it far better to restore his name to cover the New South Wales species. The specimen here figured is from the type locality, dredged off the Sow and Pigs Reef, Port Jackson, and the dimensions are: maximum diameter 2 mm., minimum diameter 1.7 mm., height slightly under 2 mm. The shell is white, smooth, hardly translucent, the peristome quite free from the body whorl, and the inner margin of the aperture is reflected slightly.

[2] Proc. Linn. Soc. N.S.W., xxvi, 1901, p. 397, f. 8,

Cirsonella reflecta, sp. nov. Figs. 28, 28a.

Shell minute, turbinate, white, translucent. Protoconch minute, apparently naticoid. Mature whorls three, the body whorl large, rounded, sutures deep. The surface is smooth except for faint growth lines. Aperture round, very oblique to the axis of the shell, outer margin round, inner margin slightly flattened and reflected, a narrow shelf commencing from the inner margin into the umbilicus, which it partly fills. Umbilicus round, narrow and deep, and owing to the rotundity of the body whorl appearing larger when viewed from in front. The peristome is complete, the aperture quite separate from the body whorl. Maximum diameter 1 mm., minimum diameter .8 mm.

Locality: 6-9 fathoms, Sow and Pigs Reef.

Remarks: This is a much smaller shell than *Cirsonella australis* Angas and has a more depressed spire. The narrow shelf partially filling the umbilicus is not a conspicuous character, but is important in its specific determination. A similar structure is found to an even more marked degree in the shell named by Hedley *Teinostoma starkeyae*, which is four times the size and even more depressed.

Cirsonella perplexa, sp. nov. Figs. 21, 21a.

Shell minute, turbinate, white, sub-translucent. Protoconch minute, apparently naticoid. Mature whorls three, the body whorl rounded, sutures deep. Defined sculpture absent, but irregular growth lines present, more prominent on the base. Aperture round, oblique to the axis of the shell, outer margin round, inner margin straightened, strongly reflected, and in older specimens thickened, overhanging and partially obscuring the umbilicus, which is round, narrow and deep. Peristome complete, the aperture quite separate from the body whorl. Maximum diameter 1.3 mm., minimum diameter 1 mm.

Locality: 40-50 fathoms, off Twofold Bay.

Remarks: This is very close to and almost indistinguishable from *C. reflecta*, and it was only after repeated examination that it was concluded that they were distinct. *C. perplexa* is the larger of the two, and the aperture is not so oblique, but the vital character is the presence of a shelf in the umbilicus of *C. reflecta* that is absent in *C. perplexa*.

This possibly also is the species included in the New South Wales list as *Lissotesta micra* Ten. Woods, and it agrees fairly well with May's figure of that species. But from the meagre information provided by the original author it agrees also with *Cirsonella weldii* Ten. Woods. Whether this and some other species by the same author should be rejected altogether as indecipherable is perhaps a matter of opinion, but at the risk of synonymy it has been thought better to give a new name to a well-defined species from the New South Wales coast. If further evidence indeed decides that this is the species *micra*, I have no doubt that it is congeneric with *Cirsonella australis*, and then as *micra* is the genotype of *Lissotesta* my interpretation of that genus is wrong, and *Lissotesta* disappears as a synonym of *Cirsonella*..

Genus LISSOTESTA Iredale.

Trans. New Zealand Inst., xlvii, 1914 (1915), p. 442.
Genotype *Cyclostrema micra* Ten. Woods.

It is unfortunate that Iredale chose this species as his genotype, as, like most of Tenison Woods' species, it was unfigured and inadequately described, and its exact identification has always been in doubt. As Iredale also gives no generic description, it is necessary to deduce generic characters from the meagre characters known of the genotype and from the general interpretation by authors in the New Zealand, Tasmanian and New South Wales check lists.

In this paper *Lissotesta* is used to designate minute shells, turbinate or broadly conical in shape, of few whorls, thin and transparent, devoid of sculpture, narrowly umbilicate, the peristomes either complete or joined over a brief gap anteriorly by a layer of *callus* on the body whorl, the apertures rounded without a varix and more or less oblique. Operculum unknown. It is possible that a knowledge of the animal will show a considerable diversity between the various species and necessitate a further revision of classification.

Lissotesta arenosa, sp. nov. Figs. 22, 22a.

Shell minute, globosely turbinate, thin, colourless and transparent. Protoconch minute, apparently naticoid. Mature whorls three, rounded, the body whorl large and inflated, sutures deep. Sculpture none, the surface smooth and shining. Aperture simple, rounded (oblique to the axis of the shell), margins thin, the peristome incomplete, a narrow band of callus across the body whorl. Umbilicus narrow, round and deep. Maximum diameter .9 mm., minimum diameter .7 mm.

Localities: Dredged in shallow water, North Harbour, Port Jackson (type); also abundant dredged in shallow water, Port Hacking.

Remarks: This is another of the species which will fit the meagre description provided of *Cyclostrema micra* Ten. Woods. In form it resembles the shell here described as *Cirsonella reflecta*, but of course the incomplete peristome and other aperture characters are quite different. In spite of its minute size its shining vitreous shell makes it easily picked out and recognised.

Lissotesta inscripta Tate. Figs. 36, 36a (after Hedley).

Hedley 453.

This species was recorded by Hedley from 40 to 60 fathoms on the continental shelf, but Hedley was not positive in his identification, pointing out that the measurements did not coincide. The diameters of the specimen he figured are 1.9 mm. maximum and 1.5 mm. minimum, and it is probable that the New South Wales species is different from the type and needs a new name. As no material is available for description, however, *L. inscripta* may provisionally be retained as a member of the New South Wales fauna.

Genus CONICELLA gen. nov.

Genotype *Cyclostrema porcellana* Tate & May.

A genus related to *Lissotesta*, but with a conical, elevated spire, and the umbilicus small, round and deep. Shell substance thin and translucent, sculpture confined to faint growth lines, aperture slightly oblique, peristome incomplete, joined by a thin layer of callus on the body whorl, margins of aperture thin and without a varix.

The genotype is included in both the New South Wales and Tasmanian lists as *Lissotesta*, but as there are several species of the same type, that is with elevated and conical spires and narrow umbilici, they may well be separated generically.

Conicella porcellana Tate & May. Fig. 38.

Hedley 455.

This species was recorded by Hedley from the "Thetis" Expedition in 40-50 fathoms, off Cape Three Points. We have a single specimen from 30 to 35 fathoms, off Crookhaven. This agrees very well with the original description, and unless ultimate comparison with the type reveals differences, it may be retained on the New South Wales list. A feature of the shell is the white, porcellanous surface, making it easy of recognition. The specimen figured is 1.7 mm. high.

Conicella lacuna, sp. nov. Figs. 39, 39a.

Shell minute, thin, white, translucent, conical, with elevated spire,. Protoconch small, naticoid. Mature whorls four, the body whorl large, rounded, slightly shouldered at the sutures, which are well impressed. Sculpture none, the surface smooth and vitreous. Aperture ovate, slightly angled posteriorly, slightly produced anteriorly, the outer margin thin, inner margin reflected, the peristome incomulete, but the callus on the body whorl so thickened as to make it appear complete. The umbilicus from in front appears as a narrow slit overhung by the reflection of the inner margin of the aperture; from below it appears as a very narrow but deep, round hole. Height 1.3 mm.

Locality: 6-9 fathoms, Sow and Pigs Reef, Port Jackson.

Remarks: This is very close to *C. porcellana* as collected from the continental shelf, but is smaller, slightly narrower, has a vitreous rather than a porcellanous texture, and differs also slightly in the details of the aperture and umbilicus. A single specimen from the Manly Ocean Beach is similar, but has a perfectly transparent shell; another from the Sow and Pigs is larger and with the inner margin less reflected. It is possible that longer series will show that there are other close but distinct species.

Conicella lata, sp. nov. Figs 37, 37a.

Shell minute, broadly conical, colourless and transparent. Protoconch minute, naticoid. Mature whorls three, expanding rapidly, the body whorl large, rounded, the sutures impressed. Sculpture none, the surface polished and viterous. Aperture ovate, produced anteriorly, outer margin thin and rounded, the inner margin straight and strongly reflected and somewhat thickened, overhanging the umbilical cavity. Peristome incomplete, a thin line of callus on the body whorl. Umbilicus wider than the other species, round and deep. Height 1.6 mm.

Locality: Manly Ocean Beach (collected Mr. Tom Iredale).

Remarks: This is relatively shorter and much broader than the other two species here described, the body whorl is relatively larger, the inner margin is straighter, and the umbilicus is larger. In the figure the upper portion of the body whorl has been accidentally drawn rather flattened, whereas the curvature should continue regularly upwards to the suture.

Genus WANGANELLA, gen. nov.

Genotype *Wanganella fissura* Laseron.

Shell minute, conical, few rounded whorls, shell substance moderately thick, smooth white and translucent, narrowly perforate, aperture slightly oblique, inner margin vertical, peristome incomplete, umbilicus a narrow slit.

This is another of the odd Australian shells which will not fit into known genera. Its exact relationship is uncertain, but it is possibly related to *Cirsonella* and cognate forms, but differs in the elevated spire, the incomplete peristome, the thicker shell substance, the narrow umbilical slit, and the straight and vertical inner margin of the aperture.

Wanganella fissura, sp. nov. Figs. 40, 40a.

Shell minute, conical, shell substance moderately thick, colourless and translucent. Protoconch minute and naticoid. Mature whorls four, increasing regularly, rounded, sutures deep, a narrow opaque band, well defined and slightly indented just below the sutures, body whorl large. Aperture with rounded outer margin, making an angle anteriorly with the straight, almost vertical inner margin which overhangs a very deep, narrow vertical umbilical slit. Height 2 mm. There is no sculpture and the surface is smooth and polished.

Locality: Shell sand, Port Stephens, a number of specimens.

Remarks: In general shape this resembles the South Australian *Lissotesta porcellana* Tate & May, but differs generically as well as specifically in the characters of the aperture and in its thicker shell.

Genus STARKEYNA Iredale.

Stipator Iredale, Proc. Linn. Soc. N.S.W., xlix, 1924, p.233.
Preocc. by Rehn, 1900, in Insecta.

Starkeyna Iredale, Australian Zoologist, 1930, p. 175. Substitute for *Stipator*, preocc.

Genotype: *Teinostoma starkeyae* Hedley.

As Iredale gave no generic description, the following characters may be taken as characteristic: Shell small, depressed turbinate, whorls few, perforate, smooth, thin and translucent, aperture without a varix, oblique, a spur developing from the inner margin and partially filling the umbilicus, which is narrow and deep, a callus on the body whorl.

Though Hedley placed his species in *Teinostoma*, it certainly does not belong there, as Adam's genus is imperforate with a thick callus filling the whole of the umbilical area. Its exact relationship is uncertain, but it may well be related to *Cirsonella*, the species *C. reflecta* forming a connecting link between the two genera.

Starkeyna starkeyae (Hedley). Figs. 35, 35a (after Hedley).

Hedley 448.

So far I have not seen this species, though the type locality is Balmoral, and the shell is by no means minute, being 4 mm. across its maximum diameter. The characters given in the generic description as well as the figure should make its future recognition not difficult.

Genus CHARISMA Hedley.

Proc. Linn. Soc. N.S.W., xxxix, p. 711.
Genotype *Charisma compacta* Hedley.

Hedley's description reads. "A new genus related to *Liotia*, but without a varix to the outer lip, few-whorled, spirally sculptured, umbilicus with an internal funicle

Operculum corneous, concave, multispiral, with a spiral frilled lamella." To this may be added as characters of generic value that the shape is conical, the spire elevated, and the shell is thick and heavy.

Charisma compacta Hedley. Fig. 29.

Hedley 468.

This species in an inhabitant of the continental shelf, the type coming from 100 fathoms, north-east of Port Macquarie. It must have a fair range in depth, as we obtained numerous specimens in 14 fathoms off Long Reef, near Sydney, the specimen figured being 3 mm. in height, larger than the type but otherwise indistinguishable.

A second species of *Charisma* appears on the New South Wales list, *C. latebrosa* Hedley (Check List No. 469). The type locality of this is the Masthead Reef, Northern Queensland, and I am unable to find any reference in literature as to its definite occurrence on the New South Wales coast, and until further evidence is obtained it seems wiser to reject it from the local fauna. Incidentally, *latebrosa* does not appear congeneric with *compacta*, as among other characters it has a different operculum.

Genus CAVOSTELLA, gen. nov.

Genotype *Cavostella radians* Laseron.

A genus probably related to *Liotia*, small, depressed turbinate, with few whorls, fine concentric sculpture, no varix on the outer lip, aperture oblique with complete peristome, the inner margin reflected into a narrow undulating platform, the umbilicus round and deep, indented with radiating furrows on the base.

This is another of the peculiar Australian shells which will not fit into any of the known genera. It belongs to one of a group which formerly would have been included in *Cyclostrema* of Marryatt, a name almost as widely used as *Helix* was used among land shells.

No shell approaching *Cavostella* has been yet recorded from localities south of Sydney, but there are some species as yet undescribed from Queensland which will probably fit here.

Cavostella radians, sp. nov. Figs 30, 30a.

Shell minute, depressed turbinate, moderately thick in substance, white and translucent. Protoconch minute, exact form not determined. Mature whorls three, the body whorl large, rounded, sutures not deep, spire visible when laterally viewed. Sculpture clear and distinct, consisting of fine, very numerous rounded concentric ridges, closely packed, about their own width apart, and perisiting right on to the base to the edge of the umbilicus. Transverse sculpture absent. Aperture round, oblique to the axis of the shell, separate from the body whorl, peristome complete, the inner margin strongly reflected into a narrow undulating platform partially overhanging the umbilicus. Base with a number of radiating furrows indenting the margin of the umbilicus, which is round, fairly broad and deep. Maximum diameter, 1.9 mm., minimum diameter 1.5 mm.

Locality: Shell sand, Port Stephens, a number of specimens; (type) 6-9 fathoms, Sow and Pigs Reef.

Remarks: I know of no described Australian shell with which this can readily be compared, but its characters are so distinct and well defined that there should be no trouble in its future recognition.

Genus CAVOTERA, gen. nov.

Genotype: *Cavotera simplex* Laseron.

A minute genus, similar to *Cavostella*, but without the radiating furrows on the base indenting the umbilicus. Like *Cavostella*, the shape is depressed turbinate, the shell substance is translucent, the peristome is complete, the aperture oblique, the sculpture finely concentric.

Cavotera simplex, sp. nov. Figs. 31, 31a.

Shell minute, depressed turbinate, the spire visible when laterally viewed, fairly solid, white and translucent. Protoconch exceedingly minute, apparently naticoid, placed in a small depression in the summit of the shell. Mature whorls three, rounded, the body whorl large. Sculpture very fine, but well defined, consisting of numerous, closely-packed spiral ridges, persistent on the base to the edge of the umbilicus. On the periphery of the body whorl a few spiral ridges are slightly larger than the others, giving a very slight and irregular angularity. Transverse sculpture none. Aperture round, oblique to the axis of the shell, peristome complete, the inner margin reflected and thickened, partially overhanging the umbilicus. Umbilicus round, narrow and deep. Operculum thick and white, nucleus subcentral. Maximum diameter .9 mm., minimum diameter .7 mm.

Locality: Port Stephens in shell sand (type); alive under stone, Long Reef (T. Iredale).

Remarks: In general form this is similar to *Cavostella radians*, but it is only half the size, differs slightly in contour, the umbilicus is narrower, there are no radiating furrows on the base, and the inner margin of the aperture differs in detail.

Genus CALLOMPHALA Adams & Angas.

P.Z.S. 1864, p. 35.

Genotype: *Neritula (Callomphala) lucida* Adams & Angas.

As applied to Australian shells, this is a well defined genus, and its characters fit with the original description. The main generic characters may be taken as the smooth, polished shell of a depressed turbinate shape, the aperture very oblique and prolonged, the outer lip terminating in a thick varix, the whole of the umbilical region covered with a thick callus, imperforate.

Callomphala lucida Adams & Angas. Figs. 23, 23a.

Hedley 446.

This is a common and well-defined species found on beaches both inside and outside the harbours on the coast. The specimen figured is from Port Jackson, its maximum diameter 5 mm., its minimum diameter 3.8 mm. Its smooth, lustrous, translucent shell, its oblique and extended aperture, terminated with a thick varix, make it very easy of recognition. A feature of the thick callus covering the umbilical region is that it is minutely pitted and thus has a matte surface in contrast to the lustrous surface of the shell proper.

Callomphala alta, sp. nov. Figs. 26, 26a.

Shell small, turbinate, stout, generally white, but the type brownish (? discoloured), sub-translucent. Protoconch minute, naticoid, glassy, slightly tilted, set in a minute depression at the summit of the spire. Mature whorls three with a rather pointed spire, body whorl greatly inflated, rounded, sutures not deep. Sculpture confined to slight growth lines, the surface smooth and lustrous. Aperture laterally extended, very oblique, outer margin rounded and fortified with a thick varix, peristome incomplete, particularly noticeable in immature shells, a thick layer of callus beginning posteriorly on the inner margin and widening anteriorly to spread in a circular disc over the whole of the umbilical region. Height about 2 mm., maximum diameter 3.2 mm., minimum diameter 2.8 mm.

Locality: Dredged Shoal Bay, Port Stephens (type and a number of specimens); dredged North Harbour, Port Jackson.

Remarks: This is quite a distinct species from *C. lucida*, being much smaller, the body whorl more globose and higher, the spire more elevated, and the aperture less prolonged laterally. It approaches nearer in shape to *C. globosa* Hedley from 30 fathoms, Torres Strait, but that species is still more globose and has fine spiral striae.

Genus ROTOSTOMA gen. nov.

Genotype: *Ethalia brazieri Angas*, Proc. Zool. Soc., 1877, p. 39, pl. 5, f. 17.

Shell small, depressed turbinate, few whorls, solid, imperforate, aperture oblique, extended laterally, without a varix, a thick layer of callus forming the inner margin and covering the umbilical region. Sculpture confined to the concentric striae adjoining the sutures.

The genotype was originally placed in *Ethalia*, but Pilsbury as long ago as 1889 (Man. Conch., xi, p. 462) suggested it should be transferred to *Teinostoma*. In his Check List Hedley included it as a *Callomphala*, but this cannot be sustained, as it entirely lacks the varix of that genus. Neither will it fit with *Teinostoma* H. & A. Adams. It is doubtful if *Teinostoma* proper occurs at all in southern Australian waters. Its genotype, *T. politum* Adams, is a larger, heavier shell, quite smooth, the aperture is angulated, and the umbilical callus is greatly developed, much more than in *Rotostoma*. Hedley has used *Teinostoma* for various Australian shells, but I think his interpretation is incorrect, as it is applied to perforate shells with an open umbilicus.

Rotostoma brazieri (Angas). Figs. 24, 24a.

Hedley 447 *(Callomphala).*

The type locality is Sow and Pigs Reef, and the specimen figured was dredged nearby in North Harbour, Port Jackson, its maximum diameter 3.7 mm., its minimum diameter 2.9 mm. It is not uncommon, in appearance not unlike *Callomphala lucida*, but of course without the thick varix of that species. There is no other southern Australian shell with which it can be confused, and a further good recognition point is the faint concentric sculpture confined to a narrow area adjoining the sutures. The remainder of the shell is smooth and polished.

Genus CALLODIX, gen. nov.

Genotype: *Callodix solida* Laseron.

A genus probably related to *Teinostoma*, small and with a depressed spire, solid, few-whorled, the sculpture fine concentric ridges, the aperture extended and very oblique, without a varix, the callosity on the base striated and greatly developed, forming not only the inner margin and covering the whole of the umbilical area, but extending above the aperture on to the body whorl, where it partially obscures the suture.

Callodix solida, sp. nov. Figs. 25, 25a, 25b.

Shell small, solid, depressed, almost oval when viewed laterally, white. Protoconch exceedingly minute, details unobservable, but in a small depression and tilted. Mature whorls two, the body whorl forming most of the shell and overlapping the earlier whorl on top, rounded, suture slight. Sculpture consisting of fine spiral edges, closely packed, and covering the whole of the base as well as the upper portion of the whorl. Transverse sculpture none. Aperture greatly extended laterally, very oblique, the outer margin rounded and without a varix, the inner margin composed of a thick callus which extends well into the aperture, covers the whole of the umbilical region, and extends posteriorly on to the summit of the body whorl. The umbilical callus is ridged transversely in relation to the aperture. Maximum diameter 2.6 mm., minimum diameter 1.9 mm., height about 1 mm.

Locality: 14 fathoms off Long Reef, near Sydney, three specimens.

Remarks: This unique little shell is so different from any other on the coast that there should be no difficulty in its future recognition. I know of no species with which it can readily be compared.

Genus HELISALIA, gen. nov.

Genotype: *Helisalia liliputia* Laseron.

A genus of minute brown shells, thin and in appearance not unlike some land shells, discoidal, coiled in practically the same plane and partially involute with incomplete peristomes. Widely umbilicate, the aperture rounded and thin, sculpture confined to faint growth lines.

In one species, not the genotype, the operculum is white and thick, but details could not be observed, though it recalls the operculum of some of the Liotidae, with which family it may possibly be related. The exact systematic position must, however, be left for the present in abeyance. The usual habitat is on various algae in rock pools and below low tide and were it not that they were taken alive, specimens might well be taken for minute land shells washed down from the shore.

Helisalia liliputia, sp. nov. Figs. 45, 45a.

Shell minute, among the smallest if not the actual smallest shell in existence, red brown, discoidal, the spire impressed below the body whorl, shell substance thin, horny and translucent. Details of protoconch indeterminable, apparently infolded. Mature whorls three, rounded and partially involute, coiled in nearly the same plane, the summit of the shell only slightly flatter than the lower surface, which is broadly umbilicate. Sutures well impressed. Sculpture confined to fine growth lines. Aperture large and rounded, not oblique, thin, with no varix, the peristome incomplete. Dimensions not exactly measured, but the largest mature specimen has a maximum diameter of not more than .5 mm.

Habitat: Abundant in various locations in rock pools and in shallow water, mainly living on algae. The type was abundant on the green weed, Ulva, at Castle Rock, Middle Harbour, Port Jackson; we also have it from Long Reef, both on seaweed and beneath stones, also on the surface of a sponge from 10 feet, North Harbour, and in mussel beds within the harbour, and from Port Stephens in the north to Crookhaven Heads in the south.

Remarks: Of the three species described in this paper this is the smallest and the deepest in colour, and where they occur together it can readily be separated beneath the microscope by these means. Close examination will reveal other differences as shown in the figures.

Helisalia pallida, sp. nov. Figs. 46, 46a.

Shell minute, but the largest of those here described, nearly white, thin and translucent, discoidal and partially involute, coiled not quite in one plane, so that the spire is about level with the body whorl and less concave than the base. Protoconch partially infolded and details unobservable. Mature whorls three, rounded, sutures impressed. Sculpture confined to faint growth lines. Aperture large and rounded, the inner margin flattened, peristome incomplete. Umbilicus narrower and deeper than in *H. liliputia*. Maximum diameter .9 mm., minimum diameter about .75 mm.

Habitat: Abundant living on algae in rock pools and below low tide, both within the harbours and on the outside reefs. The type is from seaweed at Long Reef, but we also have it from numerous other localities.

Remarks: The larger size, the pale colour, and the different contour easily separate this from the other species described. It is from this species that a partially observed operculum appears to be white and thick, but full details could not be ascertained.

Helisalia sucina sp. nov. Figs. 47, 47a.

Shell minute, amber coloured, disc-shaped, very flat, the spire depressed below the body whorl, partially involute, coiled almost in the same plane, so that there is very little difference in appearance between the top and the base of the shell, shell thin and translucent. Protoconch partially infolded and the details unobservable. Mature whorls four, rounded, sutures impressed. Sculpture confined to faint growth lines. Base shallowly concave, the concavity so wide as to hardly constitute an umbilicus, the early whorls all visible from beneath. Aperture round, margins thin, peristome incomplete. Maximum diameter .7 mm., minimum diameter about .6 mm.

Habitat: Living on algae in rock pools, North Harbour.

Remarks: Compared with the other two species here described this is intermediate in size and colour, by which characters it can easily be separated under the microscope. It is also much flatter.

Genus MICROCARINA, gen. nov.

Genotype: *Microcarina surgerea* Laseron.

A minute genus of shells living on algae in shallow water, disc-shaped, flat above and widely umbilicate below, a sharp keel at the summit of the whorl and another at the periphery, no transverse sculpture, the peristome complete, the aperture very slightly oblique, the aperture polygonal, becoming rounded in fully mature specimens, thickened slightly, but without a varix. Shell substance thin, translucent.

The relationship is uncertain, the minute disc-like shell suggesting affinities with *Orbitestella*, generally included in a family of its own, Orbitestellidae, but the complete peristome suggesting the Liotiidae.

Microcarina surgerea, sp. nov. Figs. 42, 42a, 42b.

Shell minute, colourless and translucent, flat and disc-like, flattened above, the spire just visible when laterally viewed, the top of the aperture just below the body whorl. Protoconch naticoid, slightly tilted and partially submerged. Mature whorls three, rounded above with impressed sutures, a sharp keel on the summit, and another extending beyond this on the periphery, the space between slightly concave, smooth except for very faint growth lines. A third keel surrounds the umbilical region, and this again is separated from the peripheral keel by a slightly concave area.

Aperture large, polygonal in immature specimens, but becoming rounded with maturity, the peristome complete, and separate from the body whorl, umbilicus wide and deep. Maximum diameter 1 mm., minimum diameter slightly less.

Habitat: The type was alive on algae in rock pools in North Harbour. It is quite common, and we have it from similar locations both inside the harbour and on the outside reefs; also beneath stones and in beds of the common mussel, and from shell sand on Manly Beach and in Pittwater.

Remarks: There is no other species on the coast with which this can readily be compared, and its distinctive characters should make it easy of recognition. One character of distinct use when drawing is that it stands readily on its edge on a smooth surface when manipulated with a needle beneath the microscope.

Genus ORBITESTELLA Iredale.

Proc. Malacological Soc., xii, 1917, p. 327.

Genotype: *Cyclostrema bastowi* Gatliff.

In addition to proposing a new generic name, Iredale proposed a new family Orbitestellidae for this shell. His generic description reads: "Shell thin, pellucid, discoidal, dextral, of few whorls and of peculiar sculpture, widely umbilicate, columella vertical, aperture never variced, irregular in shape, edges thin."[1] Augmenting this from the figure of the genotype, the peristome is incomplete, and the sculpture consists of a double keel, with transverse ribs radiating both on the summit and base of the shell, and the shell is minute.

The genotype is a Victorian shell, and though it is listed as from New South Wales I can find no record of its actual occurrence on this coast. Its record, therefore, should not be confirmed unless further evidence is brought to light. There are two undescribed species from the neighbourhood of Sydney which approximate to the generic characters of *Orbitestella*, and for the time being at least they may be left under that generic name.

Orbitestella decorata, sp. nov. Figs. 43, 43a, 43b.

Shell minute, white, translucent, discoidal, the summit flat, spire depressed below the body whorl. Details of protoconch unobservable. Mature whorls three, a prominent rounded keel on the periphery, indented by irregular tubercles, above this a flat step, and above this again the surface rounded to a deep suture, this portion showing from above strong transverse costae, radiating from the suture. A second keel is at the base of the body whorl, separated from the stronger peripheral keel by a slightly concave area, the base itself with transverse costae radiating from the umbilicus. Umbilicus wide, showing the earlier whorls. Aperture with incomplete peristome, polygonal, its posterior margin just below the level of the body whorl, without a varix. Maximum diameter .7 mm., minimum diameter about .6 mm.

Habitat: Living on algae, rock pools, North Harbour, not common (type); also under stones from the same locality.

Remarks: This among local species is nearest to the genotype, *C. bastowi*, and it is possibly the one that has appeared on the New South Wales list as that species. It differs, however, by the shape of the aperture, in the disposition of the keels, and in detail of the sculpture. It is a beautiful and distinctive little shell, whose further recognition should present little difficulty.

Orbitestella aura, sp. nov. Figs. 44, 44a, 44b.

Shell minute, bright golden in colour, discoidal and very flat, involute, coiled practically in one plane, in appearance very little different when viewed from above or below. Protoconch naticoid, slightly tilted and partially immersed, smooth. Mature whorls three, flattened and smooth at the periphery, sharp narrow keels above and below, beyond which are distinct narrow grooves. Upper portion of body whorl slightly rounded to rather shallow sutures, and bearing irregular transverse costae, which radiate from the suture. Sculpture on the base similar, the umbilicus so wide as to be only slightly more concave than the summit of the shell. Aperture produced, almost symmetrical with the body whorl, polygonal, but becoming rounded in fully mature specimens, the peristome incomplete. Maximum diameter .9 mm., minimum diameter about .75 mm.

Localities: Manly Ocean Beach (type); collected by Mr. T. Iredale; also alive under stones in rock pool, Long Reef.

Remarks: This very distinctive little shell is doubtfully referred to as *Orbitestella*, as the ammonite-like coiling gives it a distinct facies, yet its characters as defined fit sufficiently to justify its inclusion. Except for the incomplete peristome it is almost identical with a small New Zealand shell, *Zerotula ammonitoides* Powell, which the author places among the Architectonidae. The protoconch of *C. aura*, though tilted and partially immersed, does not appear sinistral, as in *Heliacus* and others in the family.

Genus PARISANDA, gen. nov.

Genotype *Parisanda iredalei* Laseron.

A small genus of uncertain relationship, with a depressed turbinate shell, solid, porcellanous in texture, surface polished with variegated colouring, base with fine radiating plications which do not reach the narrow umbilicus, aperture oblique, peristome complete.

This is another peculiar little New South Wales shell whose characters will not fit any known genus. The general form and texture fit the small Queensland shell *Isanda coronata* A. Adams, which has the same radiating plications on the base even more strongly marked, but *Isanda* has an incomplete peristome. The form is again almost identical with *Cirsonella australis* Brazier, which lacks the basal plications, and again has a thin, glassy and not porcellanous shell. The texture and colouring are very like the smaller species of *Phasianella*, which, however, are not umbilicate, and have incomplete peristomes. Some features again recall the Trochidae. The operculum when found may give some clue to relationship, but for the present its systematic position must be left in abeyance.

Parisanda iredalei, sp. nov. Figs. 49, 49a.

Shell small, solid, turbinate, texture porcellanous and polished, apical whorls and area surrounding the umbilicus white, body whorl pale brown with transverse streaks of deep red brown. Protoconch naticoid. Mature whorls three, rounded, sutures deep. Aperture rounded, but slightly angled posteriorly, oblique, the peristome complete and removed from the body whorl by a channel. The base of the body whorl is finely plicate, the plications surrounding but not reaching the umbilicus, and fading towards the periphery. Umbilicus narrow, round and deep. Diameter of base 1.7 mm., height about 1.5 mm.

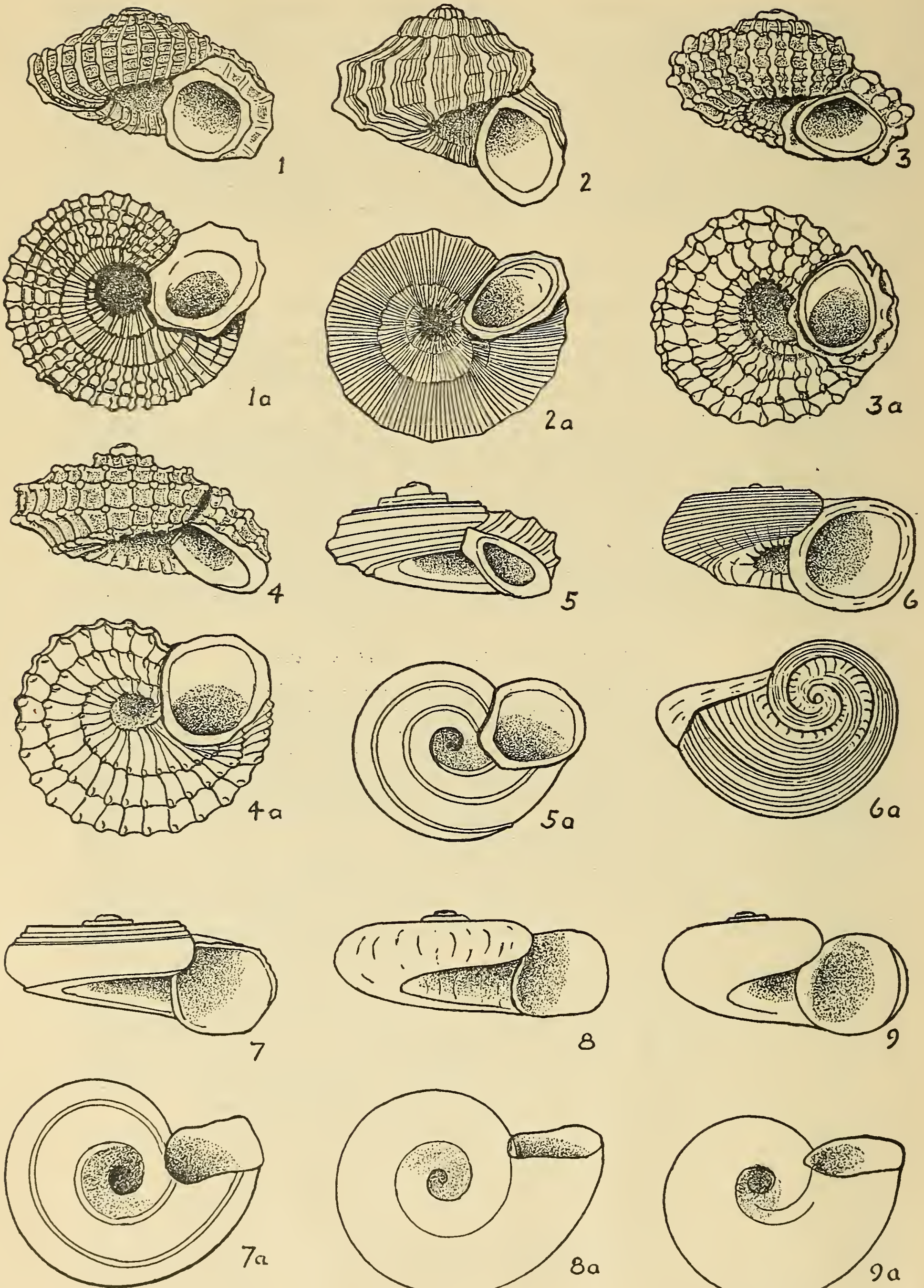
Locality: Manly Ocean Beach; collected by Mr. Tom Iredale.

Remarks: For this striking little novelty I am indebted by Mr. Tom Iredale, who generously handed it to me for description. There is no other local species with which it can be compared, and its possible generic relationships have already been discussed.

"*Liotia alazon* Hedley," Rec. Austr. Mus. vi, 1905, p. 49, fig. 14.

This is a minute shell from deep water, 111 fathoms, at 12½ miles east of Cape Byron, and is doubtfully related to the Liotiidae at all.

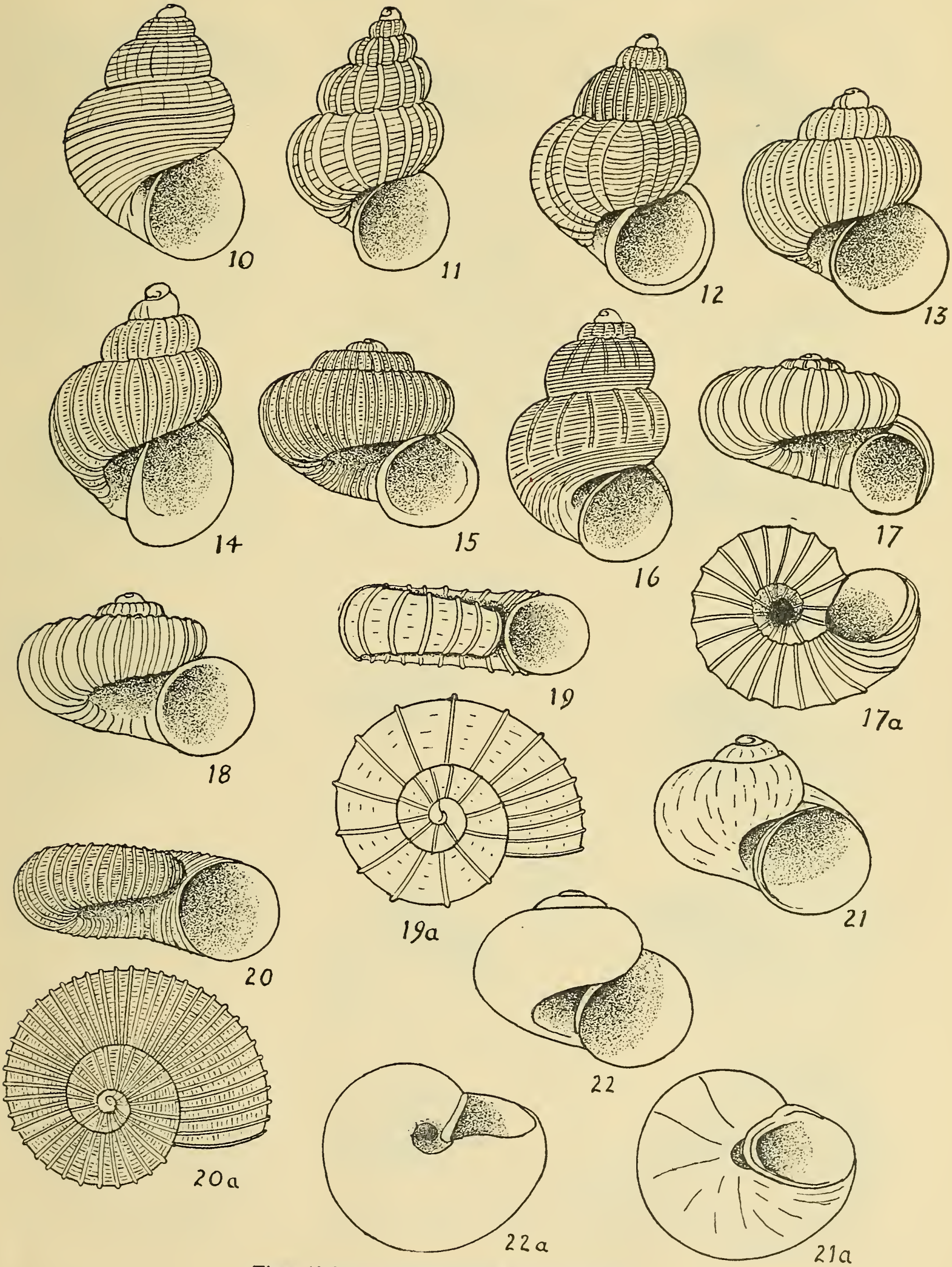
New generic names proposed above—*Callodix*, *Cavostella*, *Cavotera*, *Conicella*, *Helisalia*, *Liocarinia*, *Microcarina*, *Parisanda*, *Rotostoma*, and *Wanganella*.



Figs. 1-9: Liotiidae of New South Wales.

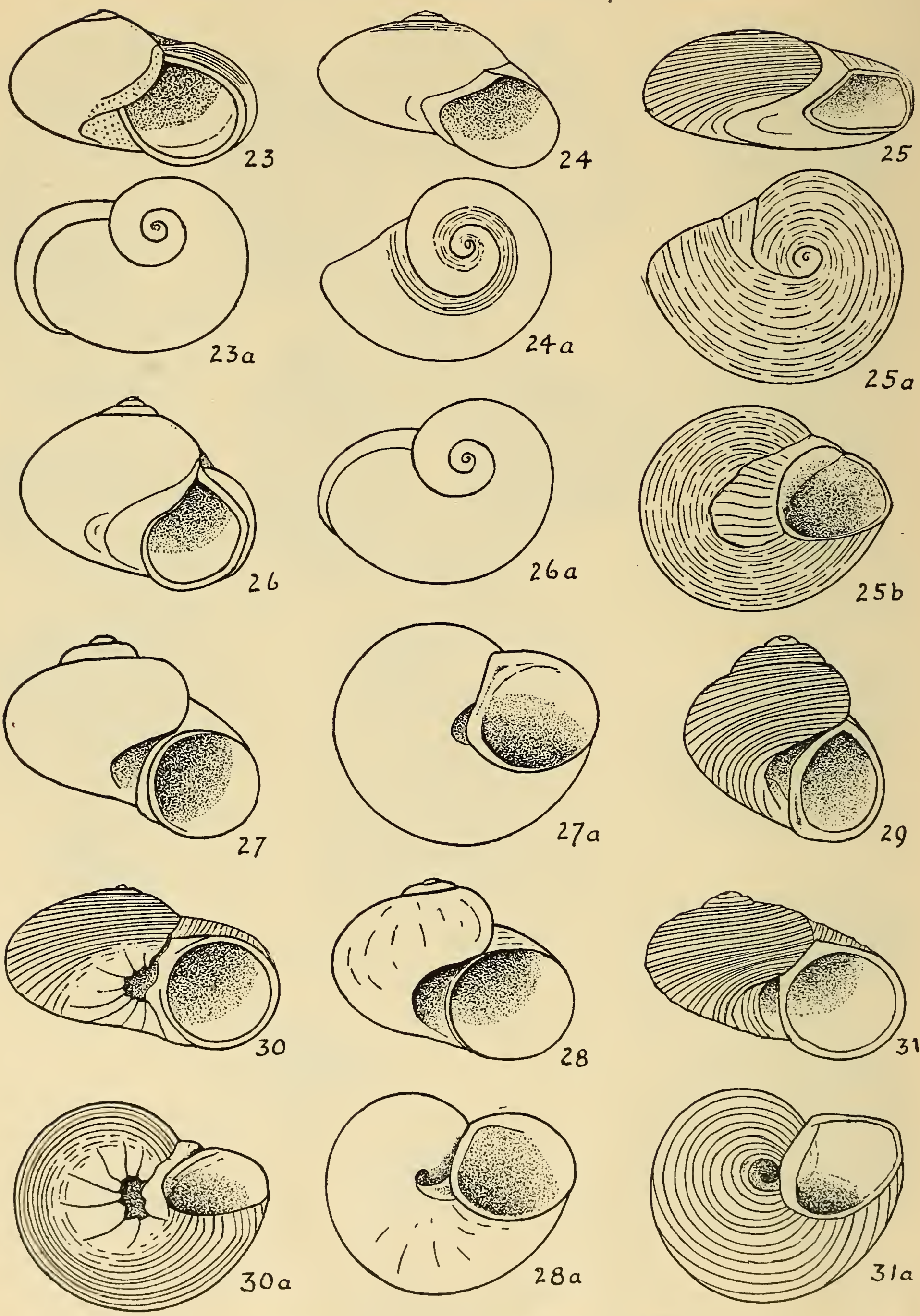
(For explanation of figures see page 25)

C. F. Laseron del.



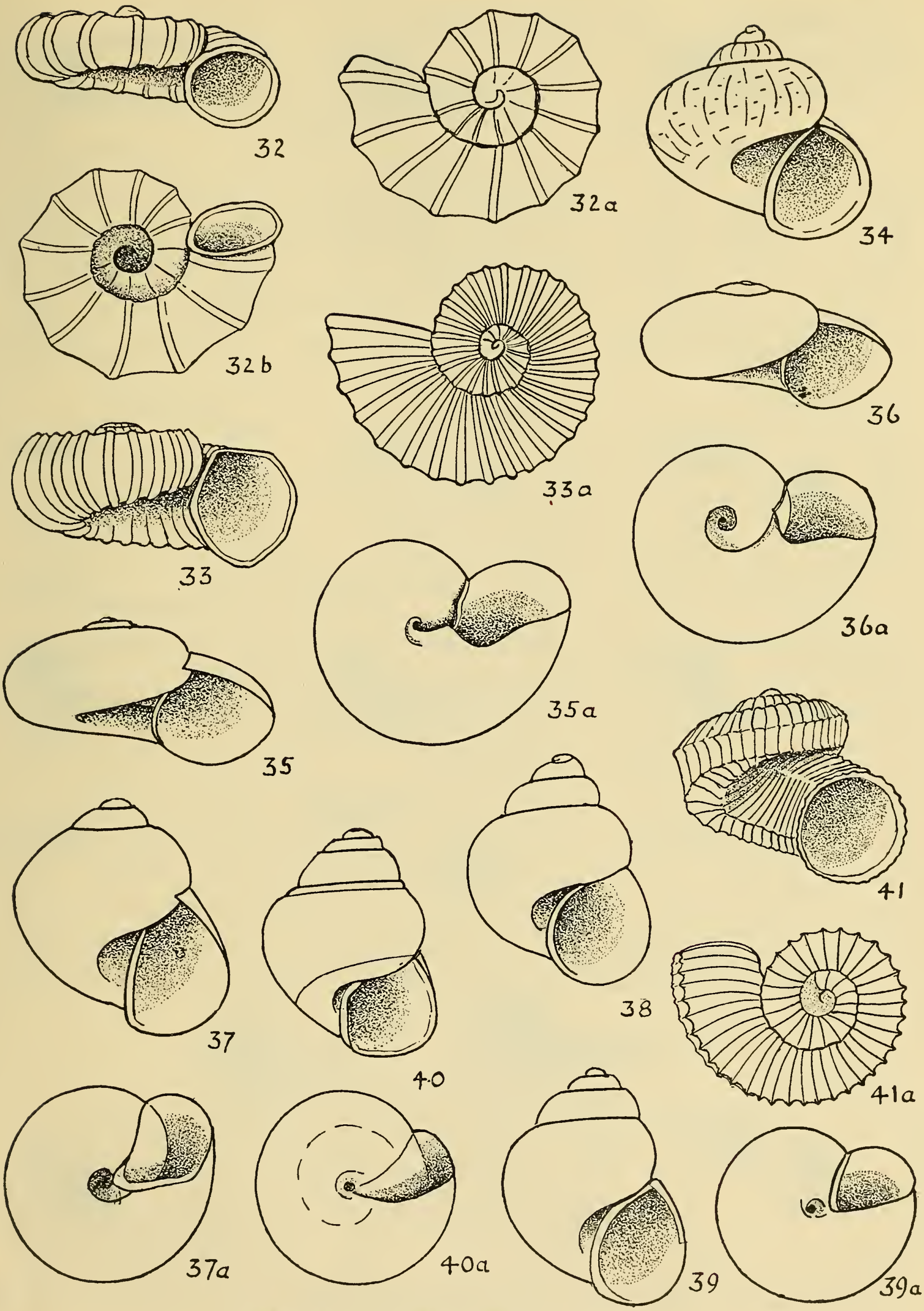
Figs. 10-22: Liotiidae of New South Wales.

C. F. Laseron del.



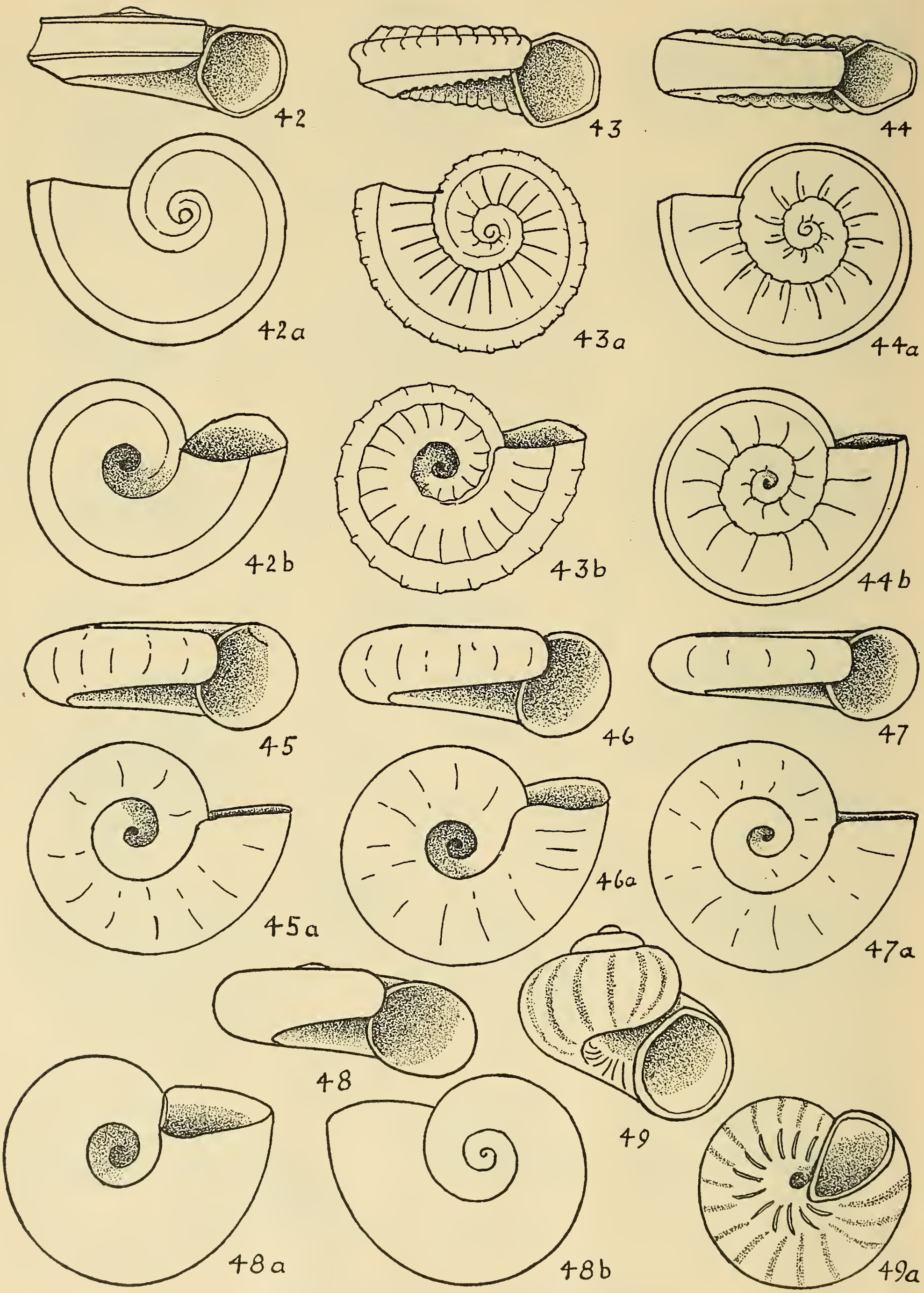
Figs. 23-31: Liotiidae of New South Wales.

C. F. Laseron del.



Figs. 32-41: Liotiidae of New South Wales.

C. F. Laseron del.



Figs. 42-49: Liotiidae of New South Wales.

C. F. Laseron del.

EXPLANATION OF FIGURES.

Figs.

1, 1a.—*Liotina botanica* Hedley.
2, 2a.— *saxa* Laseron.
3, 3a.—*Pseudoliotia micans* Adams.
4, 4a.— *speciosa* Angas.
5, 5a.—*Lodderia lodderae* Petterd.
6, 6a.—*Lodderena minima* Ten. Woods.
7, 7a.—*Partubiola blancha* Iredale.
8, 8a.—*Microdiscula vitrea* Laseron.
9, 9a.— *pellucida* Laseron.
10.—*Brookula obscura* Laseron.
11.— *jacksonensis* Laseron.
12.— *augeria* Laseron.
13.— *turbinata* Laseron.
14.— *orospatia* Laseron.
15.— *finesia* Laseron.
16.— *tumida* Laseron.
17, 17a.—*Liotella princeps* Laseron.
18.— *littoralis* Laseron.
19, 19a.— *parvirota* Laseron.
20, 20a.— *pulcherrima* Brazier.
21, 21a.—*Cirsonella perplexa* Laseron.
22, 22a.—*Lissotesta arenosa* Laseron.
23, 23a.—*Callomphala lucida* Adams & Angas.
24, 24a.—*Rotostoma brazieri* Angas.
25, 25a, 25b.—*Callodix solida* Laseron.
26, 26a.—*Callomphala alta* Laseron.
27, 27a.—*Cirsonella australis* Angas.
28, 28a.— *reflecta* Laseron.
29. —*Charisma compacta* Hedley.
30, 30a.—*Cavostella radians* Laseron.
31, 31a.—*Cavotera simplex* Laseron.
32, 32a, 32b.—*Liotella patonga* Laseron.
33, 33a.— *gravicosta* Laseron.
34.— *Brookula* sp.
35, 35a.— *Starkeyna starkeyae* Hedley (after Hedley).
36, 36a.— *Lissotesta inscripta* Tate (after Hedley).
37, 37a.— *Conicella lata* Laseron.
38.— *porcellana* Tate & May.
39, 39a.— *lacuna* Laseron.
40, 40a.— *Wanganella fissura* Laseron.
41, 41a.— *Liocarinia disjuncta* Hedley (after Hedley).
42, 42a, 42b.—*Microcarina surgerea* Laseron.
43, 43a, 43b.—*Orbitestella decorata* Laseron.
44, 44a, 44b.— *aura* Laseron.
45, 45a.— *Helisalia liliputia* Laseron.
46, 46a.— *pallida* Laseron.
47, 47a.— *sucina* Laseron.
48, 48a, 48b.—*Microdiscula fragilis* Laseron.
49, 49a.— *Parisanda iredalei* Laseron.

(Unfigured: *Liotina scalaris* Hedley, *Liotella capitata* Hedley.)

INCIDENCE OF ACARID MITES ON THE BIOLOGY OF BEES.

By TARLTON RAYMENT, F.R.Z.S., Honorary Associate in Entomology,

National Museum, Melbourne.

(Plate 1, text figure 1.)

Mites are small animals, generally white or amber-coloured, or even pinkish, with a more or less oval body comprised of two parts, the conjoined head and thorax, propodosoma, the abdominal segment, hysterosoma, and in certain species a gnathosoma, carrying the mandibulae and eyes; they have four pairs of legs, sometimes with spines, and often with long setae.

Mites are ubiquitous, being distributed throughout the world, and associated with all classes of animals, including man himself. Their general aspect under magnification is rather repellent, especially those species armed with powerful claws. If the acarids grew to even one foot in diameter they would indeed be formidable enemies. Fortunately they are all minute in size, but nevertheless capable of laying eggs, producing a tormenting irritation, and even poisoning of the host. There is, of course, no larval stage, and the young ones more or less resemble the adults.

Taxonomically, they are included in the Phylum ARTHROPODA, or jointed leg animals, arthron—a joint, and podos—foot, and belong to the Sub-class ARACHNIDA, Gr. akares—too small to cut, tiny things. The spiders are included here. The Family is ACARIDIDAE, and there are numerous genera.

Though small, the mites are nevertheless important, not only because of their ubiquity, but also for their acute incidence on so many of man's activities. They attack his crops, farinaceous meals and flours; domestic pets; find a way into the quills of caged birds; pester man, and even burrow into his own skin. None escapes the attentions of the mites, not even the bees, and solitary and social species are infested with equal favour.

The microscopic size of many species is a protection in itself, for they are too small to be seen by the unaided eye; they are bothersome to mount and study, and several are difficult to remove from the host.

The late Edwin Step suggested that the male bee, having no work to do, did not accumulate on its body any of the debris that afford sustenance to the mites, therefore the male did not suffer any infestation. That is mere specious speculation, for critical examination of a series of wild-bees will soon demonstrate that males are quite often as heavily infested as the females. Step may have postulated that as many species of mites are found on meals and flours, the male bees escaped because they did not carry on their bodies any of the nitrogenous pollen-grains enmeshed in the fleece of the female bee. He failed to appreciate the fact that the males of all wild-bees normally visit flowers for a sip of nectar, and cannot escape being dusted with pollen.

Microscopic study of live mites on a wild-bee that had large areas of its body growing a mould producing a purplish-black sporangium, showed that many of the acarids had ingested a few of the sporangia. The author is unable to determine whether or not spores form portion of the normal diet of mites, but he is certain that moulds and yeasts are entirely absent in bees' cells frequented by the acarids, but such microscopic growths are inevitable in cells studied in the artificial conditions of the laboratory. If the association of bees and mites be thus mutually beneficial, then the tiny animals are undoubtedly symbiotes and not parasites.

After a study of the mite *Parasitus bomborum* in the "nests" of the European bumble bees *Bombus (Bremus)*, Plath (1934) concluded that the association of mite and bee was mutually beneficial. The absence of mites in cells and shafts may be the determining factor in the many failures in laboratory experiments to rear fossorial bees to maturity.

However, the author has observed acarine mites piercing the delicate pellicle of bees which had died during the fourth ecdysis, but whether or not the entrance had been effected by biting or dissolving the membrane could not be determined. He has seen a mite enter a bee's cell, exude a droplet of clear liquid on the colloidal lining, and then ingest it again. The liquid may have dissolved some of the biological substance.

Recently, Armour and Campbell (1948) have found in parrots (budgerigars) suffering from "French Moult" that certain tyroglyphid mites were present in the base of the quills, causing a black substance to accumulate in the shaft. This is, of course, analogous to the mites' penetration of the tracheal tubes of the honey-bee.

The late Professor T. D. A. Cockerell concluded that since the Australian carpenter bee had no cavity in the base of the abdomen, it did not harbour a mite like the *Paragreenia* of the Indian *Koptorthosoma.* An extended study by the author of the carpenter bee *Xylocopa* demonstrated that the Australian species certainly has numbers of other mites on its body. My mentor always regretted that he had not been able to study the bees on their native heath.

The short list of bees and mites included in this paper may serve to dispel certain popular misconceptions. It will be observed that many diverse genera are recorded, so that it is probable that all bees are infested at one time or another. Rennie and his assistants postulated that normally the mites lived on the exterior of the wild-bee, but discovered by some chance that they would enter the spiracles of the honey-bee and breed there.

I am indebted to the courtesy of Mr. W. Womersley, Adelaide Museum, South Australia, for the generic names of the mites. Several of the specimens were new to science, and the generic and specific affinities of these are being worked out by Mr. Womersley for publication.

The author's researches in the Hymenoptera are assisted with a grant from the Trustees of the Science and Industry Endowment Fund.

Family: COLLETIDAE.

HOST: *Heterocolletes capillatus* Rayment.

Medium-sized black shining bees with much dull white hair. The compound eyes have numerous long hairs issuing from between the facets.

Biology: Similar to that of *Paracolletes.* (See "A Cluster of Bees," 1935.)

Symbiote: The specimens were too fragmentary for determination.

Comment: Two amber-coloured mites were taken from the axillae of the wings.

Locality: Emerald, Dandenong Ranges, Victoria.

Collector: T. Rayment.

HOST: *Euryglossimorpha nigra* Sm.

Shining black bees of medium size, often coarsely punctured, with scattered hair.

Biology: A fossorial species, digging a shallow shaft with an elbow turn. The oval skin cells hold a batter pudding of honey and pollen. (See author's account, "Australian Zoologist," xi, 3, 1948, p. 243.)

Symbiote: Adults of Tyroglyphid mites.

Comment: These bees often carry a number of mites distributed over the body. A large percentage of the bees harboured a parasitic Stylops.

Locality: Mount Canoblas, Orange, N.S.W. (Alt. 4,600 ft.)

Collector: P. Whiteley

HOST: *Paracolletes advena phillipensis* Raym.

Black bees of medium size, with four narrow bands of white hair across the abdomen. *P. euphenax* Ckll. is the male of the species.

Biology: They excavate deep shafts in sandy soil, and construct several cells of impalpable silvery skin, and the "pudding" is a rather thin batter of honey and pollen. There is only one brood for the season, and it emerges in spring.

Symbiote: Probably a new species of *Tyroglyphus.*

Comment: Numbers of minute white mites were present at the hairy junction of the thorax and the abdomen.

Locality: Gorae West, Victoria, 26 Sept., 1952.

Collector: Clifford W. Beauglehole.

HOST: *Neopasiphae insignis* Raym.

A small black bee, with transverse yellow bars on the abdomen. The male has excessively large circular scapes.

Biology: Not known, but the morphology would indicate a fossorial habit akin to that of *Paracolletes.*

Symbiote: Apparently a new species of *Histiostoma.*

Comment: This mite was found among the plumose hairs of the body in the vicinity of the metathorax.

Locality: Victoria? (No. of Best's label "570.")

Collector: D. Best.

Family: HYLAEIDAE.

HOST: *Hylaeus anmelanocephalus* Raym.

Small bees with a black head and thorax and a red abdomen.

Biology: (See author's account, "A Cluster of Bees," 1935.)

Symbiote: Hypopus stage of *Anoetus* sp.

Comment: A dozen or more mites were taken from the basal abdominal terga, where they were in a compact mass.

Locality: Lane Cove, Sydney, N.S.W.

Collector: Norman W. Rodd.

HOST: *Hylaeus anmelanocephalus* Raym.

Biology: Cells of thin skin are built in galleries in wood.

Symbiote: *Anoetus* sp.

Comment: One mite was on the metathorax.

Locality: Cheltenham, New South Wales,

Collector: Norman W, Rodd,

HOST: *Hylaeus cliffordiellus* Raym,

Small jet-black shining bees with yellow markings.

Biology: They build a series of skin cells in cavities in wood-stems and other suitable places. (See notes on biology in "Bees of the Portland District.")

Symbiote: *Calvolia* sp.

Comment: About 25 very small mites were removed from the ventral surface of the male's abdomen.

Locality: Gorae West, Victoria, Jan., 1952.

Collector: Clifford W. Beauglehole.

HOST: *Hylaeus elongatus* Sm.

A small blackish bee, with yellow face-markings, and little or no hair.

Biology: Although the author has not studied the life-history of this particular species, there is little doubt that it follows the typical pattern—colloidal skin cells in any suitable cavity. (See *Euryglossina.*)

Symbiote: *Calvolia* sp.

Comment: The mites, about ten in number, were clustered together in the polished basal abdominal sternum. The bees could easily have reached them with their legs.

Locality: Swan River, Western Australia.

Collector: L. J. Newman.

HOST: *Hylaeus honestus subhonestus* Ckll.

Black shining bees with little if any hair, and a few yellow markings.

Biology: Not known, but other species of *Hylaeus* construct cells of thin skin.

Symbiote: Not determined.

Comment: Twenty-five mites were taken from the mesothorax.

Locality: Gorae West, Victoria, 10th Dec., 1951.

Collector: Clifford W. Beauglehole.

HOST: *Hylaeus maiellus* Raym.

Small, roughly sculptured black bees with a ferruginous abdomen.

Complete life-history not known, but the colloidal thin skin cells do not differ from the typical pattern of the family. (See *Palaeorhiza.)*

Symbiote: *Tyroglyphus* species, differing from *T. farinae* (Linnaeus) by the striate, not punctured, hysterosoma.

Comment: Eight amber-coloured mites were taken from the sternal surface of the thorax of the males.

Locality: Boorooloola, Northern Australia; Edungalba, Queensland; Gunbower, Victoria.

Collectors: Gerald F. Hill, Ernest E. Adams, Tarlton Rayment.

HOST *Hylaeus nigrojugatus* Raym.

Very small black bees.

Biology: A series of tiny thin skin cells built in beetle-galleries in the pine boards of a door.

Symbiote: Not determined.

Comment: In certain cells about 18 small pear-shaped white egg-like forms were found. These were gradually developing mites that appeared to be approaching *Anoetus* sp.

Locality Clyde, South Gippsland, Victoria.

Collector: O. Dawson.

HOST: *Palaeorhiza alcyonea* (Erich.).

A handsome large bee, with a black head and thorax and a metallic-blue abdomen. The "face" in ornamented with three yellow stripes, and the collar, tubercles, and scutella are butter-yellow. The subsp. *robustus* Ckll. is larger, with two large spines on the third sternum of the male. The bees have been observed on the flowers of *Banksia* sp., *Lambertia* sp., and *Callistemon* sp.

The "nest" is typical of the Family, but as this is the first published record, the description is given in some detail. The cells were built in a twig from a dead *Acacia*—Froggatt, in litt., says *A. longifolia*. The wood is hard, and the entire tube measured 6cm. in length. There were four cells, each measuring 12 mm. in length, with a diameter of 5 mm., and separated from each other by a thin clear colloidal membrane which had been "licked on" by the glossa.

The base was filled with a mass of loose wood-parings, and covering that was a stouter plug, possibly containing some resinous material. The pudding was placed on this solid base, and the egg was attached to the pudding. The wood had been scooped out roughly, but the wall was heavily draped. The pudding was of a dry mealy consistency, and the pollen-grains resembled miniature golden rice.

Symbiote: *Tyroglyphus* sp.

Comment: A number of mites were on the bee, but 90 parasitic small chalcid wasps emerged from one larva.

Locality: Cheltenham, N.S.W., 19th November, 1950.

Collector: Norman W. Rodd.

This bee is widely spread, for the author has received it from Tasmania, New South Wales, Western Australia, South Australia, and Victoria

HOST: *Euryglossina hypochroma* Ckll.

A minute black bee, with yellow markings; abdominal sterna yellow.

Biology: The small bees occupy galleries bored by the pin-hole and other beetles in wood. They construct a series of colloidal skin cells. (See author's account in the magazine "Walkabout.")

Symbiote: A male mite *Tyroglyphus farinae.*

Comment: Very rarely are mites found on these bees; only an odd one is present on the base of the abdomen.

Locality Sandringham, Toorak, Tooradin, Victoria.

Collectors: Owen Dawson and Tarlton Rayment.

HOST: *Meroglossa basilauta* Raym.

Large black shining bees, with very little hair, and primrose markings on face and thorax. Glossa short and emarginate in female, acute in male.

Biology: The bees bore clean-cut galleries in sound, hard wood, and fill their oval cells of colloidal membrane with a soft batter of honey and pollen.

Symbiote: Hypopus stage of *Anoetus* sp.

Comment: About five large amber-coloured mites were present on each side in the cavity on the scutellum at the base of the wings.

Locality: Jamberoo (Alt. 2,100 ft.), Illawarra Range, N.S.W.

Collector: Norman W. Rodd.

HOST: *Meroglossa basilauta* Raym.

Four deutonymphs were taken from cavities at the sides of the scutellum of the female.

Locality: Gorae West, Victoria, 23rd Dec., also 16th Jan., 1951.

Collector: Clifford W. Beauglehole.

Family HALICTIDAE.

HOST: *Parasphecodes altichus* Smith.

Bees of medium size with black head and thorax, and only the first and second segments of the abdomen with any reddish colour.

Biology: [See *P. fulviventris* (Fr.) for details of the biology.]

Symbiote: A new genus and species of Laelaptidae (Nymphs).

Comment: Two large amber-coloured mites were attached to the thorax near the axillae of the posterior wings of the male.

Locality: Jamberoo, N.S.W.

Collector: Norman W. Rodd.

HOST: *Parasphecodes fulviventris* (Fr.).

Bees of medium size, with a dull-black head and thorax and red abdomen.

Biology: A fossorial species excavating its chambers and shafts in the earth, and huge colonies are sometimes formed. (The author described the biology in "Australian Zoologist," Vol. xi, Pt. 2, pp. 76-95, 1947.)

Symbiote: *Caloglyphus berlesei* (Michael).

Comment: These mites are the scavengers, keeping shafts and cells free from all biological debris. They seldom if ever attach themselves to the bees.

Locality: Sandringham, Victoria.

Collector: Tarlton Rayment.

HOST: *Parasphecodes sextus* Ckll.

Bees of medium size, with black head and thorax and red abdomen (species in this genus are difficult to determine).

Biology: (See author's account of *P. fulviventris*, "Australian Zoologist," Vol. II, Pt. 2, pp. 76-95, 1947.)

Symbiote: *Caloglyphus berlesii* (Michael).

Comment: These were numerous on larvae of the bee, and measured 75 microns in length.

Locality: Rocklands, Victoria.

Collector: Owen Dawson.

HOST: *Parasphecodes cirriferus* Ckll.

A bee of medium size with black head and thorax and a red abdomen; wings are dusky.

Biology: [Refer to *P. fulviventris* (Fr.), for details.]

Symbiote: (See *P. tilachiformis.)*

Comment. Professor T. D. A. Cockerell (Trans. Amer. Ent. Soc., XXXVI, 1910), describing the above species, made the following note: "Two large rufo-fulvous mites are attached to the metathorax." It is possible that the mites in this case are of the same species as those taken from *P. tilachiformis*. In February, 1951, the author received a series of quite typical females, and males (including the allotype) of *P. cirri*ferus, from Gorae West, Victoria. Two of the females had two large mites adhering to the metathorax, but one female had five clustered closely over the dorsum of the metathorax. Another female had one mite on the dorsum, and another under the axilla of a wing. One male bee had one mite on the dorsum, but the usual number is two to the bee. These very large mites were separated by Womersley as a new genus and species of the Family Laelaptidae, and he proposes to publish the generic diagnosis and specific description.

Locality: Victoria. Gorae West, via Portland, Victoria.

Collectors: Chas. French, Junr.; Cliff. Beauglehole.

HOST: *Parasphecodes fultoni* Ckll.

A wild bee of medium size, with a black head and thorax and a dark-red abdomen.

Biology: These fossorial bees excavate shallow burrows leading to oval cells six or so inches below ground level, (Refer to *P. fulviventris.)*

Symbiote: *Hypoaspis* sp.

Comment: Many mites were present in the earthen cells, and a few, six or so, were taken from each of the several female bees examined by the author. It would appear that in *Parasphecodes*, as in *Halictus*, the earthen nests are maintained in a sanitary condition by the numerous acarid mites which are, therefore, true symbiotes, and not parasites, as in the case of *Tarsonemus woodi* on the honey-bee.

A female *Parasphecodes fultoni* Ckll. was taken on the South Coast, 252 miles west of Dandenong, in a very different environment, and eleven mites were present.

The mites appear to be *Hypoaspis* sp., conspecific with those taken from the nests at Dandenong.

Locality: Gorae West, Victoria, 28th April, 1952.

Collector: Clifford W. Beauglehole.

HOST: *Parasphecodes tilachiformis* Ckll.

A red and black male bee of medium size, closely related to *Halictus*.

Biology: [Refer to *P. fulviventris* (Fr.) for details of the biology.]

Symbiote: A new genus and species of Laelaptidae.

Comment: Two large amber-coloured mites were attached to the sternal plates of the thorax.

Locality: Jamberoo, N.S.W.

Collector: Norman W. Rodd.

HOST: *Halictus darlingensis* Raym.

Biology: Females of a midsummer brood; no males were among them. (See author's large paper on Halictine bees.)

Symbiote: *Histiosoma* sp.

Comment: One mite was taken from the under surface of the wing of an adult female.

Locality: Tilpa, Darling River, N.S.W.

Collector: Courtesy of Dept. Agric., New South Wales.

HOST: *Halictus emeraldensis* Raym.

Small black fossorial bees with abdominal bands of white hair.

Biology: Several hundreds congregate to form a co-operative colony in the earth. There are three discrete generations—a spring brood of virgins, a midsummer bisexual one, and an autumn brood of virgins. (See author's account "Arb phys ange," Ent. Berlin-Dahlem, Band 4, Germany, 1937.)

Symbiote: *Caloglyphus* sp.

Comment: Numerous white mites literally cover the walls of the galleries and cells, and keep them in a sanitary condition. They are not distributed by the bees, but by parasitic mutillid wasps, which visit many galleries. At certain periods there is a remarkable segregation of the sexes; all the mites in one gallery will be males and in another all females. When the mites were removed from contact with the halictine cells they succumbed within twenty-four hours, probably from starvation

Locality: Emerald (alt. 1,100 ft.), Victoria.

Collector: Tarlton Rayment.

HOST: *Halictus erythrurus dimorphus* Raym. (MS.)

Small but remarkable chloralictine bees, the spring females having an apricot abdomen.

Biology: The midsummer brood is a bisexual one of jet-black females and males; the autumn brood is composed of black virgins. The spring virgins have a dark-green mesothorax. (The author has a comprehensive paper on this species in MS.)

Symbiote: Probably *Caloglyphus*.

Comment: These frequent the cells, and are of a creamy colour, but are seldom present on the bees, and appear to maintain the nests in a sanitary condition. No biological debris can be found in the bees' cells when mites are present.

Locality: Dandenong, Victoria.

Collectors: Owen Dawson and Tarlton Rayment.

HOST: *Halictus gilesi* Ckll.

Small black bees with some rather sparse white hair.

Biology: Gregarious bees digging shafts in the ground.

Symbiote: *Histiosoma* sp.

Comment: 25 mites were clustered about the metathorax.

Locality: Gorae West, Victoria, 7th Dec., 1951.

Collector: Clifford W. Beauglehole.

HOST: *Halictus littleri* Ckll.

Small black bees with a dusting of white hair.

Biology: They excavate a large number of cells, forming a colony in the ground, the sisters working together in partial co-operation.

Symbiote: *Histiosoma* sp.

Comment: About 25 large golden mites were taken from a female bee.

Locality: Gorae West, Victoria, Nov., 1951, also Jan., 1952.

Collector: Clifford W. Beauglehole.

HOST: *Halictus leai* Ckll.

Small black bees with red legs; the golden transverse bands on the abdomen are due partly to tegument and partly to golden hair.

Biology: The oval cells were excavated in firm, closely-textured black peat. The species is gregarious, but not so strongly as other halictine bees. (A full account of the biology of this bee is in MS.)

Symbiote: (Appear to be the same species as in *H. emeraldensis* Raym.)

Comment: Large numbers of mites were studied in the cells and on the bees. One dead female yielded 25 eggs, and 16 live mites, which were congregated under the head, and about the soft chitin near the articulation of the coxae. The large broad-oval eggs were distributed over the body, and measured 105 microns at the long axis and 65 microns at the short, and were covered with microscopic raised bosses arranged in rows.

The youngest mites show no conspicuous change when they hatch, the chorion of the egg *appears* to develop a few hairs, so that it is difficult to determine just when the young has hatched; the two anterior pairs of legs are the first evidence.

The bloated white mite appears to have great difficulty in climbing or crawling over the hairy body of the bee, pulling itself along by grasping the hairs with the two anterior pairs of legs, which are much stronger; the third pair meanwhile maintaining a rowing motion; the hind pair appear to have but little function in locomotion.

The cast white skins of the mites were numerous over the body of the bee.

In halictine species investigated by the author large numbers of mites were present in the cells, and since these are always deep in the earth, it is almost certain that the mites are symbiote, and not parasitic, for the cells are immaculate.

Locality: Cranbourne, Victoria.

Collector: Owen Dawson.

HOST: *Halictus bremerensis* Raym.

A small green and apricot-coloured chloralictine bee from Western Australia.

Biology: See author's accounts in "A Cluster of Bees."

Symbiote: *Calvolia* sp.

Comment: Two or three mites were present on the base of the abdomen.

Locality: Western Australia.

Collector: Tom Greaves.

HOST: Larvae and pupae of *Halictus peraustralis* Ckll.

Bees of medium size, with spots and bands of golden hair.

Biology: There are three discrete generations as in *H. emeraldensis* Raym., but the colony of *H. peraustralis* is established in the trunk of a tree well above ground; a unique departure from the typical habit. (The author has a large paper on the Biology of this *Halictus* in MS.)

Symbiote: Uropodid mites, probably new sp. of *Phaulodinychus*.

Comment: When taken from the larvae and the pupae of the autumn generation, Tertianus virgins, the mites were pinkish to reddish in colour. None of these mites were present on the Secondarius (midsummer) gneration, or the spring Primarius virgins.

Locality: Cheltenham, N.S.W.

Collector: Norman W. Rodd.

HOST: *Halictus victoriellus* Ckll.

Small black bees with faint bands of white hair, very close to *H. emeraldensis* Raym.

Biology: This fossorial species favours loose sand for its colonies. (See author's account, "A Cluster of Bees," 1935.)

Symbiote: *Calvolia* sp.

Comment: A cluster of eight or so mites in a geometrical pattern in a "pocket" at the base of the abdomen.

Locality: Sandringham, Victoria.

Collector: Tarlton Rayment.

Family: MEGACHILIDAE.

HOST: *Megachile abdominalis* Sm.

A bee of medium size with large black head, black thorax, and abdomen of apricot-red.

Biology: Although in the Leaf-cutters' Family, Megachilidae, yet they do not cut leaves, but construct cells of resinous wax in any suitable cavity, generally in wood. The species is a northern one.

Symbiote: *Sennertia bifilis* Canestr.

Comment: The mites, about eight in number, were assembled at the base of the abdomen, in a cavity.

Locality: Brisbane, Queensland, but they are widely distributed over the Northern State.

Collector: H. Hacker.

HOST: *Megachile chrysopga* Sm.

Large black bees, with red hair on face and tip of abdomen; otherwise there is much long white hair.

Biology: The bees build a series of leafy cells in any suitable cavity, usually in wood.

Symbiote: *Sennertia bifilis* Canestr.

Comment: Four mites were taken from the metathorax.

Locality: Bolgart, Western Australia, 11th March, 1948.

Collector: Rica Erickson. The author also bred out specimens of this bee from leafy cells sent to him by Clifford Beauglehole. (See "Bees of the Portland District," May, 1953, Portland Field Naturalists' Club.)

HOST: *Megachile deanii* Raym.

A small black bee with a red abdomen. One of the "leafcutters" that makes a "nest" of waxen cells. (See author's "Cluster of Bees," p. 450, 1935, for a full account.

Biology:

Symbiote: *Sennertia queenslandica* Womers.

Comment: Six large white mites were in two groups of three on the metathorax of a female bee which had only just emerged from a waxen cell.

Locality: Denman, N.S.W., 15th May, 1951.

Collector: R. E. Martin.

HOST: *Megachile*, perhaps a variety of *M. lachesis* Sm.

A large black leaf-cutter male bee which differs from *M. lachesis* by the black and white hair of face; *lachesis* has red hair.

Biology: No details are available.

Symbiote: A species of TROGLYPHOIDEA, apparently close to that present on *M. lachesis* Sm.

Comment: About 50 or so mites were scattered over the body, chiefly about the metathorax.

Locality: Bulolo, New Guinea.

Collector: B. Hough (per Agric. Dept., New South Wales).

HOST: *Megachile erythropyga* Smith.

A small black male, with red hair on face and tip of abdomen, the base of which has white hair.

Symbiote: (*Deutonymph*) *Sennertia bifilis* Canestr.

Comment: Ten large mites found near axilla of wing.

Locality: Bayswater, Victoria, 3rd February, 1916.

Collector: Probably the late F. Spry.

HOST: *Megachile lachesis* Sm.

A very large black leaf-cutting species, with a few reddish hairs on the "face" of the male, and fuliginus wings.

Biology: Builds usually in sandy banks, often near the sea. The life-history of this handsome bee was published by the author in the March issue of "Wild Life" magazine, 1949. The leafy cells are constructed at the end of horizontal galleries, and are ravaged by a parasitic bee, *Coelioxys intrudens* Sm.

Symbiote: A new species in the Family TYROGLYPHOIDEA.

Comment: The pale-amber mites, about 30 in number, were present on the abdominal sterna of both sexes, but numbers of dry skins were scattered over the body in both males and females, and one or two live mites were present. The minute white animals have difficulty in crawling over the fleece of the bee, and pull strongly with the anterior four legs; the third pair having a weak "rowing" action; the posterior pair appear to be of little use in walking. The striae are longitudinal on hysterosoma and transverse on propodosoma.

Locality: Wewak, New Guinea.

Collector: Lt.-Col. Hoare, A.I.F., and M. Faddy, Esq.

HOST: *Megachile semiluctuosa* Sm.

Biology: The cells are *not* built of leaves, but modelled of resin, and perhaps kino, in clean, hard timber, and it appears that the bees may have bored the chambers.

Symbiote: Deutonymphs of *Sennertia bifilis* Canestr.

Comment: About thirty of these mites were congregated about the metathorax of a female bee. These appear to be the same species that infest the Carpenter of the Grass-trees, *Lestis bombylans* Fabr.

Locality: Swan River, W.A. The specimen is very old.

Collector: L. J. Newman.

HOST: *Megachile quinquelineata* Ckll.

A medium-sized black bee, with five narrow bands of white hair across the abdomen.

Biology: Typical leaf-cutters construct cells of leafy pieces, but a large group use resin and wax. It is not yet known to which group this bee belongs.

Symbiote: A new species of *Calvolia*? (Deutonymph).

Comment: About 15 golden mites were scattered over the head and thorax.

Locality: Brisbane, Queensland.

Collector: Cedric Deane.

HOST: *Megachile trichognatha tosticauda* Ckll.

Medium-sized black bees with much white hair.

Biology: The bees occupy tunnels bored by longicorn beetles in dry timber, and build therein a series of chambers constructed of resin, kino and wax. (The nest was described by the author in "Walkabout" magazine.)

Symbiote: Not yet determined.

Comment: Seven mites were taken from the long fleece.

Locality: Moama, New South Wales, 10th March, 1937.

Collector: Rayment. The bees were bred out of cells.

HOST: *Megachile revicta* Ckll.

Biology: Large black bees, with much white hair about the base of the abdomen. They have the usual large head of the Family.

Symbiote: Not yet determined.

Comment: The mites, twelve or so, were taken from both males and females, and were clustered about a depression on the base of the abdomen, which is, perhaps, the most protected portion of the bee's body and the shelter most favoured by the Acarids.

Locality: Sawyers Valley, W.A.

Collector: L. J. Newman.

HOST: *Lithurgus rubricatus* Sm.

A black, shining bee of medium size.

Biology: Reputed to be parasitic on Megachile, but the sole "nest" investigated by the author contained several thin-walled cells of mud. They are widely distributed over the northern parts of Australia.

Symbiote: A new species of *Sennertia*.

Comment: The mites, about eight in number, were congregated about the base of the abdomen of a female.

Locality: Moora, W.A.

Collector: L. J. Newman.

Sub-family: COELIOXYNAE.

HOST: *Coelioxys albolineata* Ckll.

Black bees, with pointed abdomen, some with a few white bands of hair.

Biology: Parasitic in the cells of leaf-cutting bees, *Megachile*. (See author's account in "A Cluster of Bees," 1935; also in "Wild Life," July, 1949.)

Symbiote: Probably new Genus and Species of PONTOPPIDANIIDAE.

Comment: About 15 mites in circular depression at base of abdomen. The parasites choose this sheltered cavity because the host has less chance of reaching them there by brushing or combing with the legs. All bees use the legs continuously for cleansing the fleece.
Locality: Cairns, Queensland.
Collector: J. Mansky.

HOST: *Coelioxys froggatti* Ckll.
Black bees with dots of white hair, and apex of abdomen contracted to a fine "tail."
Biology: All are parasitic in the cells of the Leaf-cutting bees, Megachile. (See author's account in "A Cluster of Bees," 1935.)
Symbiote: *Tyroglyphus* sp. (deutonymphs), *not farinae* (L.).
Comment: Large numbers, 30 or more, of amber-coloured mites were clustered over the legs, coxae and femur of a male bee. Almost all of the Gunbower species had mites, but bees from Orroroo had none.
Locality: Gunbower, Victoria.
Collector: Tarlton Rayment.

HOST: *Coelioxys froggatti* Ckll.
Comment: A dozen or so mites were congregated about the median coxae of the bees.
Locality: Swan River, Western Australia.
Collector: L. J. Newman.

Family: ANTHOPHORIDAE.

HOST: *Asaropoda bombiformis* (Sm.).

Large foxy-red hairy bees which construct large mud cells in tunnels in the ground.
Symbiote: *Calvolia* sp.?
Comment: Numbers of pale-amber coloured mites are sometimes present on the copious fleece of these bees. (See author's "Cluster of Bees," 1937, for description of cells and biology.)
Locality: Sydney, N.S.W.
Collector: Phillip Whiteley

Family: XYLOCOPIDAE.

HOST: *Lestis bombylans* Fabr.

A handsome peacock-blue and green bee, not quite so large as the true carpenter-bee.
Biology: Builds a series of cells in the dry flower-stalks of Grass-trees, *Xanthorrhoea* sp. The mother "broods" over her progeny until it emerges, and this association forms a kind of primitive family. (The author described the biology in "A Cluster of Bees," 1935.)
Symbiote: Deutonymphs of *Sennertia bifilis* Canestr.
Comment: Many hundreds of mites were scattered promiscuously over the body of the bees and, if parasitic, could have caused an intolerable irritation. The deutonymphs—hypopial or wandering stage—are common on xylocopid bees, but adult mites have been found in the nests of Carpenter-bees.
Locality: Kuring-gai, New South Wales; Bowen, Queensland; New Guinea (on *Xylocopa combinata*); Moa Island, Torres Straits, Queensland.
Collector: Norman W. Rodd in New South Wales.

HOST: *Lestis aerata* var. *violascens* Ckll.
A beautiful polished species much bluer in colour than *L. bombylans.* The variety has a strong violet suffusion over the body, and the legs are slender.
Biology: Similar to that of *L. bombylans* Fabr.
Symbiote: Deutonymphs of *Sennertia bifilis* Canestr.
Comment: Several mites were taken from near the underneath of the axillae of the wings.
Locality: Wood's Reef, Barraba, New South Wales, 1942.

HOST: *Nomia australica reginae* Ckll.
A metallic-blue bee with bands of red on the abdomen and "face."

Biology: Gregarious bees digging shafts in the ground so closely that a large colony is formed.
Symbiote: Probably a new species of *Tyroglyphus.*
Comment: Six mites were taken from various parts of the body.
Locality: Meningie, South Australia.
Collector: Hans Minchin.

HOST: *Xylocopa* (*Mesotrichia*) *bryorum* (Fabr.).

The largest Australian bees; black, with a dense fleece of brassy-yellow hair over the thorax; the males are entirely covered by the yellow fleece.

Biology: The Carpenters bore galleries of large size in dry, hard timber, and make divisions of the sawdust to form their cells. The Japanese Carpenter-bee has a similar aspect.
Symbiote: *Sennertia queenslandica* Womers.
Comment: Two large mites were taken from the mesothoracic disc of a male bee, but numbers of smaller mites were present about coxae of the females. These were near to *Sennertia bifilis* (present also on *Lestis*) but differs by the transverse striae; it is partly concentric on hysterosoma in *S. bifilis.*
Locality: Cairns, North Queensland; Moa Island, Torres Straits.

Collectors: J. Manski; S. W. Schomberg.

Large specialised mites in the genus *Dinogamasus* are present in the "abdominal pocket" of certain xylocopids.

Family: CERATINIDAE.

HOST: *Exoneura concinnula* Ckll.

Small red and black bees, soft, shining and smooth.

Biology: The social bees of this genus usually build in plant-stems, but a series of "nests" were found in galls made by the beetle *Ethon affine* Cast. and Gory, on plants of *Pultenaea stipularis.* (See author's account of the biology of this social species, "Australian Zoologist," Vol. XI, Part 4, July, 1951.)
Commensal: A tyroglyphid, *Tyrofagus tenuiclavus* Zachvatkin.
Comment: The small white animal was clambering aimlessly over the cells in the gall. As it is related to the European flour mite, it was probably seeking pollen. Animals that feed at the same table are known as commensals.
Locality: Lindfield, N.S.W.
Collector: C. E. Chadwick.

HOST: *Exoneura dawsoni* Raym

Small, reed-dwelling social bees, usually with a black head and thorax and a red abdomen. A few species are entirely black.
Biology: (Refer to *E. montana* Raym., but many notes by the author on these bees have appeared in the "Victorian Naturalist," 1948-1949.)
Symbiote: *Anoetostoma* sp.
Comment: Taken from the pollen residues in the mesenteron of the larva. The mite had evidently been ingested with the pollen. It was interesting to discover a triungulin, another parasite of bees, in the debris.
Locality: Macedon, Victoria.

Collector: Owen Dawson.

HOST: *Exoneura montana* Raym. (Figure 1.)

Small reed-bees of social habit, with a black head and thorax and a red abdomen.
Biology: Primitive social bees, with several females co-operating in the rearing of the brood in plant-tubes. The larvae in this genus are unique in Australia in having "arms" and "fingers" on lateral appendages. There is sustained progressive feeding of the young. The author has described many of these bees in the "Victorian Naturalist," 1948-1949.
Symbiote: Deuteronymphs of a Tyroglyphid mite.
Comment: A female has about 20 mites on the membrane of each of the anterior wings. *Exoneurae* are as a rule singularly free from mites.

Locality: White Swamp, New South Wales; Queensland border.

Collector: J. Hardcastle, Junr.

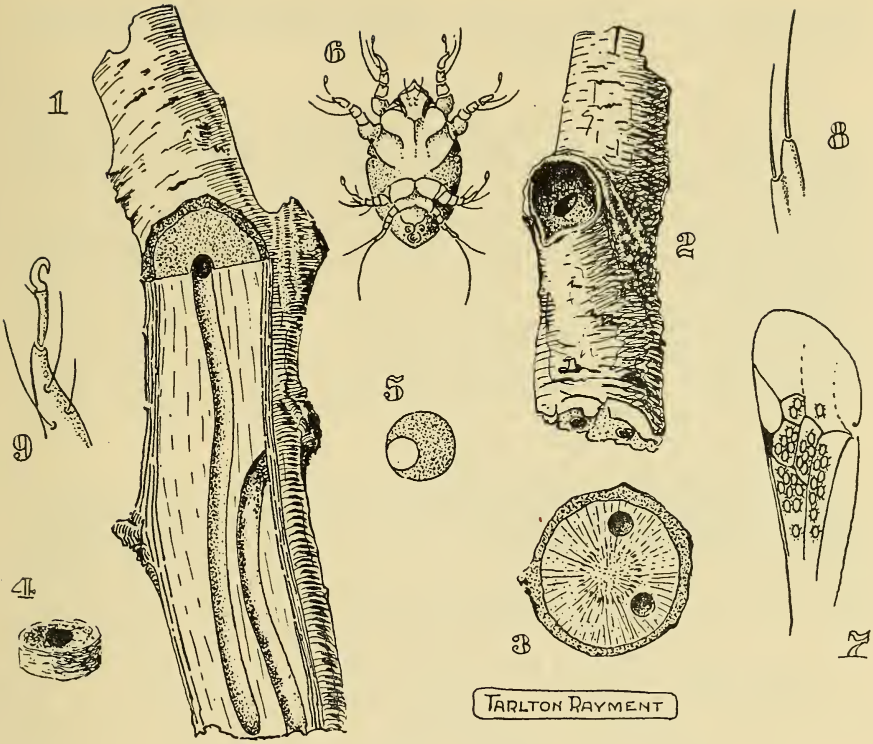


Fig. 1: The symbiote of *Exoneura montana*.

1. Section of punky cherry-wood, showing the bores of *Exoneura montana* Raym.
2. Exterior of the stick, showing the entrance in an old scar.
3. Cross-section; note the position of the bores.
4. A papery entrance plug, much enlarged.
5. The bee packs the powdery residue to one side.
6. The ventral surface of the tyroglyphid mite to display the eight legs; it is distinct from an insect, being nearer to a spider.
7. Large wing of bee with cluster of acarid mites adhering.
8. The two hind legs of the mite have no hooks.
9. The six others are powerfully armed to enable the animal to cling on to its host during flight.

Superfamily: APOIDEA.

Family: APIDAE. Subfamily: APINAE.

HOST: *Apis mellifica* Linn., the hive or honey-bee.

Biology: The domesticated species form the highest group of the true social bees; they are organised in the most efficient commune known to man; they have a perfect distribution of labour; defending the hive by concerted attack; nursing the larvae; building several sheets or combs of hexagonal cells, in which are reared many thousands of workers, and a few hundred drones. The four or so queens are cradled in typical oval cells of wax. The workers have ability to plot angles in the field, and to communicate them to the others when they return to the hive. *Apis* stands at the head of all insects.

Parasite: *Tarsonemus woodi.*

Comment: These small animals effected an entrance to the thoracic tracheae of the bees, thus interfering with the supply of oxygn, and poisoning the host with toxins. This mite exterminated the hive-bees in Great Britain during World War I, 1914-1919. The author has not succeeded in recording this species for Australia.

Locality: Great Britain.

Collector: Dr. J. Rennie and his assistants, 1921, were the original investigators of the condition.

HOST: *Apis mellifica* Linn.

Commensal: *Glycyphagus domesticus* (De Geer).

Comment: Found in the debris of bee-hives.

Locality: Perth, Western Australia, but widely spread.

Collector: Recorded by H. Womersley ("Studies in Australian Acarina," 1941).

HOST: *Apis mellifica* Linn.

Commensal: *Tyroglyphus farinae* (Linn).

Comment: Recorded as infesting the pollen of the bee-hive.

Locality: Adelaide, South Australia; Burnley, Victoria; but widely distributed in Europe. Recorded by H. Womersley.

EXPLANATION OF PLATE I.

1. A new genus and species of Tyroglyphid mite.
2. A new species of Hypoaspis mite on bee, *Parasphecodes fultoni* Ckll.

THREE NEW LAND SHELLS FROM NEW SOUTH WALES.

By C. F. McLAUCHLAN.

(Figure 1.)

Strangesta sanguinolenta sp. nov.

Shell varnished dark chestnut, fades to red brown, very thin; protoconch flat, tight; spire flattened, comparatively small; suture shallow: body whorl flattened; aperture rounded; sloping, not inflated below; suture 2/3 height of shell; ribs very fine, close, hardly dented by minute spirals; umbilicus open, medium width, not deep. Normal shell $5\frac{1}{2}$ whorls, 25 mm. by 12.5 mm. high. Maximum shell 6 whorls, 30 mm. by 14 mm. Animal medium brown, median line very light brown, $2\frac{1}{2}$ in long, half inch of tail behind shell; mantle blood red. Radula 20 mm. long, 3 mm. wide, teeth 46 rows. Habitat: Sugarloaf Range, West Wallsend to Glenbrook. Compare with *S. capillacea*, which has taller, loose spire, convex whorls; shell deep; aperture inflated below, ribs strong, decussating spirals; umbilicus narrower, deeper. Animal inky grey, $2\frac{1}{4}$ in. long. Mantle golden flecks over colourless base. Radula smaller, fewer rows of teeth. Anatomical differences. Will not breed with former.

Meridolum bowdenae, sp. nov.

Shell uniform dull blackish-brown, thickened; spire raised, broad; protoconch granulose; aperture oval, lip pale, reflected slightly, deep violet within, descending above; columella thicker, rounded, nearly covering very small umbilicus, white callus joining margins. Whorls 6, very convex, ribs strong, straight. Normal shell 27 mm. by 19 mm. high. Radula 8.5 mm. by 2.5 mm. Teeth 54—1—54, rows 196. Animal flecked gold over brown; mantle orange gold Habitat, Sassafras Gully, Springwood. Distribution, Glenbrook, Woodford. Not depressed or keeled like *M. depressum*. *M. corneovirens* is taller, inflated, and has no keel.

Fig. 1. Left to right: *Strangesta sanguinolenta*, *Meridolum bowdenae* and *M. middenense*.

Meridolum middenense, sp. nov.

Shells bleached white, in thousands on aboriginal middens on beach sandhills. Live shells, flattened, brown above, pale under, sub-sutural dark band on body whorl only, dark umbilicus patch; 6 convex whorls; aperture oval, pink, descending slightly, lip reflected a little; umbilicus very small, open, partly covered by columella; keel faint; ribs strong, even. 23.5 mm. by 16 mm. high. Animal 50 mm. long, gold over chocolate; brown eyestalks; mantle golden. Radula 6.75 mm. by 2.25 mm., teeth 54—1—54, rows 162. Habitat: Mona Vale. Distribution, Stanwell Park to Broken Bay. Marked anatomical and shell differences from *M. jervisense* and *M. duralense*.

* Editorial Note.—In 1951, Mr. C. F. McLauchlan published his "Basic Work on the Life Cycle of Some Australian Snails" in *Proc. Roy. Zool. Soc. N.S. Wales*, 1949-50, pp. 26-36 and plate. In that he referred to another paper which was in the press for the *Australian Naturalist* in 1951. However, the Naturalists' Society of N.S. Wales has been unable to publish its *Australian Naturalist* for some years, and Mr. McLauchlan's paper is now being published in the *Australian Zoologist* instead. Three new species of *Meridolum* and *Strangesta* are now defined in detail, having been unavoidably *nomina nuda* in the earlier *Proceedings*.

LAND SHELLS ORIGINALLY INTRODUCED.

By C. F. McLAUCHLAN.

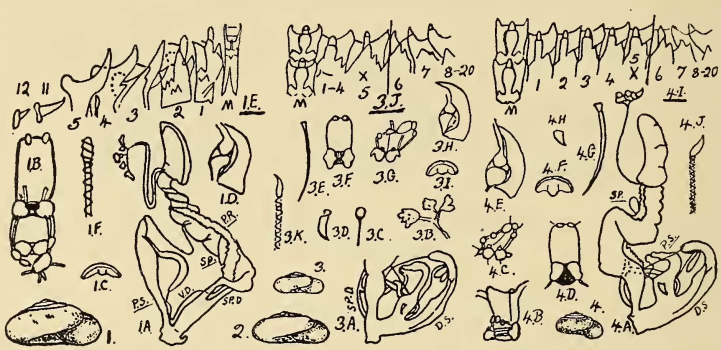
(Figs. 1 to 4.)

The following will be of interest to overseas and Australian conchologists.

Oxychilus sydneyensis. Cox. Cat. Aust. Land Shells, 1864. Developed apparently from introduced English *Hyalinia (Oxychilus) cellaria compacta* Jef. *(Helicella cellaria).* Still in transitional stage. Depressed, smooth, small umbilicus, aperture roundly lunate, whorls $6\frac{3}{4}$. 13 x 7 mm. Common Sydney, Eastern Australia, coastal. Fig. 1. 1A, anatomy; 1B, nerve centre; 1C, jaw; 1D, heart; 1E, teeth; 1F, spermatozoon, 1200 X, 1/10 total length.

Oxychilus tasmanicus, sp. nov. Very depressed and smooth; weak striae; spire very depressed; umbilicus very small; aperture depressly oval; amber yellow; transparent; 9.5 x 4.5 mm. $5\frac{1}{2}$ whorls. Anatomy later. Launceston, also Hobart, Tasmania. Fig. 2.

Alienitor lyndhurstensis, Cox. Apparently developed from an introduced form of *zonitoides*. Depressed; smooth; striated; spire flattened dome; aperture oval; umbilicus medium; thin; brownish; whorls 5. Size, 6.5 x 3.25 mm. Fig. 3, 3A, reproductive anatomy. Two pendant coronal glands low in curve of dart sac. Spermatheca duct forked, one fork attached to back of penis sheath, other to vagina. P.S. shows the calcareous channel sheath. 3B, ovotestis; 3C, spermatheca, round; 3D, channel; 3E, dart; 3F, 3G, nerve centre, surrounds buccal; 3H, heart, pulse 124 per minute at 65 deg.; 3I, jaw; 3J, teeth; 3K, spermatozoon, spiral striae, 1200 X. 1/10 total length. Lyndhurst St., Glebe, Sydney, New South Wales, common Queensland to Victoria.



Figs. 1 to 4. Anatomy of Land Shells (see context).

C. F. McLauchlan del.

Alienitor lyndhurstoides, sp. nov. Clifton Gardens, Sydney, New South Wales. A little elevated; growth lines rugged, rib-like; spire raised, whorls rounded, aperture rounded; umbilicus wider; thickish; brown; duller shine; whorls $5\frac{1}{4}$. Size, 5.25 x 3.25 mm. Fig. 4: 4A, anatomy. One long gland high in curve of dart sac, note dart. Spermatheca oval, duct forked, one fork attached to back of P.S. 4B, nerve centre, surrounds buccal; 4C, 4D, nerve centre: 4E, heart, pulse 96 per minute at 65 deg.; 4F, jaw; 4G, dart; 4H, channel; 4I, teeth; 4J, spermatozoon, zig-zag striae; 1200 X, 1/12 total length.

Types in the author's collection will be presented to the Australian Museum.

DISTRIBUTION OF THE GREEN VEGETABLE BUG.

DISTRIBUTION OF THE GREEN VEGETABLE BUG (*Nezara viridula* var. *smaragdula* Fabr.) IN 1950. OTHER BUGS LIKELY TO BE CONFUSED WITH IT.

By C. E. CHADWICK, B.Sc.

Systematic Entomologist, Department of Agriculture, Sydney.

(Plate II and Map.)

Although the green vegetable bug is a well-known pest of many plants in N.S.W., records exist within the State of at least two other bugs likely to be confused with it.

The mature female green vegetable bug is generally about ⅝ inch long and ⅜ inch across the widest part of the body. The male is slightly smaller and may be distinguished from the female by the different structure of the tip of the abdomen (Zeck 1933). In the female the end of the abdomen is rather rounded; that of the male is definitely incised, as seen by the naked eye. Specimens of the insect usually encountered are light green in colour, but other forms, of a purplish or brown colour, may be found, especially in the cooler months.

As stated by Freeman (1940), there are four varieties of this insect, the common form being more correctly known as *Nezara viridula* var. *smaragdula* Fabr., the type specimen being merely a yellow variety. The insect is of considerable economic importance, and is found in every continent, although in Europe it occurs only in the south; it has also spread to many islands in the Pacific and elsewhere.

According to Froggatt (1916), the green vegetable bug first appeared about 1911 on tomato plants near Sydney. However, Gross (1949) says the South Australian Museum contains "a single specimen attributed to a large reed beds area near Port Adelaide (now non-existent), and stated to have been captured in 1867. Whether this specimen represents the insect at the beginning of a long period of adaptation from which it has just emerged, an isolated introduction (near a port) which did not become established, or a wrong locality, though that was a very rare occurrence in the particular collection in which this specimen occurred, I am not prepared to say."

May (1938) states "In 1917 its presence in Queensland was first recorded at Ipswich, where the bug was injuring tomatoes. It had been known associated with potatoes some years previous to this." He believes the insect was introduced into Queensland by ship from N.S.W.

The green vegetable bug was first reported from Western Australia in 1920, when it was recorded as attacking beans, potatoes, tomatoes and other garden plants near Bunbury (Newman, 1926). Early in 1936 it was found in Victoria, and has since spread over the greater portion of northern Victoria (Pescott, 1940).

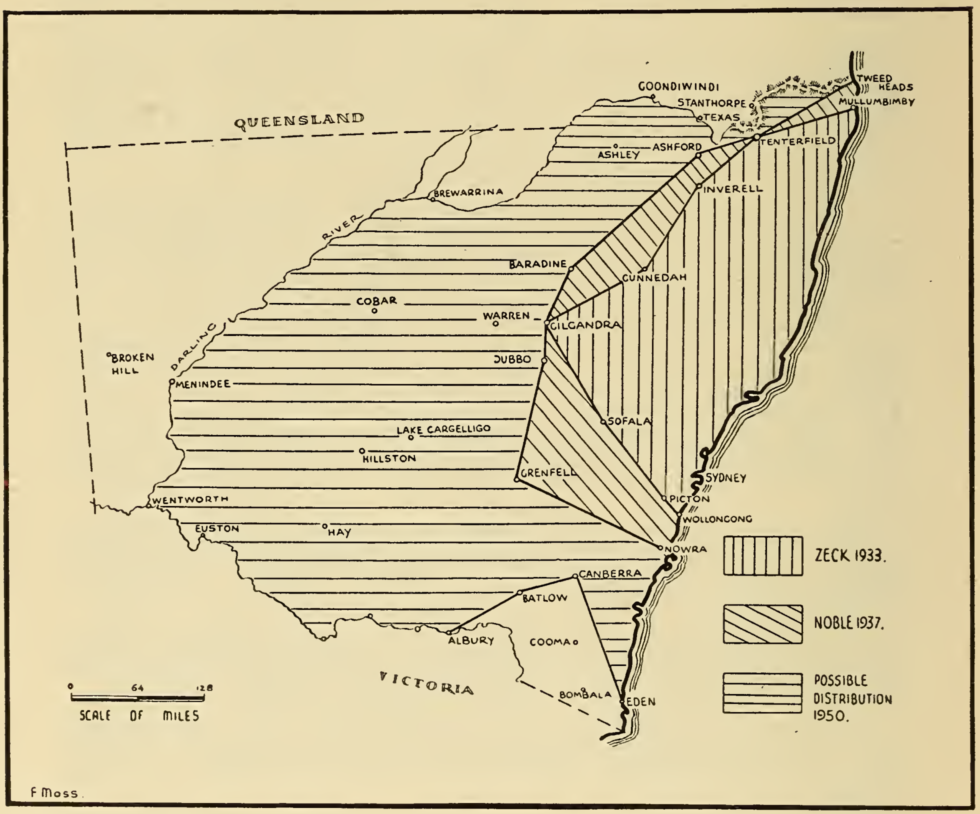
The bug was first recognised in South Australia in March, 1938, when specimens were identified from Berri on the Murray River near the Victorian border. In May, 1939, it had reached Adelaide, and by 1941 had become a common pest (Swan, 1949).

Up to the present time there is no record of the insect being present in Tasmania, but it is believed to have been introduced into New Zealand in 1941 (Cumber, 1949), and is now spreading rapidly (Everett, 1950).

Within N.S.W. its known distribution as a pest in 1933 was roughly a triangular area of about 50,000 sq. miles, having as its apices Mullumbimby, Gilgandra, and Wollongong (Zeck, 1933). Later on, Noble (1937) stated that it had been recorded from the Tweed River, Tenterfield, Ashford and Murrurundi in the north, Grenfell, Dubbo and Baradine in the west, and Nowra in the south.

Since then the insect has spread both west and south. In the west of the State specimens were identified in 1949 and 1950 from Mungindi, Collarenebri, Brewarrina and Menindee on the Darling River. In March, 1950, it was identified from cabbages and beans at Broken Hill, although it was not recorded by the writer during four years' residence (1941-44). To what extent the bug has spread beyond the Darling River has not been determined, owing to the sparseness of settlement. To the east of the Darling the insect has been reported as occurring at Ashley, Warren, Cobar, Lake Cargelligo, Hay (September, 1941), Euston and Wentworth. As it was recorded from Stanthorpe, Texas and Goondiwindi in 1934 (May, 1938) it would appear to be open to speculation whether the insect reached the Darling via its tributaries or from the western part of this State. (At Nyngan recently Mr. J. W. T. Armstrong observed a green vegetable bug on a lorry load of furniture which had come from Dubbo.)

On the coast the pest has been reported from as far south as Eden. It has not been possible to confirm the presence of the bug south of Eden, Canberra, Batlow



Map of the distribution of the Green Vegetable Bug, *Nezara viridula* var. *smeragdula Fabricius* in New South Wales.

and Albury, although it is suspected of occurring at Cooma and Bombala. It appears to occur all along the Murray River from Albury westwards.

It has been reported (Anon., 1940) that Dr. N. S. Noble collected a solitary female of the American green soldier bug (*Acrosternum hilare* Say) on passion vines at Lindfield, Sydney, but there is no record of this species being collected since then. This insect is found in Canada, Central America, West Indies and Brazil; Whitmarsh (1917) says it is entirely probable that it may be found in nearly every State in U.S.A. Underhill (1934) records the insect attacking 52 species of plants. Besides attacking a large variety of native American plants, it is a particular pest of peaches in certain States, and causes pitting in the fruit. Host plants also include tomato, mulberry, blackberry, grape, cotton, turnip, pea, orange, cherry, pear, cowpea, mustard, soya bean, Lima bean, cabbage, corn, apple and egg plant. It also transmits yeast spot (*Nematospora phaseoli* Win.) of Lima beans. It will be seen that the insect might develop into a serious pest should it become established in Australia.

The adults are bright green in colour, and oblong oval in shape. Females average about $\frac{3}{4}$ in. in length, and males about half an inch, but occasionally exceptionally small individuals are only half the normal size. The lower surface of the abdomen is lighter green than the upper surface. Males and females may be distinguished as in the green vegetable bug.

In early March, late May and early June, 1948, a number of specimens of a native green bug (*Glaucias amyoti* Dallas) were collected in a garden at Chatswood. The specimens obtained in March were collected at light, and a search through the branches and leaves of garden hibiscus (*Hibiscus hortensis* L.), from which they were thought to have come, yielded no result. The other specimens were found later only below the petals in the flower heads, in association with odd green vegetable bugs. There is no appreciable difference in the sizes of the two sexes, each being about $\frac{5}{8}$ inch long and having a maximum width of about $\frac{3}{8}$ in. Among the specimens collected, males were much more numerous than females. In females the tip of the abdomen is rounded, whereas in males it clearly incised.

This insect was first described from N.S.W. and New Zealand by Dallas (1851). Until collected in 1948, N.S.W. specimens were not represented in any official collections housed in Sydney. However, Smith (1948) states that it appears to be quite common in Queensland, having been collected mostly in scrub areas; it is not considered to be of any significance as a pest. It is also known from the New Plymouth district of New Zealand and from the Kermadec Islands, but there also does not appear to be of any economic importance (Salmon, 1948).

P. C. Hely (1950) has obtained immature forms of this insect and states: "Stages III, IV and V were collected at Moorland on 17th March, 1950, feeding on green berries of the giant privet (*Ligustrum*). Nymphs taken to Gosford developed to adults in cages on these berries. The nymphs are more rounded in outline than those of *Nezara*, and also more strongly convex. The ground colour of the nymphs in these stages is cream to light green, and the markings are orange, pale green and yellow. Adults emerged on 4.4.50." Tillyard (1925 and 1926) refers to the insect as "useful" and "occasionally beneficial," without amplification, but Hely says: "At no time did I have any evidence even to suggest that they might be predaceous."

A few other species of green plant bugs occur in N.S.W., but none of them should be confused with the green vegetable bug. The spined citrus bug (*Biprorulus bibax* Bredd.) is somewhat longer, being about $\frac{3}{4}$ inch long and about $\frac{3}{8}$ inch wide, but it may be readily distinguished from any other green shield bug by the sharp-pointed, dark spine which projects outward and forward for $\frac{1}{8}$ inch from each side of the thorax. Members of the genus *Vitellus* are green, and have a conspicuous reddish spine projecting from the prothorax; they are smaller than either the green vegetable bug or the spined orange bug, but they are uncommon insects. Members of the genera *Cuspicona* and *Plautia* are green or predominantly green, but are considerably smaller than the green vegetable bug. An undescribed species of *Cuspicona* found on blackberry inflorescences has been confused with the green vegetable bug on occasion.

The following table, based on some of the more obvious characters, shows how the green vegetable bug may be distinguished from the American green soldier bug and from the native bug—

Character.	American Green Soldier Bug. *Acrosternum hilare* Say.	Green Vegetable Bug. *Nezara viridula* var. *smaragdula* F.	Native Green Bug. *Glaucias amyoti* Dallas.
Head	As in *Nezara*, or a yellowish to red line may extend round margin of head.	Yellowish to red mark on margin of head just in front or eye.	Margin of head may be paler, but no distinct mark or line.
Antenna	Segments one and two green; segment three mostly green, but tip reddish; segment four basal half orange green, rest blackish; segment five basal half and tip orange, rest blackish.	Segments one and two green; segment three green except for tip, which is reddish; segment four mostly reddish, but greenish at base; segment five mostly reddish (lighter at base and at tip in some specimens). Darker specimens have antennae more uniformly reddish.	All segments green.
Prothorax	Narrow yellow, orange or red marginal line usually present.	Very narrow line, mostly yellow or light greenish (or reddish in darker forms), extends along edge of front margin from head to shoulder.	Edge of prothorax green, but a yellow band extends behind the edge from head to shoulder.
Shield	Yellowish spots small or absent. Black spots absent. Shield tapering more noticeably posteriorly and ending in a more acute point.	Three (occasionally five) yellowish spots across front edge, one black spot in each of anterior corners. Posterior angle of shield coming to a broad point.	Yellowish and black spots both absent. Posterior end of shield rounded and broader than either of the other species.
Scent gland Spout (metathorax)	*Opening of spout further from base of leg than in *Nezara*; a practically straight ridge extends well beyond halfway to side of body.	*Short, blunt, never reaching half way from base of second pair of legs to side of body, not drawn out into a long ridge.	Similar to *Acrosternum*, except that ridge is slightly curved.
Abdominal spine	Abdominal spine pointed.	The spine extending forward from the first abdominal segment between the third pair of legs is blunt.	Abdominal spine pointed.
Underside of abdomen	Keel less pronounced. No light line.	Distinct keel present with lighter line down the centre of abdomen.	Abdomen broadly rounded. Keel and white line absent.
Puncturation, etc.	Pits less dense and each pit shallower. Upper surface slightly glossy.	Upper surface densely covered by tiny pits, especially on forewings. Upper surface dull.	Pits still less dense and still more shallow. Upper surface distinctly glossy.

* Figures 6 and 7 of Jones (1918) have been inverted and reversed, as may be demonstrated by photographing these figures and printing from each side of the negative.

BIBLIOGRAPHY.

Anon. (1940). A Green Shield Bug. Agric. Gaz. N.S.W., li (May), 271-2,

Cumber, R. A. (1949). The Green Vegetable Bug *Nezara viridula*. New Zealand Journal of Agriculture, 79 (6), (December), 563-564.

Dallas, W. S. (1951). List of Specimens of Hemipterous Insects in the collection of the British Museum. Pt. 1, 278.

Everett, P. (1950) Spread of Green Vegetable Bug. New Zealand Journal of Agriculture, 80 (2), (February) 145-146.

Freeman, P. (1940). A contribution to the study of the genus *Nezara* Amyot and Serville (Hemiptera, Pentatomidae). Trans. R. ent. Soc. Lond. 90, (12), 351-374.

Froggatt, W. W. (1916). The Tomato and Bean Bug (*Nezara viridula* Linn.). Agric. Gaz. N.S.W., xxvi (September), 649-650.

Gross, G. F. (1949). Personal communication, 29/7/1949.

Hely, P. C. (1950). Personal communications, 6/6/1950 and 25/7/1950.

Jones, T. H. (1918). The Southern Green Plant-Bug. U.S.D.A. Bull, No, 689, p. 5.

May, A. W. S. (1938). The Distribution of *Nezara viridula*, Entomological Society of Queensland, Minutes of Meeting 13th September, 1938.

Newman, L. J. (1926). The Green Tomato Bug (*Nezara viridula* Linn.). Journ. Dept. of Agric., West Australia, (3), 1, (March), 68-75.

Noble, N. S. (1937). An Egg Parasite of the Green Vegetable Bug. Agric. Gaz. N.S.W., xlviii (June), 337-341.

Pescott, R. T. M. (1940). Insect Pests of Tomatoes. Control Measures, Journ. Dept. Agric. Victoria, xxxviii, 3 (March), 140-152.

Salmon, J. T. (1948). Personal communication, 20/8/1948.

Smith, J. H. (1948). Personal communication, 1/7/1948.

Swan, D. C. (1949). Personal communication, 21/7/1949.

Tillyard, R. J. (1925). Australian Encyclopaedia, 1925. Vol. 1, p. 609.

Tillyard, R. J. (1926). Insects of Australia and New Zealand, p. 148.

Underhill, G. W. (1934). The Green Stinkbug. Bull. Virginia Agric. Expt. Sta. No. 294, 1-26.

Whitmarsh, R. D. (1917). The Green Soldier Bug (*Nezara hilaris* Say). Ohio Agric. Expt. Sta. Bull. 310, 515-552.

Zeck, E. H. (1933). Investigations on the Green Vegetable Bug (*Nezara viridula* Linn.). Agric. Gaz. N.S.W., xliv (August), 591-594; (September), 675-682.

EXPLANATION OF PLATE II.

Nezara viridula var. *smaragdula* F. Fig. 1: Dorsal surface. Fig. 2: Scent gland and ridge. Fig. 3: Ventral surface of abdomen..

Glaucias amyoti Dallas.. Fig. 4: Dorsal surface. Fig. 5: Scent gland and ridge. Fig. 6: Ventral surface of abdomen.

Acrosternum hilare Say. Fig. 7: Dorsal surface. Fig. 8: Scent gland and ridge. Fig. 9: Ventral surface of abdomen.

Photo: C. E. Chadwick.

REMARKABLE BEES FROM A RAIN FOREST.

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(Text figures 1-3.)

INTRODUCTION.

The Illawarra range, five miles or so inland, runs more or less parallel to the South Coast of New South Wales, and the elevation of the "tops" is approximately 2,100 feet above sea-level. Clouds rolling in on the south-eastern winds from the warm Pacific condense on the eastern slopes of the range, and shed an annual precipitation of 79 inches (in 1949 over 90 inches were recorded), consequently, the climate is a humid one.

Shelter from the dry westerly winds favoured the development of a unique rain-forest at no great elevation, and the mesophytic flora is varied and spectacular, with genera such as *Tristania, Backhousia, Doryphora, Eugenia, Ceratopetalum, Brachychiton, Ficus, Prostanthera,* with Cedrela only by rare specimens.

Leptospermum and *Persoonia* are in "pockets" on the partially-cleared terraces "or ledges," which may be a quarter-mile wide, but provide good pasture for the milch cows of the dairy farmers. The district has been settled for over a hundred years, and the introduced blackberry is now a ubiquitous and noxious weed.

The soil is of red volcanic loam, but the rocks in the gorges are mostly basalt; rim-cliffs at the 2,000 ft. level are sandstone slightly metamorphosed; the coastal plain is of volcanic loam with outcrops of basalt, which is quarried for road construction.

It was postulated by Norman W. Rodd, an analytical chemist of Sydney, and who has made many contributions to our knowledge of the Australian Hymenoptera, that such an area should have an insect fauna equally as remarkable as the flora.

His subsequent excursions into the rain-forest in 1949-50 have amply demonstrated how soundly he had reasoned, for his collections contain a number of new and spectacular forms. Only the Apoidea are dealt with in this paper, but the wasps *(Sericophorus)* are not less surprising, and a paper on these is in the press.

The author's researches in Hymenoptera are assisted with a grant from the Trustees of the Science and Industry Endowment Fund.

Division: COLLETIFORMES.

Family: COLLETIDAE.

Paracolletes alleynae Raym.

A male very close to *P. alleynae*, but may be separated by the distinct punctures of the clypeus; absence of transverse lineation on the metathorax; black polished tegulae; long, narrow abdomen; lighter red of the legs. The bee is close to *P. providellus bacchalis* Ckll., but that has reddish-amber margins on the abdominal terga. When the female is known it will probably be separated.

Jamberoo, N.S.W., January, 1950, Norman W. Rodd.

Taken on flowers of *Leptospermum flavescens* var. *grandiflorum.*

Paracolletes chalybeatus Er.

A female is referred to this doubtful species. It is similar to specimens from Mt. Victoria, New South Wales (leg. Keith McKeown, Jan., 1941), but the nervures of the wings are black, not brown.

Locality: Jamberoo, New South Wales. Jan., 1950, Norman W. Rodd.

Paracolletes crassipes leptospermi Ckll.

A series of females were observed digging and entering shafts in the middle of a busy colony of *Cladocerapis persooniae* Raym. The collector suggested that the association of the two bees should be investigated.

Jamberoo, N.S.W., Jan., 1950. Norman W. Rodd.

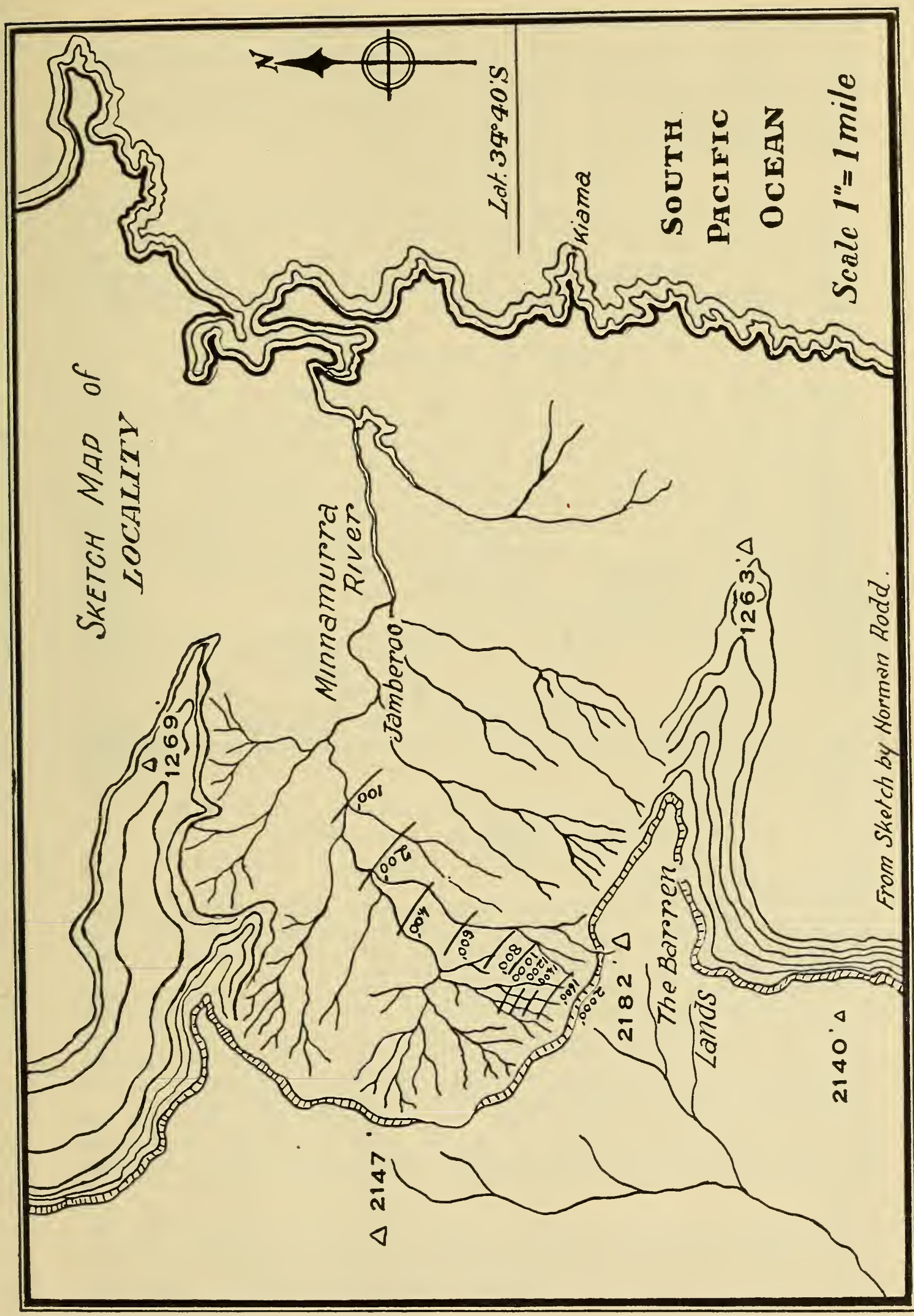


Fig. 1: Sketch Map of the locality in New South Wales.

Paracolletes subviridis illawarraensis sub-sp. nov.

Two females which are exceedingly close to the species, but lack the metallic lustre on the head and the thorax; abdomen obscurely green, but not dull, very smooth and shining; second recurrent meets the third intercubitus nervure. This may be only a mainland form. The species was described from Bridport, Tasmania.

Jamberoo, N.S.W., Jan., 1950 Norman W. Rodd,

Taken on flowers of *Leptospermum flavescens* var. *grandiflorum.*

Cladocerapis persooniae Raym.

A large series of males and females. The bees had excavated a number of shafts, forming an extensive colony on one of the "ledges" at the 1,600 ft. level. The bees in this genus are endemic to the botanical genus *Persoonia,* and the females were observed visiting the flowers of *P. mollis.* The collector detected the characteristic odour of these plants in the stores of the bees. (A brief account of the remarkable colony is given here.)

NOTES ON THE BIOLOGY.

The collector excavated an extensive colony in the red volcanic ground at the 1,600 ft. level. The shafts went down sometimes to a depth of 35 cm., but the majority terminated at about 25 cm. The pear-shaped colloidal skin cells measured 15 mm. at the long axis, and 7 mm. at the short, and the moist pollen-pudding of batter is spherical, with the characteristic aromatic odour of the flowers. The larvae present no marked departures from the typical form of bees, for there are no nodes or spines such as are found in halictine and nomiine larvae. Those reared in the artificial conditions of the author's laboratory required twelve months for their full development, consequently there would be only one brood for the season. The cells are separated from the main shaft by earthen plugs, so that the architecture differs from that of *C. colmani* Raym.

Hordes of parasitic wasps, one very close to *Labium rifiscutum* Curran, and the other a large red evanid, ranged tirelessly to and fro over the shafts. (See *Paracolletes crassipes.)*

Callomelitta picta Sm.

A female typical in all characters, with the red scutellum (black in *C. perpicta* Ckll). Taken from cells built in punky wood, a habit observed at Emerald, Ringwood, and Mt. Bogong, Victoria. The bees, it would seem, prefer localities with a heavy rainfall.

Locality: Jamberoo, New South Wales, Jan., 1950, Norman W. Rodd.

...*Binghamiella (Pachyodonta)* sub-gen. nov.

The author proposes a new sub-genus for a remarkable red and black female, 8 mm. approximately in length.

Sphecodes antipodes was described by Smith in 1853, but the species was separated as *Binghamiella* by Cockerell in 1907. No other species was added, but in 1916 Cockerell proposed the sub-species *insularis,* from Tasmania, and Rayment in 1939 described a variety, *nigra,* from Cann River, Victoria.

In January, 1950, Norman W. Rodd collected a series of red and black females which differ from *Binghamiella* by the following characters: The large spoon-like mandibulae are excessively short and broad: there is a large maxillary inner comb; the pygidial plate long and narrow; lateral margins of the long patella nodulose; segments 3-4-5-6 of the abdomen have a hairy vestiture; the gradulus of the third (morphological) sternum is different, and there is a peculiar lateral carina.

In other characters the female agrees with *Binghamiella;* the rugose head and thorax; the short, broad emarginate glossa; the strigilis of the anterior tibia; the finely serrated calcariae of the posterior leg; the long patella, and the dark wings; the polished basal segment of the abdomen. Unfortunately, only the female is known.

The fuliginous wings of a number of bees show a "shadow" neuration of white lines, and these are regarded by many authors as vestiges of a neuration that has become obsolete. Since they are present in Families with little relation they have probably descended from some ancestral PROTOHYMENOPTERON. The pattern is more extensive in *Pachyodonta.*

Such lines are conspicuous on the European species *Andrena flessae* Pz., and the unique Australian bee *Melitidia manskii* Raym. They are present also on *Halictus peraustralis* Ckll., but these bees are in the Division ANDRENIFORMES. They may be observed in the more primitive COLLETIFORMES; other Australian genera with such pale lines are *Hylaeoides, Hylaeus, Crocisa,* and even *Megachile.*

Bees with clear wings often have "breaks" in the neuration which aline with the shadow neuration, so that it would appear that they, too, retain the vestiges, although they are not evident to the eye. The author has not attempted to work out the homologies of the pale lines or alar fenestrae.

Binghamiella (Pachyodonta) fulvicornis sub-gen. et sp. nov.

(Fig. 2.)

Genotype, Female—Length, 8.5 mm. approx. Black and red.

Head shining, excessively rugose, a few golden hairs over the face; two deep, short foveae laterally; frons with the coarse rugae in longitudinal lines; clypeus large, polished, convex, coarsely punctured, a few golden hairs; supraclypeal area highly convex, with a polished area; vertex finely adapted to the mesothorax; compound eyes with the anterior margins almost parallel; genae coarsely rugoso-

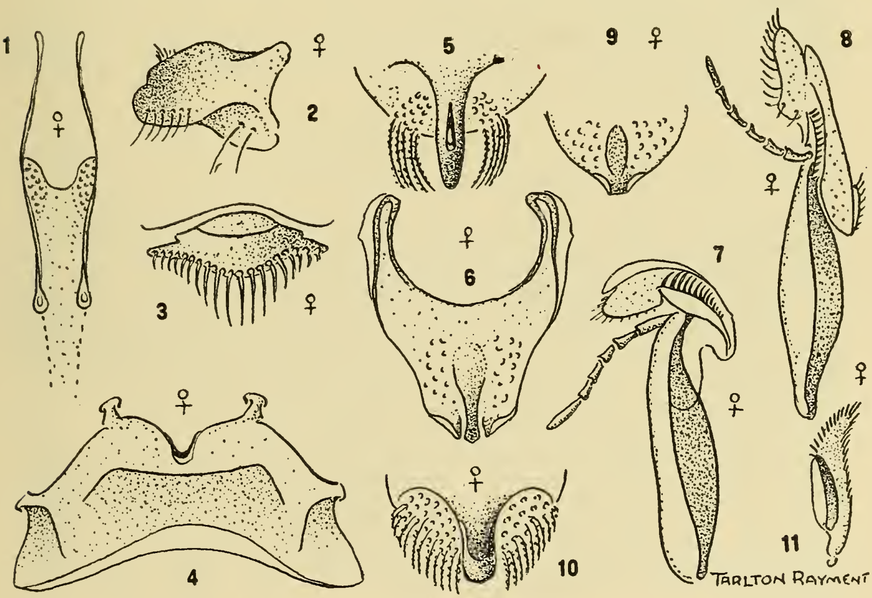


Fig. 2: Details of *Binghamiella (Pachyodonta) fulvicornis* Raym.

1. Pharyngeal plate of female *B. (P.) fulvicornis,* sp. nov.
2. The broad, short mandible is very different from the tridentate one of *Binghamiella antipodes* (Sm.).
3. Labrum and fringe.
4. Third (morphological) sternum of the abdomen has a peculiar lateral carina.
5. Pygidial plate of the female.
6. Apical sternum of the abdomen.
7. Maxilla with palpus and inner comb.
8. Maxilla with palpus and inner comb of *Binghamiella antipodes* (Sm.).
9. Apical sternum of abdomen of *Binghamiella* female.
10. Pygidial plate of *Binghamiella.*
11. Strigilis of *B. (P.) fulvicornis.*

punctate, a few long golden hairs; labrum amber, a long narrow suboval with a fringe of golden setae; mandibulae short and broad, amber, spoon-like; antennae fulvous, the scape slender and darker.

Prothorax not visible from above; pleura coarsely rugoso-punctate; tubercles dark-red, with a fringe of white hair; mesothorax with the disc red, but a black triangle posteriorly, excessively coarsely punctured and rugose, a median depression, the parapsidal furrows conspicuous; scutellum with a similar coarse sculpture, black; postscutellum with finer sculpture, black; metathorax black, shining, with a complicated rugosity difficult to describe, tufts of pale hair laterally; abdominal dorsal segment 1 black, highly polished, few large punctures, 2 red, closely punctured, hind margin black; other segments blackish with amber margins, much more closely punctured, much appressed golden hair; ventral segments black, with a scopa of long white hair, caudal fimbria reddish-gold.

Legs red, coxae, trochanters, and femora basally black, with white hair; tarsi reddish, slender; claws red, bifid; hind calcar reddish, finely serrated; tegulae reddish-amber; wings deep fuliginous, with a rich purple lustre; nervures brownish, strong, the two recurrents entering the two cubitals at about the same distance from the ends (see discussion); pterostigma brownish-black; hamuli seven, weak.

Locality: Jamberoo, New South Wales, January, 1950, Norman W. Rodd.

Genotype in the collection of the author.

Allies: Not very near to *B. antipodes* (Sm.), and may be raised to full generic rank when the male is known. It is a very distinctive bee, and there is a probability that *Callomelitta turnerorum* Ckll. will be referred to *Pachyodonta*.

Taken on flowers of *Prostanthera lasianthos*.

Family HYLAEIDAE.

Stilpnosoma clypeata, sp. nov.

Type, Female—Length 10 mm. approx. Black, with an obscure silky lustre.

Head large, quadrate, wider than the thorax, shining, and adapted to the curve of the mesothorax, the whole with a microscopic tessellation; frons with a fine carina reaching the median ocellus; clypeus short but wide, with a median depression, and two large nodes laterally, and a small median tooth; supraclypeal area large and convex; vertex depressed laterally, ocelli elevated, with a minute sulcus between; compound eyes reniform; genae large, microscopically lineate, a few shallow punctures; labrum black, polished; mandibulae short, broad, tridentate, subtriangular, a few golden hairs; antennae black, flagellum obscurely brownish beneath.

Prothorax covered with a dense fleece of mossy golden hair which is partly masked when the head is against the mesothorax; tubercles masked with similar golden hair also a small area posteriorly; mesothorax coriaceous, a minute tessellation that is almost granular, a few inconspicuous shallow punctures; scutellum similar, with a median depression; postscutellum rougher and duller; metathorax with an area covered by a scale-like sculpture, a few white hairs laterally; abdominal dorsal segments sericeous, finely transversely lineolate, some blackish hair apically, and a minute narrow pygidial plate; ventral segments similar, with a few scattered punctures.

Legs black, almost nude, very few white hairs, the posterior tibiae with a number of spiculae; tarsi black, hair yellowish, curved in a peculiar manner on anterior legs for collecting pollen; claws bifid red; hind calcar finely serrated, amber-colour; tegulae black; wings somewhat dusky; nervures black, strong; second cubital cell half the length of the first, receives the recurrents at equal distances; pterostigma large and black; hamuli about seven, weak.

Locality: Jamberoo, N.S.W. 20th January, 1949. Norman W. Rodd.

Type in the collection of the author.

Allies: It should, perhaps, form the genotype of a new genus, for it is not a typical *Stilpnosoma* The remarkable structures of the clypeus and the mandibles resemble those of certain *Megachiles*, but the general fascies approaches that of *Euryglossimorpha*. Had a male been available for study I should have proposed a new generic diagnosis.

Meroglossa basilauta, sp. nov.

Type, Female—Length, 12 mm. approx. Black, yellow marks.

Head long, shining, coarsely punctured; lateral face-marks primrose-yellow, shaped like a Mexican hat; frons more closely punctured; clypeus somewhat aciculate, a few coarse punctures, and a large hexagonal yellow mark at apex reaching the lateral ones; supraclypeal area high, with a sulcus and a quadrate yellow mark; vertex with two long facial foveae that curve in to meet the lateral ocelli, where they open out into a large smooth area; compound eyes reniform; genae prominent, microscopically lineate, a few large punctures; labrum black, with a large tubercle; mandibulae black, hardly bidentate, numerous yellow hairs; antennae black, flagellum obscurely reddish beneath.

Prothorax black, thickened; tubercles primrose-yellow, but *no* yellow mark on pleura; mesothorax closely punctured, a few short black hairs, a minute sculpture; scutellum with a broad yellow band; postscutellum black, granular; metathorax black, granular, a few indistinct longitudinal rugae; abdominal dorsal segment one polished black, scattered small punctures, in contrast to the duller black of the others, which have larger closer punctures; ventral segments shining, coarsely punctured.

Legs black, slender, white hair; tarsi similar; claws bifid, blackish-red; hind calcar finely serrated, amber; tegulae black, finely tessellate; wings somewhat fuliginous; nervures black, strong, first recurrent meeting the first intercubitus; long second cubital receiving the second recurrent at its apical third; pterostigma long and black; hamuli nine, not strong.

Locality: Jamberoo, N.S.W. 10th January, 1950. Norman W. Rodd.

Bees taken on flowers of *Loranthus* species.

Type in the collection of the author

Allies: *M. nigrifrons* (Sm.), which has yellow tubercles and a yellowish crescent on pleura; *M. diversipuncta* Ckll., which has black tubercles and a yellow crescent.

The yellow marks of the "face" of the new species are conjoined to form a conspicuous diamond pattern.

Two acarine mites, hypopus stage of *Anoetus* species, were taken from the thorax.

Analastoroides foveata Raym.

A series of remarkable black females closely resembling *Hylaeoides concinna* Fabr., with a wide abdominal band of reddish-orange colour, due to *hair*, and not to integument. The bees in this genus lack the tibial hooks of *Hylaeoides*, and both bees closely resemble alastorid wasps.

Locality: Jamberoo, N.S.W. January, 1949-50. Norman W. Rodd.

Meroglossa nigrifrons (Sm.).

(*Prosopis nigrifrons* Sm., Cat. Hym. B.M., i, p. 30, 1853.)

A series of males, and females larger than type, but otherwise typical.

Jamberoo, N.S.W. 20th January, 1950. Norman W. Rodd.

Both sexes on flowers of *Loranthus* sp.

Males (allotype) and females, typical.

Cheltenham, N.S.W., 16th April, 1950. Norman W. Rodd.

Both sexes sheltering in a gallery bored in an *Acacia* tree. The small chamber, 45 mm. long, with a diameter of 5 mm., was lined out with white silk, probably not woven by the bees.

Males, Typical.

Cowan, N.S.W. 30th August, 1947. Norman W. Rodd.

Allotype, Male—Length, 9 mm. approx Black, with yellow markings.

Head shining, very long, laterally a deep sulcus along anterior orbital margins; face-marks yellow, paler and leaf-like in the polished sulcus, but above the insertion of the antennae they terminate in a yellow dome, frons black, clypeus narrow, the yellow truncate at apex; the deep lateral grooves force th clypeus and the supraclypeal area up into a high narrow ridge; a small pale dot just under the scapes; vertex coarsely punctured; the deep narrow facial foveae curving to the lateral ocelli; compound eyes large, converging below; genea black, with black hair; a short fine yellow line along posterior orbital margin; labrum black, with a short median yellow bar; mandibulae black; antennae with expanded black scapes, flagellum black, obscurely red beneath.

Prothorax black, with many white hairs in a line, swollen laterally; tubercles butter-yellow, a much larger yellow mark posteriorly; mesothorax with a microscopic tessellation and many coarse large punctures; scutellum and postscutellum with large yellow areas; metathorax with an elevated area covered with coarse longitudinal rugae, sides of elevation with scale-like sculpture, but coarse punctures beyond; abdominal dorsal segments shining, with well-spaced coarse punctures, closer and finer on basal; ventral segments black, coarsely punctured, a few stiff long bristles apically; the basal sternite very small and partially divided.

Legs black, a few white hairs, chiefly on the femora, anterior tibiae with reddish on front; tarsi blackish-brown, with some smoky hair; claws bifid, dark-red; hind calcar black, finely serrated; tegulae black, anteriorly closely punctured; wings slightly dusky; long hairs; nervures blackish-brown; the large second cubital cell receiving both recurrents well inside the intercubiti; pterostigma large, blackish-brown; hamuli about eight.

Locality: Cheltenham, N.S.W. 16th April, 1950. Norman W. Rodd.
Cowan, N.S.W. 30th August, 1947. Norman W. Rodd.

Allotype in the collection of the author

Allies: By the deep caniculation of the "face" it approaches *M. eucalypti*, which has similar rugae on the metathorax, but much red on the mesothorax; *M. sculptissima* has the caniculation of the face, but scapes are ivory. (I had already written the specific description for a new species when the true association of the sexes was proved by the collector.)

Meroglossa xanthocollaris sp. nov.

Type, Female—Length, 7 mm. approx. Black with yellow marks on thorax.

Head long, black, tessellate sculpture; face with scattered shallow punctures; frons nude; clypeus black, sculptured like the frons; supraclypeal area somewhat aciculate; vertex with short facial foveae; compound eyes reniform; genae with a short malar area, a few shallow punctures; labrum black, with a tubercle; mandibulae black, bidentate; antennae black, flagellum ferruginous beneath.

Prothorax primrose-yellow, swollen laterally; tubercles yellow; mosothorax black, with a dull tesselate sculpture and a few shallow punctures; scutellum and postscutellum similar, without any yellow mark; metathorax short, with a scale-like sculpture; abdominal dorsal segments black, with a silky lustre, and an excessively fine transverse lineation, a few black hairs apically; ventral segments similar.

Legs slender, black, except the anterior femora and tibiae basally which are primrose-yellow, a few white hairs; tarsi black; claws reddish; hind calcar black; tegulae black; wings slightly fuliginous; nervures blackish; the large second cubital cell receiving both recurrents; pterostigma brownish-black.

Locality: Jamberoo, N.S.W. 20th January, 1950. Norman W. Rodd

Type in the collection of the author

Allies: Approaches *M. kelvini* Ckll. (8.5 mm.), which is smaller, and easily separated by the entirely black legs and coarse puncturing of the frons. The mouthparts cannot be examined, but it is almost certainly *Meroglossa*.

Taken on flowers of *Leptospermum flavescens* var. *grandiflorum*.

Family: HALICTIDAE.

Parasphecodes altichus Sm.

A male that conforms to Smith's description, except that the dark-red of the first tergum is almost obscured by a large black triangular mark; the second tergum has a still larger black area, so that the red is reduced to a mere lateral spot. The truncation of the metathorax has the carina of the type. Described from van Dieman's Land (Tasmania), but the altitude of Jamberoo probably offsets the difference in latitude.

Locality: Jamberoo, N.S.W. January, 1950. Norman W. Rodd.

On flowers of *Leptospermum flavescens* var. *grandiflorum*.

Two large golden mites, nymphs of a new genus and species of LAELAPTIDAE, were attached to the thorax. These will be described by Mr. H. Womersley, Adelaide.

Parasphecodes atronitens Ckll.

Four females, typical except for a tuft of creamy-coloured hair on the post-scutellum (not mentioned in the original description). This species is entirely black.
Locality: Jamberoo, N.S.W. January, 1950. Norman W. Rodd.
Taken on flowers of *Prostanthera lasianthos*

Parasphecodes fultoni Ckll.

Two females, typical in all characters.

Locality: Jamberoo, N.S.W. January, 1950. Norman W. Rodd.

Taken on flowers of *Leptospermum flavescens* var. *grandiflorum.*

Parasphecodes submeracus Ckll.

Three females, not quite typical, with considerable black colour on the third tergum.
Locality: Jamberoo, N.S.W. January, 1950. Norman W. Rodd.
Described from Stanthorpe, Queensland.
On flowers *Leptospermum flavescens* var. *grandiflorum.*

Parasphecodes tilachiformis Ckll.

Three males.
Locality: Jamberoo, N.S.W. January, 1950. Norman W. Rodd.
On flowers *Leptospermum flavescens* var. *grandiflorum.*

Parasphecodes percallomelittinus, sp nov.

Type, Male—Length, 9 mm. approx. Black and red.
Head black, almost circular from the front; face with much long white hair; frons excessively closely punctured; clypeus produced, with a large oval yellow mark with a pointed extension above; supraclypeal area black, coarsely punctured; vertex with scanty white hair; compound eyes reniform, converging below; genae lineate, with a few long white hairs; labrum black; mandibulae black; antennae very long, black.
Prothorax laterally produced to a large triangular node; tubercles black, with a copious white fringe; mesothorax black, with a median broad band of dull-red, excessively closely punctured, dull, a few white hairs (on some specimens the band is very short); scutellum red, closely punctured; postscullum red; metathorax black with a sharp rim, and a few large rugae more or less radiating; pleura black and rugose; abdominal dorsal segments black, shining, many large punctures, black hair apically, a light dusting of white hair; ventral segments black, shining, a few large punctures, light fringes of white hair.
Legs black, knees and a red line on anterior pair red; tarsi black, apical segment reddish; claws red; hind calcar amber; tegulae black, polished, punctate basally; wings subhyaline; nervures strong, blackish-brown, first recurrent meeting second intercubitus; second cubital cell contracted at top, higher than wide; pterostigma large, dark-brown; hamuli ten, strong.
Locality: Jamberoo, N.S.W. January, 1950. Norman W. Rodd.
Type in the collection of the author
Allies: Approaches *P callomelittinus* Ckll., which has much yellow on legs, polished red mesothorax, and red pleura.

Halictus leichardti Ckll.

Syns. *H. paracolletinus* Ckll., *H. scutellatus* Fr.

A series of large males and females, typical in all characters.
Locality: Jamberoo, N.S.W. 10th January, 1949-50. Norman W. Rodd.
Described from Mackay, Kuranda; Dunk Island, Queensland.
One typical female.
Locality: Woy Woy, N.S.W. January, 1933. J. Willey.
One typical female
Patonga, N.S.W. 26th January, 1947. Norman W. Rodd.
Taken on flowers of *Leptospermum flavescens* var. *grandiflorum.*

A DISPUTED SPECIES OF RARE BEE.

A series of females, and one male (allotype), definitely establishes an old species and a new record for the State.

When Cockerell, 1931, published his key to Australian species in the genus *Nomia*, he doubted the validity of Friese's species *Nomia flavo-punctata*, described from Mackay, Queensland, leg. Gilbert Turner. Taken on flowers of *Xanthorrhoea* sp. Cockerell concluded: "It is said to be known by the anterior corners of the thorax and the tubercles being thickly covered with yellow tomentum. This seems to me to be a *Paracolletes* of the type of *P. irroratus* Smith." The author has a series of both bees, and there is a superficial likeness, but that is all. The glossa of Friese's bee is long and acute; that of Smith's bee short and emarginate, and the structure of the metathorax is very different; there are, in fact, all the characters that separate HALICTIDAE from COLLETIDAE. It follows, then, that Friese's species is a perfectly valid one, but it is not *Nomia* sensu stricto. The radial cell is acutely pointed on the costal margin (obtuse in *Nomia*); the second cubital cell is often small and quadrate in both genera; the third cubital cell is short (long in *Nomia*); basal nervure often arched in both genera; there is a distinctive sculpture, rugose, on the metathorax.

Unfortunately, the author has only three females and one male from New South Wales, and they are larger than the type (7 mm.), but he refers them to *Halictus flavopunctatus* (Friese); when the two males are known they may be separated from the Queensland bee.

However, Friese's description is inadequate, and not readily available to students, and the species is now redescribed.

Halictus flavopunctatus (Perez et Friese) stat. nov.

Female—Length, 10 mm. approx. Black, with maculae of golden hair. Head circular from the front, bright, a few pale hairs; face with a few black hairs laterad of the clypeus; frons rugoso-punctate; clypeus prominently convex, a median sulcus, coarse scattered punctures, very shining; supraclypeal area convex, shining, rising to a fine carina that reaches the median ocellus; vertex with some smoky hair; compound eyes reniform, black; genae finely rugose, with blackish hair; labrum black, with a large median tubercle; mandibulae black; antennae black, flagellum dull ferruginous beneath.

Prothorax laterally, the anterior corners of the mesothorax, the tubercles, and a large patch posteriorly, all united to form a conspicuous macula of golden hair, felted, mesothorax with well-separated coarse punctures, the interval shining, a few blackish hairs; scutellum and post-scutellum similar, but the latter covered with a felting of moss-like golden hair; metathorax large. with a sharp rim, and a few longitudinal coarse rugae superimposed on a fine tessellation; abdominal dorsal segments finely and closely punctate, a few blackish hairs; caudal fimbria of smoky hair (in certain lights the abdomen has an obscure metallic-green sheen); ventral segments with a fringe of stiff black hair; anteriorly the segments are polished.

Legs black, with black hair, smoky on the trochanters and femora; tarsi black; claws reddish-black; hind calcar black, finely serrated; tegulae black, with a large polished area; wings dusky, nervures blackish, first recurrent meeting the second intercubitus; second cubital cell contracted a trifle at the top; the third cubital cell short (it is as long as the first in *Nomia* sensu stricto); pterostigma amber, suffused with blackish; hamuli ten, strong.

Allotype: Male, length, 10 mm. approx. Similar in colour.

The slender aspect is typically halictine. Head capsule circular when viewed from the front; the compound eyes converge sharply below; clypeus polished, highly convex, with the yellow subtriangular mark pointed apically; segments of the flagellum are very long, and clear ferruginous beneath.

Although neither the mouth-parts, nor the appendage of the labrum, or the genitalia could be critically examined, yet there is no doubt that these bees are *Halictus*, and not *Nomia*.

The scutellum is highly bituberculate; postscutellum with a dense tuft of golden hair; the large enclosed area of the metathorax has twelve or so coarse longitudinal rugae superimposed on a delicate sculpture; the anterior "corners" of the meso-thorax have the distinctive maculae of golden hair; pleura finely and transversely striate.

The elongate abdomen is only 2.5 mm. in width, and the long slender legs are not at all modified, but there is much blackish hair.

Locality: Jamberoo, N.S.W. January, 1950. Norman W. Rodd.

Specimens in the collection of the author

Allies: Not close to any described species The superficial aspect is that of *Paracolletes irroratus* Smith.

Taken on flowers of *Parsonia straminea*.

Sub-family NOMIINAE.

Nomia miranda, sp. nov.

Type, Male—Length, 11 mm. approx. Black, dark green abdomen.

Head black, closely punctured; face with a dense mat of long golden hair; frons closely punctured; clypeus convex, with a median depression, anteriorly pale-amber;

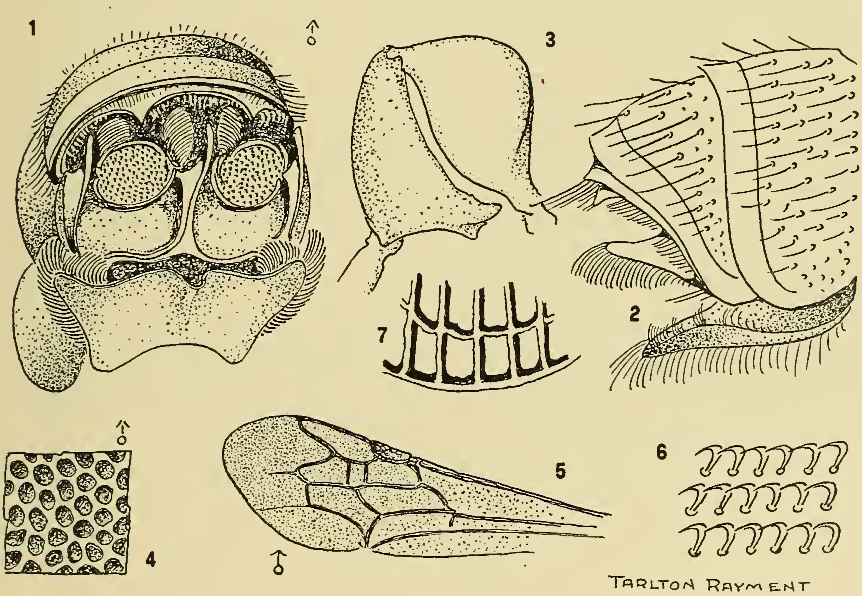


Fig. 3: Details of *Nomia miranda*, sp. nov.

1. Oblique view of apical ventral segments of male, showing the remarkable structure of the sterna.
2. Lateral view of apical segment of the abdomen.
3. Trigonal hind femur and tibia.
4. The interval of the coarse punctation of the mesothorax is smooth and shining.
5. Anterior wing; note the large third cubital and the quadrate second cubital cell.
6. The sense-organs of the sternum are difficult to observe, but they appear to be arranged in this order.
7. Position of the coarse rugae of the metathorax.

Tarlton Rayment del.

supraclypeal area rising to a fine carina reaching the median ocellus; vertex closely punctured, with some golden hair; compound eyes reniform; genae with shallow punctures, and long pale hair; labrum reddish-amber; mandibulae largely amber, blackish apically; antennae long, flagellum black, scape amber, short.

Prothorax black, laterally with much golden hair; tubercles black, with a fringe of white hair; mesothorax black, closely punctured, with long loose straw-coloured hair; laterally a maculae of whitish hair in the scutellar suture; scutellum conspicuously bi-tuberculate, with erect long black hair; postscutellum with denser whitish hair; metathorax with the area enclosed by a sharp rim, a number of coarse longitudinal rugae connected by a median transverse ruga, tufts of long white hair laterally; abdominal dorsal segments metallic greenish-blue; the posterior margins aeneas, with fasciae of golden hair, all closely punctured; only six segments visible, the seventh concealed by the structure illustrated in the text figure, dorsally there are many long coarse black setae; ventral segments polished green, the fourth excessively large, and bent down in a unique manner and developed laterally with two long white fringes.

The fifth sternum is polished with a large median black tooth directed apicad from a median carina, posteriorly are two large circular depressions densely covered with golden hooked setae forming some kind of sensory organ; laterad is a large tooth; the other apical segments cannot be examined since they are masked by the structure, but long white hairs project between the segments. It is impossible to describe adequately these unique sterna of the abdomen.

Legs black, with white hair, and when the triangular hind tibia is folded against the triangular femor, the outline is quadrangular; both are incrassate; tarsi black, white hair; claws bifid, reddish-amber; hind calcar small, amber; tegulae amber, with a large black area; wings deeply infuscated; nervures brownish-black, the first recurrent meeting the middle of the small second cubital cell, which is quadrangular; pterostigma brown, large; hamuli fifteen, well developed.

Locality: Jamberoo, N.S.W. 10th January, 1950. Norman W. Rodd.

Type in the collection of the author

Allies: Plainly near *N. australica*, but darker, and differs by the structure of the abdomen.

The sense organs of the sternum appear to be homologous with those on a male *Megachile remeata* Ckll. illustrated by the author in Victorian "Naturalist," January, 1950, and probably has some function in the congress of the sexes. The author again regrets that he has only the type insect, and the structure could not be critically investigated. The species will be confused with *N. australica* unless the sterna be examined critically.

Taken on flowers of *Leptospermum flavescens* var. *grandiflorum*.

REFERENCES.

Cockerell, T. D. A. (1931).—"Australian Zoologist," Vol. vii, Pt. I, p. 54.

Friese, H. (1911-17).—"Allgemeine Betrachtungen uber die Bienenauna Australiens," *Arkiv. fur Zoologi*, v, pp. 1-9.

Smith, F. (1853).—Cat. Hym. B.M., 1, p. 12.

MORE NEW FISH NAMES AND RECORDS.

By GILBERT P. WHITLEY, F.R.Z.S.

Curator of Fishes, The Australian Museum, Sydney.
(Contribution from The Australian Museum.)

Family DASYATIDAE.

Genus BATHYTOSHIA Whitley, 1933.

BATHYTOSHIA BREVICAUDATA (Hutton).

Trygon brevicaudata Hutton, Ann. Mag. Nat. Hist. (4), xvi, 1875, p. 317. Dunedin, New Zealand

"Sting ray" Anon., Journ. Voy. "Endeavour," London, 1771, pp. 112 & 116, and of later accounts of Cook's voyage. Sting Ray Bay, now Botany Bay, New South Wales.

Trygon thalassia Hutton, 1872; George, 1880, *non* Muller & Henle, 1841.

Trygon or *Dasyatis pastinaca* of Austr. authors, *non Raja pastinaca* Linne, 1758.

Trygon, Dasyatis or *Bathytoshia brevicaudatus* of Austr. authors.

Trygon schreineri Gilchrist, Trans. Roy. Soc. S. Africa, iii, 1913, p. 33 & fig. False Bay, South Africa

Dasybatis agulhensis Barnard, Ann. S. Afr. Mus. xxi, 1925, p. 78, Agulhas Bank, South Africa

Dasybatus latus Baughman, Copeia, 1946, 1, p. 43. Sydney. *Non Trygon lata* Garman, 1880.

This large stingray has been recorded from New Zealand, New South Wales, Bass Strait, South and Western Australia, and South Africa.

Two females were caught in the Cook Graving Dock, Sydney, on 27th November, 1952, and transferred to Taronga Park Aquarium. One died and had no embryos in her. The other, about 9ft. long and 6ft. wide, gave birth to eight young during the night of 9/10 March, 1953, 102 days after being placed in captivity. Mr. D. Boness, of the Aquarium staff, told me that the water was milky with fluid from the mother the next day. The young were dead when found in the morning, light grey in colour (post-mortem effect), and had barbs pointed, not sheathed, and had no umbilical cords, so they were probably overdue. The total weight of all the embryos was 22½lb. There were three males and five females, all the females being larger than the males. The largest female was 25in. in total length (snout to end of tail) by 14¾in. wide and weighed 3½lb. The smallest male was 22½in. in length, 12in. wide, and weighed 2½lb.

Apart from Seymour George's notes (Trans. N.Z. Inst. xiii, 1880, p. 426) of a New Zealand female which gave birth to at least three young in March, 1880, the above seems to be the only note of birth, sex-ratio of embryos and number in litter in *Bathytoshia brevicaudata*, and I am indebted to Mr. Boness for his observations. In my "Fishes of Australia," i, 1940, p. 210, I noted from the Manly Aquarium, Sydney, that the allied species, *B. thetidis*, gave birth to two young, 23½ by 13 inches, with no umbilical scar, barb protected by a bulb, and dorsal fin present. That birth was in November, 1939.

Family AMIIDAE.

PSEUDAMIATUS, gen. nov.

Orthotype, *Pseudamia heintzi* Lehman = *Pseudamiatus heintzi*. New name for *Pseudamia* Lehman (Tromso Mus. Aarsheft Naturh. (39), vol. 70, 1951, p. 5), preoccupied by *Pseudamia* Bleeker, Nederl. Tijdschr. Dierk. ii, 1865, p. 284, another genus of fishes.

Family PALAEONISCIDAE.

STEREOLEPIDELLA, gen. nov.

Orthotype, *Stereolepis marginis* Casier—*Stereolepidella marginis*.

New name for *Stereolepis* Casier Bull. Inst. Roy. Sci. Nat. Belg. 28, 1952, p.47), preocc. by Ayres, Proc. Calif. Acad. Sci. ii, 1859, p. 28, another genus of fishes.

Family MURAENIDAE.

Genus NOTOROBULA Whitley, 1934.

NOTORABULA CALLORHYNCHA (Gunther).

(Plate iii. Fig. 1.)

Muraena callorhyncha Gunther, Cat. Fish. Brit. Mus. viii, 1870, p. 122.

Rabula callorhynchus Ogilby, Proc. Roy. Soc. Qld. xx, 1907, p. 11.

Notorabula callorhyncha Whitley, Rec. Austr. Mus. xix, 1934, p. 154.

I am indebted to Mr. A. Fraser-Brunner for the accompanying illustration of the unique holotype in the British Museum (Natural History), from Fremantle, Western Australia.

Family ISTIOPHORIDAE.

Sub-family MARLINAE.

Genus ISTIOMPAX Whitley, 1931.

Makaira Lacepede, Hist. Nat. Poiss. iv, 1803, p. 688. Haplotype, *M. nigricans* Lac. (pl. xiii, fig. 3, opp. p. 537) from near La Rochelle, France. Emended to *Machaera* by Cuvier, 1832, and Agassiz, 1846 (*non* Gould, 1841).

Marlina Grey, Natural History (N. York), xxviii, 1928, p. 47. Haplotype, *Tetrapturus mitsukurii* Jordan & Snyder, Journ. Coll. Sci. Imp. Univ. Tokyo, xv, 1901, p.303, pl. xvi, fig. 5, from Japan. The Striped Marlin.

Istiompax, Whitley, Austr. Zool. vi, 1931, p. 321. Orthotype, *I. australis* (Wall) from New South Wales. The Black Marlin.

Kajikia Hirasaka & Nakamura, Bull. Oceanogr. Inst. Taiwan iii, 1947, p. 11. Logotype, *Tetrapturus mitsukurii* Jordan & Snyder, by present designation. A synonym of *Marlina*, the Striped Marlin.

Marlina Hirasaka & Nakamura, *op. cit.*, p. 15. Haplotype, *Makaira marlina* Jordan & Evermann, Occas. Pap. Calif. Acad. Sci., xii, 1926, p. 59, pl. xvii, from Mexico, a Black Marlin. Preocc. by *Marlina* Grey, 1928, which is probably at least subgenerically distinct.

Eumakaira Hirasaka & Nakamura, *op. cit*, p. 16. Haplotype, *E. nigra* H. & N., from South China Sea and Japan Current.

Makaira is unrecognisable, and *Marlina* Grey and *Kajikia* are doubtful synonyms of *Istiompax*.

ISTIOMPAX HOWARDI, sp. nov.

(Plate iii. Fig 3.)

A fine immature female marlin swordfish, over 11 ft. long and weighing 402 lb., was taken off Bermagui, New South Wales, in March, 1953, by Colonel John Howard, who generously presented it to the Australian Museum, where a cast of it is being made for exhibition. It does not exactly fit any described species, and seems, from authors' keys, to be intermediate between several nominally distinct forms, whilst retaining enough characteristics of its own to warrant the bestowal of a new name.

Diagnosis.—A marlin with general characters of the Black Marlin (*Istiompax australis* and allied species), but with depressible pectoral fins and bluer colouring above; it has a narrow rostrum, a long ventral skin-groove, and the rather low anterior profile of the Striped Marlin (*Marlina mitsukurii* and allies), yet it has a deeper body than a Striped Marlin, without light bands, and without the elevated first dorsal fin. The first dorsal fin has large dark spots, and the posterior spines are short. Vertebrae 11+13=24. Body robust, not compressed, its depth less than one-fifth of total length. Lateral line indistinct. Spinous dorsal lobe lower than depth of body. Ventral fins much shorter than the long, low pectorals.

Description.—Br. 7, D.xl/7; A.xvi./7; P.1,21; V.1; C. more than 20, General facies as usual in marlins; the proportions can be ascertained from the figure and the dimensions given below. Sword 4.6 in length to caudal fork

Dimensions in inches.

Total length—133.
Length to caudal fork—122.
Girth—52.
Snout to tail base—114.
Breadth of sword above lower jaw—2.
Tip of snout to ant. border of eye—$26\frac{1}{2}$.
Snout, tip to maxillary border—$32\frac{1}{2}$.
Body depth—$20\frac{1}{2}$ below first dorsal or 19 above first anal.
Head—42.
Eye—$2\frac{1}{2}$.
Interorbital—$7\frac{1}{2}$.
Postorbital—$12\frac{5}{8}$.
Lower jaw—14.
Maxillary fold—6.
Eye to preop. margin—$7\frac{1}{2}$.
Spread of tail—42.
Level of second dorsal and anal origins to middle caudal rays—25.
Caudal lobe—$27\frac{1}{2}$.
Caudal keels—$3\frac{1}{2}$.
Minimum depth of caudal peduncle—$4\frac{1}{2}$.
Length of caudal peduncle—$11\frac{1}{2}$.
Height of first dorsal fin—15.
Height of second dorsal fin—4.
Base of second dorsal fin—$5\frac{1}{2}$.
Last ray of second dorsal fin—$5\frac{1}{4}$.
Median dorsal spines—$2\frac{1}{2}$.
Height of first anal fin—14.
Origin of pectoral to that of anal—$36\frac{1}{2}$.
Pectoral fin, length—$21\frac{3}{8}$.
Pectoral fin, base—$2\frac{1}{2}$.
Ventral fin, length—$7\frac{1}{2}$ (incomplete).

Upper jaw (sword) straight, slightly flattened above, rounded and granular below. Profile evenly elevated, not so steep as in Black Marlin *(I. australis)*. Very small teeth on jaws, vomer, palatines and tongue. Free end of tongue convex. Few scales on sides of head, cheeks and temples, none on eye. Gills reticulate, without rakers; a slit behind the last.

Form robust, rounded, not compressed. No rugose area behind operculum. A groove extends from behind first dorsal sheaths along most of the short inter-dorsal area. A more pronounced median groove along the belly from behind ventral fins to near anal. Scales rhomboid, slender, closeset or imbricate, subdermal. Lateral line indistinct. Caudal peduncle almost elliptical in transverse section, with two fleshy keels on each side.

First dorsal fin lower than body, its margin concave and posterior spines very short. The 30th and 32nd dorsal spines may be missing, as there are long membranes where these might have occurred after the 29th spine; if so, the dorsal formula would have been xlii/7. First anal lobe acute, rounded. Insertion and end of second dorsal in advance of levels of those of second anal. Pectoral very long, adpressible, reaching more than halfway to anal, its insertion low, level with lower jaw. Ventrals narrow and short, with fused rays.

The stomach contained unidentifiable fish bones. The sausage-like roes ran most of the way along the coelome, but were not ripe. Air-bladder with more than one row of vescicles. Flesh reddish to pink, of edible quality, but rather "dry" to taste. No internal parasites noticed, but some *Caligus* external to shoulders.

Colour in life, blue above, with very indistinct bands from some aspects. After freezing, generally bluish to gunmetal grey, a ragged line of junction between the dark upper and silvery lower parts of sides. No light or blue area on first dorsal fin, which is uniform dusky with large, darker, round spots, perhaps originally blue. Pectoral grey. No cross-bars on body.

Described and figured from the female holotype, 11 ft. 1 in. long and weighing 402 lb., taken off Bermagui, New South Wales, early in March, 1953, by Colonel John Howard.

Australian Museum regd. No. IB.2924. Cast and portions preserved. Differs from other marlins as described, especially in proportions, colour, depressible pectorals, ventral skin-fold, and maxilla not far behind eye.

The accompanying figure has been reduced to a total length of 12 cm. (i.e., about one-twenty-eighth natural size) for direct comparison with Gregory and Conrad's graphed typical body-forms of marlins (Bull. Amer. Mus. Nat. Hist. lxxvi, 1939, pp. 443-456, fig. 1). It agrees best with their Blue Marlin, but differs in having anal base farther back in relation to second dorsal base, and in its less tapering thorax. Could Colonel Howard's fish be, as he himself suggested, an old female striped marlin? The differences between it and Australian striped marlins seen by me appear to be the comparatively shorter sword, lower dorsal lobe, and more posterior insertion of the second anal fin.

The description of *Makaira nigricans tahitiensis* Nichols & LaMonte (Amer. Mus. Novit. 807, 1935, p. 1, fig. 1), the Silver Marlin of Tahiti, since said to range to western Mexico, differs in proportions from the Bermagui marlin.

The so-called "Black Marlin" known as "Boydtown Ben," 1,226 lb. in weight, washed ashore at Eden, New South Wales, may have been a Howard's Marlin, which species rather than the black would thus be the giant marlin of eastern Australia.

Mr. Peter Goadby caught what appears to be a young example of this species, about 5 feet long and 25 lb. weight, at Hayman Island, Queensland, in May, 1953. The middle dorsal rays were long, also the ventral fins.

ISTIOMPAX DOMBRAINI, sp. nov.

"Blue Marlin?" D'Ombrain, Outdoors and Fishing (Sydney), Oct., 1950, p. 24, 5 figs. Off Port Stephens, New South Wales.

Resembles the Black Marlin, *I. australis* (Wall, 1854), in most characters, and in having pectoral fin rigidly extended, not adpressible along body, and dorsal lobe not much elevated, but has a thinner and more tapering sword.

When first caught has distinct pale blue bars on upper part of body and a very marked blue patch near pectoral fin (sometimes with another patch behind it on lower side of thorax). It has more numerous large, cobalt-blue spots all along the spinous dorsal fin than is customary in Black Marlin. Most specimens weigh less than 150 lb., but some reach 200.

Named after Mr. Athel D'Ombrain, of Newcastle, New South Wales, the well-known naturalist, who has taken specimens of this fish and provided me with photographs and data from the type-locality, off Port Stephens, New South Wales.

Mr. Peter Goadby has taken this species in southern Queensland, having seen 22 fish in February, 1951, near Hutchison Shoals, off Cape Moreton. In black-and-white photographs it usually has more "white" of eye than other marlins.

Family SCORPAENIDAE.

Sub-family PTEROIDICHTHYINAE.

Genus RHINOPIAS Gill, 1905.

Rhinopias Gill, Proc. U.S. Nat. Mus. xxviii, 1905, p. 225. Orthotype, *Scorpaena frondosa* Gunther, Proc. Zool. Soc. Lond., 1891, p. 482, pl. xxxix, from Mauritius.

Peloropsis Gilbert, Bull. U.S. Fish. Comm. xxiii, 1903, 2, publ. 5 Aug., 1905, p. 630. Orthotype, *P. xenops* Gilbert, from Hawaiian Islands. *Rhinopias* is earlier. published 23 Feb., 1905.

Pteropelor Fowler, Proc. U.S. Nat. Mus. lxxxv, 1938, pp. 51 and 77. Orthotype, *P. noronhai* Fowler, from near Hong Kong, China.

Pteropelor is evidently a synonym of *Rhinopias*, named 33 years earlier in the same publication. There are four species of this rare genus, distinguished by their proportions, size of supraocular and other tentacles, fin-counts, and naked or scaly breasts.

RHINOPIAS GODFREYI, sp. nov. (Plate iii, Fig. 2.)

Br. 7. D.xi,10; A.iii,6; P.14; V.i,5; C.11? (damaged, reconstructed in figure). Sc.24. L.lat.5. Tr.4/12.

Head (21 mm.) 2.3, depth (16) 3 in standard length (49). Eye (4.5) 4.6 in head. Interorbital (4) 2 in snout (nearly 8). Maxillary, 10; upper caudal rays, about 18; predorsal length, 16; and ocular tentacle, 14 mm.

Maxillary reaches below eye, its truncate expansion equals interorbital. Bands of small acute teeth in jaws and on vomer, none on palatines. Interorbital deeply concave. Gill-openings very wide, separated by keel-like isthmus, behind which is a small, branched, median skinny flap. No opening behind last gill-arch. No barbels. Snout rising obliquely to a bump before the preocular concavity in the profile. Nostrils large, with branched flaps (less than diameter of eye) and small spines on each side. Supraorbital spines obsolete. Very small coronal spine on each side, then occipital and nuchal spines close together. Three postocular spines followed by suprascapular; preorbital spine small, directed a little backward. Suborbital stay with four spines. Three spines and two skinny flaps around preopercular edge. Two divergent opercular spines, the lower the longer. Humeral spine obsolescent. Eyes moderate, surface with lappets; supraorbital tentacles enormous, fimbriate. A large flap overhangs maxilla.

Most of head and an area of body above pectoral base naked. Breast scaly. Body compressed, its width near the gills (7 mm.) less than half its depth. Scales imbricate, cycloid, some with small papillae or fleshy flaps. Lateral line reduced to about five tubes anteriorly, sloping down axially, and with the tubes long, slender and exposed.

Dorsal fin originating well behind eye, over operculum, its anterior spines long and with excavate membranes, becoming smaller, weaker and united at the notch; soft dorsal rounded, higher than spinous. Anal similar to soft dorsal. Pectoral base on lower half of fish, its rays all simple, the longest reaching about anterior dorsal and anal rays; lowermost rays not detached as feelers, though their membranes are well incised. Ventrals originating behind level of first dorsal origin, joined to body but not to one another.

Brown, obscurely clouded and mottled with blackish, darkest on supraocular tentacles and some fins, notably the anal. Some small whitish spots on head and along back, and more distinctly along front ventral and anal spines and rays. Larger irregular white areas on pectoral and dorsal fins. No notable axillary pattern.

Described and figured from the unique holotype of the species, 49 mm. in standard length or about 2.6 inches overall. Australian Museum, Regd. No. IB. 2977.

Loc.: Exmouth Gulf, north-western Australia; prawn trawl from M.V. "Lancelin," 3rd August, 1952. Collected and presented by Mr. Kitchener Godfrey, of C.S.I.R.O. Division of Fisheries,, to whom I am grateful for assistance in collecting and studying tropical Australian fishes, and after whom this novelty is named.

Rhinopias godfreyi differs from *R. frondosa* (Gunther) in having slenderer form, fewer flaps, one more anal ray, fewer and slenderer pectoral rays, and has no large white spots. It differs from *R. noronhai* (Fowler) in lacking supraorbital spines and having enormous supraocular tentacles, breast scaly, and minor proportional differences.

From *R. xenops* (Gilbert), the new species is distinguished by its high supraocular tentacles, lower spinous dorsal fin, slenderer caudal peduncle, fewer pectoral rays, and obsolete supraorbital spines. A *Rhinopias* has been figured in colour by Deraniyagala (Atlas Vertebr. Ceylon i, 1952, p. 109, pl. xxxii), who found it in a hollow in a lump of dead coral from Ceylon.

Family ALEUTERIDAE.

Genus AROTROLEPIS Fraser-Brunner, 1941.

AROTROLEPIS NOTONECTIANUS (Whitley).

Monacanthus filicauda notonectianus Whitley Austr. Zool. vi, 1931, p. 330, and fig. Maroubra and Coogee, New South Wales.

Arotrolepis notonectianus Fraser-Brunner, Ann. Mag. Nat. Hist. (11) viii, 1941, p. 184.

Arotrolepis filicauda notonectianus Marshall, Ichth. Notes ii, 1953, p. 60 (Redcliff, South Queensland).

The stranding of many thousands of dead and dying leatherjackets of this species along the ocean beaches of eastern Australia in February, 1953, aroused much interest. On the 14th February, fishermen reported that many of these fishes were coming to the surface several miles from the coast of New South Wales from about Newcastle to Long Bay, and by the 27th at the latest they had also been recorded from Ulladulla and other places as far south as Pambula; on the 6th March Mr. John G. Johnson aboard s.s. "Bundaleer" abeam of Gabo Island light collected some others. Thus a species hitherto known from a couple of bottles of Museum specimens was shown to exist in untold thousands, from south Queensland to Victoria.

At the same time there was an epidemic amongst the allied northern species, *A. filicauda* (Gunther), for the same Mr. J. G. Johnson brought me examples from thousands of surfaced dying fish encountered at the end of February from 50 miles north to 50 miles south of High Peak (S. Lat. 22°), between the Percy Group and North Reef, Queensland.

All were obviously sick fish, would not take food, quivered, had much difficulty in balancing and swimming, and had blister-like pustules, full of a milky fluid, in the body-cavity. The fluid, under a high-powered microscope, was seen to be full of countless numbers of sporozoa, evidently the cause of the mortality. For references to diseases caused by sporozoa, see Dean's Bibliography of Fishes iii, 1923, pp. 548-549, wherein similar symptoms are noted.

I have noticed small batches of *A. notonectianus* washed up on the ocean beaches near Sydney in previous years, from January to March, some times as late as May, but in 1953 the number of fish killed reached epidemic proportions. No other species of local leatherjacket or other fishes were affected. The mortality was at first attributed to gunnery or depth charges, but the Royal Australian Navy denied responsibility ; other "explanations" proffered at the time were merely fanciful or guesswork.

Family TRIURIDAE.

Genus TRIURUS Lacepede, 1800.

TRIURUS LAEVIS (Pennant).

Ostracion laevis Pennant, Brit. Zool. iii, 1776, ed. 4, p. 129, pl. xix, fig. 54, Plymouth, England.

Triurus laevis Whitley, Mem. Qld. Mus. xi, 1937, p. 147 (q.v. for refs. to syn. and bibliogr.). *Id.* Hale, S. Austr. Nat. xxii, 4, 1914, p. 1 and fig, (S, Australia),

Ranzania truncata Raven, Amer. Mus. Novit. 1038, 1939, p. 1 and figs. (W. Australia—anatomy and refs.). *Id.* Oliver, Rept. Mus. Wellington, N.Z., 1941, p. 8 (Kermadecs).

Ranzania laevis Phillips, Proc. Roy. Soc. N. Zeal. lxxi, 1941, p. 245, fig. 6 (Kermadecs and New Zealand) *Id.* Anon., "West Australian" (newspaper), 22nd May, 1947 (W. Australian occurrences). *Id.* Powell, Native Anim. N. Zealand, 1947, p. 73, fig. 344. *Id.* Fraser-Brunner, Bull. Brit. Mus. Nat. Hist., Zool. i, 6, 1951, p. 93, figs 3-5.

Triurus truncatus Fowler, Proc. Acad. Nat. Sci. Philad. xcvi, 1944, p. 199, and Mem. Bish. Mus. xii, 1949, p. 158 (New Hebrides).

"Strange Fiji Fish," Anon., "Weekly News" (Auckland, N.Z.), 24 Sept., 1952, p. 37, 2 figs. (Near Suva, Fiji.)

"Oblong Sunfish," Anon., Anglers' Digest (Sydney), Nov., 1953, p. 137, fig. (Vila), New Hebrides.

Mr. Eric A. Nicholson, of the Clarence Valley Field Naturalists' Club, sent an Oblong Sunfish to the Australian Museum from Mulloway, north of Woolgoolga, New South Wales (about 30° S. Lat.), where it had been taken in shallow water by a boy, David Featherston, early in March, 1953. It was slightly less than one foot long and 2 lb. in weight. The clavus has 18 rays.

A sketch of another specimen washed up at Shelly Beach, Cronulla, was sent to me by Mr. John Merton.

New record for New South Wales.

The above references bring my 1933 and 1937 bibliographies of this species up to date as far as Australasia and Oceania are concerned.

EXPLANATION OF PLATE III.

Fig. 1: Eel, *Notorabula callorhyncha* (Gunther). Fig. 2: Scorpion Fish, *Rhinopias godfreyi* Whitley. Fig. 3: Marlin, *Istiompax howardi* Whitley.

CUTTLE-FISH "BONES" AGAIN.

By TOM IREDALE.

(Plates iv-v.)

Since my initial venture into the determination of Eastern Australian Cuttlebones, an accession of much material from North and Western Australia has accrued through the enthusiasm of my colleague, Mr. Gilbert Whitley, and my friend, Mr. Melbourne Ward, famed as a crustaceologist. These two, wherever they were, collected cuttlebones, and have provided a good basis for future work on the Australian forms. With Whitley and Ward, I have collected along the Queensland coast and the Great Barrier Reef, and Whitley has collected in Tasmania and Western Australia as well, the bulk of the material here studied being due to his efforts. Mr. Ward collected a nice series at Melville Island, Northern Territory adding a new group to our fauna, a very important one, the genus *Sepiella*. Through Mr. Whitley's collections at Shark's Bay, Western Australia, the puzzle of the miscalled *latimanus* has been solved. Since I wrote, Mr. B. C. Cotton, of the South Australian Museum, has reported upon the Southern forms, ranging from Victoria to South-west Australia, while the Victorian forms have been listed by Miss MacPherson and Mr. Chapple with the aid of the collections of Mr. Allen Carter.

Cuttle-fishes have been described as "littoral," but while they are undoubtedly local, and agree in general with the distribution of littoral mollusca, these animals are met with in the dredge in depths up to one hundred fathoms. Numbers may be secured in a single trawling, and, while the majority may in some cases be of a single species, as many as half a dozen species have been sorted out of one haul, and varied sizes of the one species from small to large may occur together.

Very little is known about the animals, accounts of the superficial examination of the external characters being given, but these are of little significance, save the sucker construction, and the character of the suckers on the clubs of the tentacles. The "bone," however, is very distinctive, and with a little study can be utilised for the separation of species and higher groups, and use of the latter will enable determination of any species, which otherwise may prove difficult. As above noted, the species are local, and thus errors of identification easily suggest themselves. The Southern Australian, that is, extra-tropical Australian, forms have a restricted range, though the tropical ones may be more widely distributed. This, however, is in doubt, as the greater range accredited to the latter may be due to faulty determination. World distribution is curious, as no species occurs in the New World (only two doubtful records exist from the Caribbean Sea), while the Pacific Ocean east of Fiji seems to lack any records; the case of New Zealand will be noted hereafter. From Japanese waters a large number of species have been recorded, and from the Moluccas there seems to be almost as many, but in the latter locality little systematic collecting has taken place.

As previously recorded, it is possible that some "bones," here regarded as merely variations, may, from animal examination, prove to belong to distinct species. The variation in growth with age may differ in apparently closely related species, and this may be seen in animals, but so few animals, in comparison with bones, have been yet criticised. Animals are still being acquired with the hope of providing some stable means of determination, but at the present the bones are the only sure means of differentiation.

It will be noted throughout this paper that Mr. G. P. Whitley has collected more than all the rest of us, and now he has generously provided the illustrations, without which this essay would have had very little value. My thanks are sincerely rendered for his interest in this intriguing group, as he has collected series of both large and small specimens, and the conclusions, here recorded from their study, will be found to be stable when the animals are treated in as much detail.

CLASS CEPHALOPODA.

Cuttlefishes belong to a large class of curious molluscan forms, including the Octopus-like creatures and Squids. Some of the latter are of huge size, a large body with longer tentacles, but Cuttlefishes are mostly small animals. The Cephalopoda are divided into orders, one of which, the Dibranchia, includes the abovementioned animals. This order is again subdivided into two series, one of which produces eight tentacles, commonly called arms, such as the Octopus; the second, in addition to the normal eight, has developed two much longer, which are retractile, and are used to capture prey by sudden propulsion, making ten in all, as in the Squid and Cuttlefish. These sections were very early discriminated and given sectional names, as the latter two have also developed an internal "backbone" of horny or shelly formation. The names selected were the obvious ones, Octopoda and Decapoda, the "poda" meaning feet, though arms is the word used now. An objection was raised almost simultaneously, and the names, Octocerata and Decacerata, were selected, the "cera" indicating tentacles. As an alternative pair, Polypacea and Sepiacea, were suggested, the very ancient name of the Octopus being Polypus, while Sepia had been also used about the same time for the Cuttlefish and Squid. At the time anyone could introduce names, without any regulations, so another worker added Anosteophora and Sepiaephora for the same two divisions. The names Decacerata and Octocerata were amended to Decacera and Octocera, and the latter pair were used by accurate workers, one reason being the use of Decapoda for a Crustacean group, which had been proposed before the time of the Molluscan Decapoda. Another proposal was Enterostea for the group, Octopoda being retained for the Octopus series. Then still another couple of names was invented, Sephinia and Octopia, the former probably a misprint. All these proposals were published more than one hundred years ago, and the Decapoda or Decacera with Octopoda or Octocera gained usage. Perhaps someone may unearth some other combinations as these sectional names have not been listed as have the generic and specific names, and have been ignored by the law-givers. There would have been no need to recapitulate all these unfortunate mishandlings of the groups had not, twenty years ago, another innovation been added to the long list, Decembrachiata and Octobrachiata, to provide further confusion. This novelty has been used by some recent writers unaware of the facts given above.

For easy reference the propositions are listed below—

1817 Decapoda and Octopoda Leach (Decapoda antedated by the use of Decapoda by Latreille in 1806 for a Crustacean group).
1818 Decacerata and Octocerata Blainville.
1818 Sepicea and Polyacea Blainville.
1821 Sepiaephora and Anosteophora Gray.
1824 Decacera and Octocera Blainville.
1827 Enterostea and Octopoda Berthold.
1830 Decacera and Octocera Menke.
1849 Sephinia and Octopia Gray.
1882 Decacera and Octopoda Verrill.
1890.1902 Decacerata and Octocerata Verrill.
1932 Decembrachiata and Octobrachiata Winckworth.

Apparently the correct name (if Decapoda be rejected) would be Decacerata, but there seems no reason for the rejection of Octopoda, save that of uniformity, in which case Octocerata would come into use.

The earlier references before 1847 will be found in Herrmannsen's Indicis Gen. Malacozorum; the later ones: Sephinia and Octopoda Gray, Cat. Moll. Brit. Mus., Pt. 1 Cephal., p. 2, 1849; Decacera Verrill, Trans. Connect. Acad. Vol. VI, pt. 2, p, 426, 1882; Decacerata and Octocerata Verrill in Webster's International Dictionary 1902, probably in 1890 edition; Winckworth, Journ. Conch., Vol. 19, pp. 248-251, 1932. It may be noted that Octobrachidés and Decabrachidées are also credited to Blainville by Orbigny, but no latinization has been seen.

Solitosepia liliana Iredale.

This was figured and described (15), and proved to be unmistakeable, and so far restricted to the East Coast of Australia. It has been found all along the coast of Queensland as far north as Low Isles, and southward on the New South Wales coast to Eden. There seems little geographical variation, though the far northern "bones" seem to the eye a little narrower. As to sexual variation, it is not determinable in the "bones," and little is seen to attract attention. The growth stages are of interest, as at about 15-20 mm. all the adult features are recognisable. The very young are however, a little different in shape, lacking the spine, but otherwise show all the specific characters, and the latter remark applies to all the Australian species, which can be easily determined at any stage above 10 mm. in length, and most of them even below that size. The average size was 90 mm. by 45 mm., with the type 114 mm. by 51 mm., the largest one 138 mm. by 65 mm.; it may be noted that the variation is small, and that rarely, as in the instances cited, does the proportion of breadth to length differ much from 1 to 2. A series collected recently varied from 19 by 12, 34 by 19, 53 by 26, 56 by 26, 65 by 30, 64 by 33, 80 by 40, 93 by 46, 100 by 50, 102 by 48, to 109 by 54 mm. Specimens from Northern Queensland range from 38 by 20, 56 by 30, to 82 by 39 mm., while one from Eden, Southern New South Wales, measures 119 by 58 mm.

Solitosepia mestus Gray.

Figured (15) and described (10), the type had been previously figured (13), this is again a distinctive "bone" with a range apparently similar to that of the preceding, reaching into North Queensland, and as far south in New South Wales as Eden, reappearing at Lord Howe Island. At the northern localities, it is however a much scarcer "bone," while only one "bone" has been received from Lord Howe Island. The variation is a little more marked than in the preceding, and there may be more sexual variation, but again this is not seen easily in the "bones." It must be remembered that the "bones" are susceptible to fracture when the animal is alive (how, it is not known), but so many cases are met with that "bones," disagreeing with the mean, must be at once critically examined for fracture, which can be usually recognised. Thus an extra narrow *mestus*, 82 mm. by 29 mm., showed only slight signs of fracture, but the spine was shortened, thickened directly ventrally and split, indicating some mischance in life. The type was 71 mm. by 30 mm., an average specimen, but, by some error, in my first paper the dimensions were all given wrongly, reading "40 by 18 mm. Average specimen figured, 57 by 21 mm." As noted above, the average would be about 70 mm. by 30 mm.; three broad specimens, one from Manly, 92 by 39 mm., another from Eden, the farthest south, 87 mm. by 37 mm., and the third from Bribie Island, Queensland, 90 mm. by 40 mm. The ordinary range of growth reads: 24 by 12, 40 by 18, 55 by 24, 63 by 25, 69 by 27, 90 by 30, 75 by 30, 78 by 34, and 81 by 34 mm., and it should be noted that the broadest part varies in position, sometimes the outer cone being more expanded, and the last loculus lessened. Close to the edges of the last loculus may sometimes be discerned a faint irregular depressed line following the margin but not exactly parallel to it. The significance of the line is not yet known. In the middle of the last loculus there is a depression in the medial line. These features occur in most specimens, more or less marked, throughout the group.

Solitosepia submestus Iredale.

This was described and figured from the Capricorn Group (16), and has been since found in various forms throughout Northern Australia, and distinction of the forms will depend on study of the animals. The Queensland form has been found along the coast of Queensland and the Great Barrier Reef, but a species was called *papuensis* (12) from Station 188 of the "Voyage of the Challenger," the locality being given as Arafura Sea, Lat. 139° 42' E., Long. 9° 59' S., and this point is inside the area fixed as the waters of Queensland in 1877. This may intergrade, but more specimens from intervening localities are necessary. From Western Australia, a "bone" was called *galei* (20) from Shark's Bay, and another, *occidua*, (6), from Rottnest Island. These are of the same type, but the Western Australian form, *galei*, must be accepted at present, *occidua*, however, falling until animals are examined. The "bones" found in the southern part of Western Australia do not appear separable from the Shark's Bay series, though the variation in this species is puzzling. Thus a series from near Bundaberg, Queensland, collected by Mr. and Mrs. R. Page, which initiated this review, is very constant, varying in length from 74 to 89 mm., and in breadth from 28 to 32 mm., the ratio of increase of growth being very regular. The size of the type of *submestus* was given as 68 mm. by

24 mm., and this was the largest at the time, but several longer, as given above, have since been found. Many small specimens, measuring 24 mm. by 9 mm., 24 mm. by 10 mm., and so on, occurred in Queensland waters, but a strange specimen, apparently referable to a distinct species, was secured at Low Isles; this measured 99 mm. by 37 mm., but, in addition to its greater breadth, it was dark coloured and coarsely pustulose, all the other Queensland bones being pale and finely pustulose, and definitely narrower. This may be named *Solitosepia lana* sp. nov. The figure of *papuensis* measures 64 mm. by 22 mm., a narrow form, but Melville Island specimens measured 64 mm. by 23 mm., 68 mm. by 24 mm., 70 mm. by 24 mm., and 71 mm. by 24 mm. The type of *galei* from Shark's Bay, Western Australia, measured 80 mm. by 27 mm. by 7 mm. thick, still narrow, and specimens from that locality range from 38 mm. by 13 mm. up to 110 mm. by 37 mm., the inner cone being consistently narrower than in eastern bones. The type of *occidua*, from Rottnest Island, measured 48 mm. by 19 mm. by 4.5 mm. thick, and a bone collected by Whitley at Garden Island measures 49 by 19 mm., others reaching up to 68 mm. by 26 mm., the inner cone being narrow as in *galei*, and these cannot be separated. As for the consideration of these allied forms, it seems best to admit the named forms, *submestus*, *lana*, *galei* and *papuensis*, as species, in the super-species or group of *papuensis*. The distribution will then read: *Solitosepia papuensis*, from the Arafura Sea, probably at Melville Island and mayhap through Torres Strait; also along the southern coast of New Guinea as far east as the Louisiade Archipelago. *Solitosepia galei*, along the coast of Western Australia from Broome to Rottnest Island, the latter locality the source of *occidua*, which is here regarded as synonymous. (Note: All synonymous names from different geographical areas are in doubt. *Solitosepia lana*, from Low Isles, Queensland, a similar type of bone, but so peculiar as to suggest different animal characters; and *Solitosepia submestus*, described from South Queensland, and ranging northwards up to Low Isles, sometimes all small bones being secured, at others all large, so that possibly two species are confused.

Solitosepia genista sp. nov. Plate V, Figures 17-18.

Whitley collected some bones at Broome, Western Australia, and these were placed with the *galei*, until it was noticed that two species were confused, some bones being *galei*, but others, longer and narrower, represented a new species to Australia. It recalled *singaporensis* (22) from Singapore, but upon comparison it was seen to differ. It is more like the narrow *papuensis*, but the inner cone is not produced: the bones of *galei* occurring with it are typical. The type measures 67 by 23 mm., others varying from 46 by 16, 59 by 23 to 69 by 22 mm., indicating a narrow species. The bone is elongate, narrow, recalling *plangon* in appearance, the inner cone well developed, seen crossing but not obscuring the siphonal cavity, the ventral surface rather flattened, the striated area not deeply excavate, the last loculus long, no ventral sulcus, but a slight indication of a groove medially. The spine is keeled, a little recurved. The dorsal surface is rayed with three rays, forming a median strong rib with the outer radials weakly displayed. The outer cone is slightly calcified.

Solitosepia plangon Gray.

This is another of the curious forms restricted to the East Coast of Australia, but also reaching Lord Howe Island. It has been secured all along the coast of Queensland and the Great Barrier Reef as far north as Low Isles, but becoming very scarce in the northern part of the range. In New South Wales the animal frequents the great inlets such as Sydney Harbour, Botany Bay, Broken Bay, etc., and has not been commonly met with in trawling in deep water. It was described from Port Jackson, New South Wales (10) and figured (15) from Manly Beach. It is unlike any other in its long narrow form with a deep ventral sulcus. No measurements of the type bone were given, and the figured specimen from Manly Beach measured 110 by 30 mm. A northern form, *adhaesa*, was named from the Capricorn Group as being narrower, more elongate, with inner cone more strongly marked, the outer cone passing ventrally in front of the spine, the dorsal surface flatter and the ray sculpture more defined, measurements being given as 88 by 26 mm. Specimens have been collected as far north as Low Isles. However, larger specimens occur along the coast, some from Yeppoon, Queensland, reaching 100 by 28 mm. Similarly, larger specimens have been collected in the south, bones reaching 135 mm. by 35 mm., and in these again there is no marked difference between bones to indicate sex, and bones taken from sexed animals do not show any distinction. A series recently collected measured 39 by 13, 42 by 14, 48 by 15.5, 59 by 19, 61 by 19, 72 by 22, 73 by 21, 77 by 23, 82 by 24, and 83 by 25 mm. Most of the northern species of *Acanthosepion* and its associates show the spine to recurve normally, sometimes strongly. It is worthy of note that the northern bones of *plangon* (*adhaesa*) show a tendency to recurve the spine, whilst in the southern *plangon* the spine is very straight.

Solitosepia rozella Iredale.

This figured and described (15), is apparently even more restricted in range than the two preceding. It does not appear as far north in Queensland, though it still reaches the southern coast of New South Wales at Narooma, and has been found at Lord Howe Island. The northern form has been separated sub-specifically, as showing slight geographical variation, but the sexual variation is scarcely indicated in the bones. One of the handsomest of the local cuttlebones, the great development of a ventral sulcus does not appear until the bone is over 30 mm. in length, after which the sulcus shows deeply in the striate area; the non-striate area in a bone of 60 mm. is only 20 mm. from the peak of the sulcus, the striate area being singularly acute. In a bone over 130 mm., the sulcus is very long, the angle of the striate area sharp; the non-striate area being only 30 mm. from the peak. This non-striate area was called the last loculus by Hoyle, and was regarded as a differential character. As it varies with age, and probably with sex, it can only be used as a general indicator with no absolute value. The type measured 135 by 47 mm., larger ones being rarely met with. The northern form, *peregrina* (16), was separated as being smaller, shorter and comparatively broader, the inner cone wider, the dorsal sculpture more pronounced, the type measuring 89 mm. by 34 mm. A normal shell from Manly, 80 mm. long, measures only 29 mm. in breadth. The largest Manly specimen measured 150 mm. by 48 mm., reaching that figure through 34 by 15, 42 by 17, 50 by 20, 58 by 21, 80 by 29, 115 by 38, 130 by 44, and 145 by 45 mm.

Blandosepia baxteri Iredale. Plate V, Figures 12, 13, 14.

A large number of cuttle bones was secured on Lord Howe Island by Mr. Robert Baxter, and it was found that the commonest bone was quite novel, suggesting the New South Wales species, *Solitosepia mestus*, but it lacked the spine. It was named (17), but has not yet been figured. The non-development of the spine seems an important feature. The type measured 74 mm. by 32 mm., the largest at that time being 90 mm. by 37 mm. Bones received since include small specimens as low as 28 mm. by 13 mm. The figured specimen measures 83 mm. in length and 37 mm. in breadth, the range being through 28 by 13 to 90 by 37 mm., measurements reading 44 by 21, 59 by 25, 75 by 34 and 77 by 32 mm.

The bone is elongately oval, the dorsal area finely granulose, showing faintly a dorsal rib and adjacent lines, scarcely separating areas. This is brownish pink, and the outer cone which is produced is whitish, weakly calcified, and bounded by a narrow, horny margin which extends round the bone. There is no spine, but only a slight knob. The inner cone is well developed as a narrow band, reaching in front of the siphonal cavity, and enclosing a striate area. The striated area is long, and, while it does not show any ventral sulcus, there is a shallow median depression with minor ridges each side. The last loculus shows a faint linear median depression and the usual marginal lines. It resembles in most features, as noted above, *Solitosepia mestus*, but as well as the lack of the spine, the dorsal surface shows more definite traces of sculpture than is met with in *mestus*.

The species, so far received from Lord Howe Island, are *Blandosepia baxteri*, *Solitosepia mestus*, *S. plangon*, *S. rozella*, *Glyptosepia opipara*, *G. gemellus*, *Decorisepia rex*, *Amplisepia apama* (*verreauxi*) and *Crumenasepia hulliana*.

Blandosepia bartletti sp. nov. Plate V, Figures 15, 16.

At my request the Rev. H. K. Bartlett secured a number of cuttlebones at Misima, and the Conflict Group, both in the Louisiade Archipelago. A number of species was included, but the commonest species was a shell recalling *Solitosepia liliana* of New South Wales, but lacking any spine. Since its acquisition, a similar bone has been described from the Island of Banda in the Moluccan Islands, and given the name of *Sepia bandensis* (3), but that species seems referable to a different source of evolution. The new species may be described thus: Spineless at all stages of growth; in form oval, with calcareous outer cone; it may be classed under *Blandosepia*, but this is only a tentative grouping. The type and figured specimen measures 73 mm. in length and 37 mm. in breadth. Other measurements reading 45 by 20, 45 by 24, 50 by 29, 62 by 29, 68 by 33 and 70 by 34 mm. This resembles the preceding in the dorsal aspect, but there is no dorsal sculpture at all visible. The ventral surface has the inner cone similar, but smaller, and the long striated area shows no signs of sulcus or groove, and is more excavate throughout. The last loculus shows a shallow depression medially, and is never more elevated than the margin. This seems to be a spineless representative of *Solitosepia liliana*, paralleling the previous one and *mestus*.

Mr. Bartlett sent, in addition to the above, some six species, represented by immature and broken bones. *Ponderisepia, Crumenasepia, Solitosepia papuensis* aff., and a narrower form; also a large square-backed pustulose bone, unlike any other seen by me, but with the posterior end missing; lastly, an elongate, medium-sized bone, also with the posterior end missing, with a faint resemblance to *Sepia sulcata*, but otherwise different from any Australian species. As only a few bones were included in the sending, it is suggested that a large and varied Cuttlefish faunula exists in this locality. It is, at present, hoped to receive Cuttle bones from the Torres Strait area, when the distribution of the species will become clearer, as some of the above species may be found in Australian water. A fragment, recalling the square-backed pustulose bone from Misima, has been picked up at Eagle Island, North Queensland.

Since the above was written, a first consignment has been received from Torres Strait, forwarded by Mr. D. Tranter, of the C.S.I.R.O,, and this shows four expected species: *Solitosepia* of the *papuensis* form, *Acanthosepion ellipticum, A. pageorum* (the narrow form) and *Crumenasepia hulliana.*

Mesembrisepia novaehollandiae Hoyle.

This species is involved in a little confusion as it was described (21) from a "bone" collected by Peron at Kangaroo Island, South Australia. The name chosen was *australis*, and it was apparently figured about the year 1826, but the plate was not issued at that date. Six years afterwards (1832), Quoy and Gaimard described and figured (23) a different species under the name *australis* from the Cape of Good Hope. This name is valid. However, about 1845, a series of monographs was begun by D'Orbigny, and continuing his 1826 proposal he retained the name *australis* for the Australian shell and renamed the Cape shell *capensis*. For years the two "*australis*" confused workers, who did not refer to the original data, until Hoyle, recognising the difficulties, introduced the name *novaehollandiae* (14) for the South Australian species. Apparently, more than one form is being classed under this name, and the original description demands a shell 78 mm. long with the breadth 30% of the length, not 30 mm. as sometimes quoted. This is a narrow shell, and no sexual variation has yet been recorded, though some of the variation noted may be due to this cause. The New South Wales representative, *macandrewi* (15) is a broader shell, and there is a slight variation, which may be sexual, in the breadth. It has been urged that the female of some species has a broader shell, but this is not apparent in a few specimens, and in connection with the species *chirotrema*, Berry stated that the body "was relatively much broader and flatter in the male," indicating the difficulty of noting sexual difference. It would be a valuable contribution to study a series of animals and bones from the type-locality, as Berry's data on the animals of "*dannevigi*" (4), which is regarded as the same as *novaehollandiae*, having been collected at the same place, are very confusing. Cotton (7) illustrated a bone 140 by 50 mm., apparently from Robe, South Australia, and observed: "A wide form obtained at Robe is probably the sepion of the female, which is wider across the outer cone and more excavate ventrally." This may be another species.

Mesembrisepia irvingi Meyer. Plate IV, Figures 3, 4.

Meyer described (20) this species from Garden Island, Western Australia, under the genus *Sepia*, and Cotton commented: "This is possibly a variant of *Mesembrisepia* *novaehollandiae* Hoyle," also observing: "Among hundreds of specimens from South and West Australia, the numerous variants (of *novaehollandiae*) are not separable into any distinct varieties." The collections made by Whitley suggest that the Western Australian bones, north of the Swan River, are constant enough, in their narrowness and prominent ventral surface anteriorly, to be admitted as different. Consequently, the western name may be used for these bones until the matter is decided absolutely by study of animals. The measurements of the type read 115 by 41 by 13 mm., indicating a narrow shell with an elevated anterior ventral surface, so that the name is applicable. It should be noted also that Meyer gave the total length of the animal as 170 mm., the dorsal length 120 mm., breadth 75 mm., and figured the tentacular club with small suckers and two rows of larger ones, the illustration differing appreciably from that of the tentacular club of *dannevigi* (- *novaehollandiae*) given by Berry. This was described "suckers excessively numerous and minute," "of practically similar aspect."

The bone figured was collected at Point Cloates, Western Australia, measuring 142 mm. in length, 40 mm. in breadth, and 16 mm. in thickness, and may be regarded as typical. A series from Geraldton ranges from 62 by 20, 78 by 24, 104 by 37 to 130 by 40 mm., while the longest is from Pelsart Island, measuring 173 mm. by 45 mm. Many of these specimens have the anterior ventral elevated, some very, and none, from the smallest, shows a somewhat flattened anterior ventral, seen in *ostanes*. There is a shallow median ventral sulcus, which in old specimens becomes pronounced and deep, and slighter sulci show at the sides towards the posterior end. The last loculus is fairly long, much longer than in *ostanes*, and the horny margin is more extensive. The outer cone is somewhat restricted, slightly calcified, and the inner cone is narrow, as a strong glaze extending towards the mucronal area, which is slightly separated dorsally by a granulose area.

Mesembrisepia ostanes sp. nov. Plate IV, Figs. 5, 6.

Mr. G. P. Whitley secured a series from Marrawah and Strahan, West Tasmania, as well as Stanley and Burnie, North-west Tasmania, and these differ very appreciably from typical *novaehollandiae*, so mayhap the animals may differ likewise. The shell shows all the features of the genus, but is broad and with anterior ventral shallow, not elevated. The difference is too marked to be sexual. All these specimens are similar, and the narrowest recall the New South Wales *macandrewi*, while none is as narrow as *novaehollandiae*. The broad bone, with all the characters agreeing, is found along the southern coast of Australia, and round the south-west corner of Western Australia as far as Swan River. It is easily separable by the flattened anterior ventral surface, which shows a round depression. The description of the figured type, which measures 140 mm. in length and 50 mm. in breadth, with a thickness of 10 mm., from Stanley, Marrawah specimens 128 by 45 mm. and 145 by 50 mm., Burnie, 130 by 48 mm. The type has a large expansive outer cone, practically calcified throughout, a thin horny margin round the edges; the inner cone is seen as a thick glaze extending in front of the siphonal area; the striated area very long and showing a lengthened ventral sulcus which peters off into a circular depression reaching to the last loculus, round the inner edge of which will be seen linear grooving, not parallel with the margin. The dorsal surface is pinkish, the outer cone white, the spine short, stout, straight, with a depression behind, coarsely pustulose; the rest of the dorsal surface is very finely granulose, with a broad median triangular area succeeded on each side by a slight flattened band, angularly separated from the rounded sides, which show a slight exposed horny area towards the posterior end. A series of median "bones" from the mainland near Esperance, South-west Australia, show all the differential characters of this species, but are smaller, 90 by 34 mm. to 110 by 37 mm., while among bones collected on the Perth beaches are almost typical bones, one measuring 130 by 46 mm.

A large number of bones has been just received from North Tasmania, forwarded by Mr. R. Kershaw, a grandson of the late well-known Director of the National Museum, Melbourne. These prove very interesting; the most numerous species is *Decorisepia rex*, and there does not appear to be any difference in these from the typical series, measuring 50 by 20 mm., 90 by 30 mm., 111 by 40 mm., 118 by 40 mm. to 123 by 42 mm. A series of *Mesembrisepia* ranges from 110 by 38 mm., 114 by 42 mm., 130 by 44 mm., 138 by 44 mm., 144 by 45 mm. to 150 by 49 mm., thus becoming very near to *macandrewi*, but not reaching its size. The National Museum, Melbourne, has allowed me to examine the specimens recorded by Chapman from Torquay, Victoria, and the "plesiotype" of *latimanus* proves it to be a *Mesembrisepia* as above noted, the measurements, 138 by 47 mm., coming close again to *macandrewi*. The "plesiotype" of *capensis* is also *Decorisepia rex*, as determined, and others from Nelson's Promontory and Betha River mouth, East Victoria, confirm the non-distinction of the bones from typical *rex*, measuring 28 by 13 mm., 54 by 22 mm., 57 by 23 mm., 64 by 26 mm., 76 by 29 mm., 105 by 39 mm., 117 by 43 mm. to 124 by 45 mm. Thanks must be given to Mr. R. Kershaw and Miss Macpherson, of the National Museum, for their assistance in the elucidation of these matters.

Mesembrisepia macandrewi Iredale.

This species has been described and figured (15), but its exact distribution is not yet determined. It reaches Sydney, N.S.W., as drifted shells, but may occur alive with the other species in the trawl along the coast. It may be found on the eastern Victoria coast, and to the north and east of Tasmania, but the bones from north-west and west of Tasmania are broader, and represent a different form. The western Victoria bones may be *novaehollandiae*, or an intermediate form. The type, from Shellharbour, N.S.W., measured 170 mm. by 56 mm., and this is an average bone. Chapman (5) gave the measurements of a bone, which he named *latimanus*, but the figure shows it to be of *novaehollandiae* form, as 138 mm. by 47 mm. by 13.5 mm. were given as measurements. A series from Stanley, north-west Tasmania, collected by Whitley recall this species, but are a little narrower, ranging from 145 by 45 mm., 155 by 49 mm., 171 by 50 mm., 174 by 51 mm. to 183 by 53 mm.

Mesembrisepia chirotrema Berry.

This South Australian species was described (4) from dredged specimens off Kangaroo Island, along with other specimens regarded as true *novaehollandiae*, as they come from the type locality of that species. Had the bones alone been known, there might have been doubt cast, as they resemble those of *novaehollandiae*, save that they are more elongate and more strongly sculptured. The animals, however, showed valid distinctive features. The bones are not common, so that little can be said about the sexual variation, while the geographical variation is not remarkable. The species has been recorded as far west as Rottnest Island, and Whitley collected bones at Geraldton, and the Abrolhos Group, further north. Little difference can be seen in the bones from these localities when compared with typical bones, but little material has been available. The type bone was imperfect and not measured, but the illustration (reconstructed) of another bone measured 168 mm. by 50 mm., a broader shell than specimens recently measured, Cotton recording from Robe, South Australia, 160 mm. by 42 mm., and the largest from Western Australia 145 mm. by 42.5 mm. A South Australian specimen from Joslin measures 200 mm. by 50 mm. A Western Australian bone from Rottnest Island measured 125 by 40 mm., one from Geraldton 135 by 45 mm. These agree quite closely with South Australian bones, but another from near Cape Leeuwin, measuring 123 mm. by 39 mm., is curious, having more the appearance of *novaehollandiae* on the dorsal surface, save for the presence of a notable median longitudinal rib, and less pronounced tuberculation. The sculpture of the dorsal area is weaker than that of typical *chirotrema*, and the area between the spine, which is short, and the dorsum is level and not so strongly granulose. The inner cone is broader, as is the outer, while posteriorly the ventral surface is elevated. This is almost paralleled by another bone from Pelsart Island, measuring 100 mm. by 38 mm., in all the distinguishing features, the outer cone being slightly less broad.

Amplisepia apama Gray.

This was described from South Australia (10), and ranges round the southern coasts as far north as South Queensland and even Lord Howe Island, while westward it reaches south-western Australia, but is displaced by a distinct form in Shark's Bay. Geographical variation can be seen, and the eastern form has been listed (15) under the name *verreauxi* (24), but animals must be studied to substantiate the distinction. The Lord Howe Island bones are quite fresh, and of varying sizes, showing that the animal lives there, but three bones are recorded from New Zealand, where so far no animals have been found. These New Zealand records seem doubtful, as Powell has concluded, because the shells are common where the animals live. Sexual variation is not noticeable in the bones examined, varying from minute specimens up to a length of nineteen inches, the breadth being comparatively agreeable to variation in length. Seventeen inches seems to be the average adult size of the bone, but larger have commonly been reported, the largest in hand being nineteen inches, the breadth at that size being nearly seven inches. This huge bone, probably the largest in the world, appears first as a small triangular flattened scrap with little resemblance to the adult, recalling more the *Solitosepia* species. A little later it develops a spine, and, at about 20 mm. long, it recalls a *Solitosepia*, but the short spine points ventrally, not dorsally as in that genus.

The animal has been well described and figured by McCoy (19), and this is copied in Cotton & Godfrey (8), so it is easily accessible.

The shell is elongate, the dorsal surface, almost flat, little rounded, rather smooth, with large chitinous edges showing anteriorly, the anterior portion granulose, prolonged into a long beak, with the spine missing, but the end thickened and rough. The ventral surface is rather swollen anteriorly, sometimes strongly so, with a short unstriated area; striated area with no deep sulcus, but sometimes a shallow median area. The characteristic difference is the prolonging of the outer cone so that the inner cone appears as an elongated glaze only; the limbs bordering the striated area meet and develop a notable warty thickening forming an inverted V.

The variation in sex is not notable, the large bones showing little distinction, and the only feature of interest is the development of the junction of the inner limbs into the quaint warty angle. At first there is no indication, but with growth the reversed V emerges, becoming more warty with age. At the same time the beak elongates at the spinal area, the spine disappearing or leaving an indication only. The spine is sometimes retained until the bone reaches a length of 200 mm., but generally is lacking at a much smaller size. As the beak elongates, the inner cone continues with it, becoming weaker, so that it is only a faint glaze in the largest bones. The eastern bones, known as *verreauxi*, appear to grow to a much larger size with a narrower inner cone, smaller phragmocone and the more prolonged mucronal area. This form ranges into South Queensland and Lord Howe Island as far as bone features are concerned, but the animals may be distinguishable, as Sydney specimens do not agree exactly with the detailed account given by McCoy.

Amplisepia palmata Owen.

Owen (21a) described a large Cuttlefish, captured off the shore of Norfolk Island, as *Sepia palmata*, description of bone not very definite, but the illustrations suggest that the bone be referred to *Amplisepia*, and that it was distinct from *apama*. The figures are stated to be natural size, and this gives the length of the bone as 118 mm., the breadth 39 mm. At this size the beak is well elongated, measuring about 19 mm. from the junction of the inner limbs to the extremity, while no inner cone is shown, nor is there any incrassation at the juncture of the inner limbs indicated. This species so far depends upon the original description, though Brazier added North Coast of Australia, and it is not known what species he had in mind. Nothing like it has been found recently in North Queensland, and the *apama* form found in South Queensland and Lord Howe Island cannot be confused with Owen's species from his description and figures.

Amplisepia parysatis sp. nov. Plate IV, Figs. 1, 2.

The record of floating cuttlebones in Western Australian waters goes back as far as the seventeenth century. W. A. Roosenbergh, near Shark's Bay, on September 17, 1627, noted. "Close inshore we also saw a quantity of cuttlebone, but the pieces were very small and scattered," while Dampier added: "At about 30 leagues distance (from the coast of New Holland) we began to see some Scuttle-bones floating on the water; and drawing still nigher the Land we saw great quantities of them." These remarks may have applied to the present species, but Whitley found floating bones in the Timor Sea which were referable to *Crumenasepia*. Probably more than one large species occur together. The large Shark's Bay species was recorded by Meyer (20), without consideration, as *latimanus* (3), described from Dorey, west New Guinea, and this turns out to be very different, as was anticipated. Whitley brought back a large number of all sizes, and these prove to belong to a distinct species of

Amplisepia. It is smaller, and at all stages a narrower shell, with the posterior end less developed, and retaining the spine until adult. It was mentioned in connection with the introduction of *Mesembrisepia* that the development of that genus suggested a relationship with *Amplisepia*, and the juvenile of the present species is not unlike that of the western species of *Mesembrisepia*, occurring where the ranges overlap.

The general description of the type of *Amplisepia* applies to this species as follows: Length 195 mm. by 70 mm. in breadth. Other measurements are 160 by 58 mm., 187 by 70 mm., 185 by 62 mm., 192 by 70 mm., and the oldest senile bone measures 215 by 78 mm. In this last mentioned the mucronal area is prolonged but thrust forward almost at right angles, quite unlike the area in *apama*. Compared with *apama*, it is a smaller species, notably narrower at every stage of growth, with the striated area less elevated anteriorly and more elevated posteriorly, the last loculus short and depressed. The outer cone is advanced and well calcified, a fairly large horny area being exposed laterally. The spine is always present, and there is no dorsal sculpture nor any ventral sulcus, although sometimes a faint ventral groove may be noticed.

Decorisepia rex Iredale.

This species was described and figured (15) from Manly, New South Wales, and has a somewhat different distribution from the species described at the same time. It does not range far into Queensland, but has reached Lord Howe Island, but similar shells have been named *jaenschi* (7) from Western Victoria and South Australia, and another shell from Rottnest Island, Western Australia, *cottesloensis* (6). This form occurs in northern, southern and western Tasmania also, but there do not seem any tangible differences in the shells so far examined. The most pronounced variation, geographically, is seen in a series from the Capricorn Group, which includes bones much larger than any seen elsewhere. There is some variation in breadth which may be to some extent sexual, but it has not yet been gauged in the bones. Some specimens have the outer cone developed into a broad hood, with others show the hood comparatively small, but the variation in the shell negatives any separation, as some of these differences are due to early (or even late) mishap to the animal. The type, from Manly Beach, measured 119 mm. by 40 mm., while *jaenschi* measured 103.5 mm. by 37 mm. by depth 6.7 mm., and *cottesloensis*, a small specimen, 42.6 mm. by 18.3 mm. by 4.5 mm. Chapman recorded (5) *capensis* from Torquay, Victoria, fortunately giving a figure, so it is recognisable as *Decorisepia rex*, the measurements reading 120 mm. by 42 mm. by 10.5 mm. thick with the spine 6.5 mm. long. The largest New South Wales bones measure 127 mm. by 43 mm., and 124 mm. by 47 mm., but the Capricorn Group bones, which are broken, measure from 140 mm. to 150 mm. with a breadth of 50 mm. Although the inner cone is missing, "coalescing with the edges of the striated area" in most cases, some bones with favourable lighting show a very narrow inner cone as a slight glaze in old shells, not young ones. The very small bones, as 17 mm. by 9.5 mm., 20 mm. by 10.5 mm., 21mm. by 11 mm., and 29 mm. by 13 mm., are recognisable by the adult characters, although the smallest is just starting a spine, and none of these shows the slightest sign of an inner cone. A series collected by Whitley at Stanley, north-west Tasmania, gives very similar measurements throughout, and cannot definitely be separated from *rex*.

As noted under *Mesembrisepia macandrewi*, bones from North Tasmania and east Victoria agree completely with typical specimens of *Decorisepia rex*, and at present cannot be separated.

Glyptosepia opipara Iredale.

This beautiful bone is so far only known from Queensland, drifted bones from New South Wales as far south as Sydney, and Lord Howe Island. It is one of the most brittle of all bones, the majority being broken. It is easily recognisable by its form, its strongly sculptured back and its deep dorsal coloration, with its long spine.

Sexual variation is not notable in the bones, and with the restricted distribution no geographical variation can be seen, while the immature show all the adult features. The description and figure (15) are of a specimen measuring 132 mm. by 42 mm., but many larger bones have been secured. Generally they increase regularly from 63 mm. by 19 mm. to 169 mm. by 45 mm., but some broader shells may be noticed as in the case of such measurements as 151 mm. by 45 mm., and 68 mm. by 22 mm., and 56 by 19 mm.

Glyptosepia cultrata Hoyle.

The story of this species has been given (15), and there is nothing yet to add, but it may be noted that there are some fragments in the Australian Museum regarded as *cultrata* by E. A. Smith at the British Museum, and they are not *gemellus*, *macilenta* or *hedleyi*. This suggests that, in the confusion of the hauls, there may have been other mistakes, but at present no decision can be made. At any rate, it can be left on the suspense list until the deeper water of the south coast of New South Wales has been fully exploited.

Glyptosepia gemellus Iredale.

After the study of many specimens of bones from the Manly beaches, two species of *Glyptosepia* were admitted, one broad and one narrow. The differences seemed too great to regard them as sexual, and the position remains in this stage at present. The broader shell was named *gemellus* (15), and the narrow form *macilenta* (15), and it has been shown by Cotton (7) that the South Australia species *hedleyi* (4) is also a *Glyptosepia*, and Cotton (6) also recorded this from Western Australia. These records seem to confirm the distinction of the two first named, as the South Australian bones appear to be broad, with the Western Australian ones even broader and larger. The measurements of *gemellus* from Manly are 96 mm. by 35 mm., which is about the same as Berry's reconstruction of one of the bones from the Great Australian Bight. Cotton (7) figured a specimen from Robe, South Australia, only 44 mm. by 15 mm., but illustrated (6) a bone from Cottesloe or Rottnest Island, Western Australia, measuring 107 mm. by 39 mm. by 9 mm., also noting the largest specimen was 120 mm. by 41 mm. by 11.5 mm. thick. Later, Cotton & Godfrey (8) noted the bone was rare on South Australian beaches. Whitley collected bones at Cottesloe and the other Perth beaches, as well as Rottnest Island, and also Pelsart Island in the Abrolhos, and their measurements read 115 mm. by 41 mm., 116 mm. by 39 mm., and 84 mm. by 26 mm. from Rottnest Island, 110 mm. by 39 mm. from Cottesloe, 106 mm. by 39 mm. from the Perth beaches. It will be noted that all these bones are larger and broader than the broadest eastern shells of *gemellus*. The largest Manly bone is 104 mm. by 35 mm., others reaching 95 mm. by 34 mm. and 90 mm. by 34 mm. A large bone, measuring 109 mm. by 35 mm., was collected at the Capricorn Group, South Queensland. No series of measurements is available of South Australian bones, but obviously the Western Australian *hedleyi* is larger and broader, and can be separated on that account.

A series of *Glyptosepia* sent by the National Museum, Victoria, for examination, collected at the Betka River Mouth, east Victoria, appears referable to *gemellus*, measuring 64 by 22, 74 by 24, 75 by 25, 76 by 25, 77 by 25, 77 by 28, 78 by 25, 80 by 25, 85 by 31, 85 by 27, 92 by 32, 91 by 33, 98 by 33 and 98 by 33 mm., figures agreeing fairly well with those of a typical series, but also suggesting the later suppression of *macilenta*.

Glyptosepia macilenta Iredale.

This species was introduced at the same time as the lastnamed. It agreed in most characters, save proportions, and it might have been suggested it was the male of the broad *gemellus*. Many collections made since have shown the differences, but no animals have yet been sexed to prove the matter of the sexes. On this subject it may be noted that when *hedleyi* was proposed on animals, no distinct characters for separating the sexes were indicated, and the broad bone was taken from a male. It should be added that this form approaches nearest the missing *cultrata* in proportions, but *cultrata* was almost as narrow, and it was from a female. The type bone of *macilenta* measured 92 mm. by 28 mm., while the measurements of *cultrata* were 90 mm. by 29 mm. Gray had recorded a bone in the British Museum as *capensis* var.from Sydney, and this was figured and described for comparison, but it was not regarded as *cultrata*, while it is a good illustration of *macilenta*, measuring 85 mm. by 26 mm. Narrow bones have been secured in South Queensland, as also have *gemellus*, but no narrow shells have been seen from Tasmania yet. So until animals are well studied it is best to allow *cultrata* to remain in suspense, and use *hedleyi*, *gemellus*, and *macilenta*, noting the far west *hedleyi* have larger and broader bones. Measurements of Manly bones referred to *macilenta* may be recorded as varying from 17 by 9 mm. to 60 by 24, 75 by 26, 79 by 26 to 92 by 28 mm., none reaching to 30 mm. in breadth. Nearly all the Queensland bones belong to the broad *gemellus*, only a couple of solitary bones being referable to *macilenta*, while a bone from Lord Howe Island is also *gemellus*.

Glyptosepia hendryae Cotton.

This is a distinctive bone, described (6) from Rottnest Island, Western Australia, and though it was placed under *Solitosepia* it lacks the characteristic inner cone of that group, and its dorsal surface sculpture is also discrepant. Specimens were collected (singly) by Whitley at Princess Royal Harbour, King George Sound, Pelsart Island in the Abrolhos, and Dirk Hartog Island, as well as at Rottnest Island. These show the anterior end to be formed in the style of that of *Glyptosepia*, and not of *Solitosepia*, and the rest of the characters lean to the former genus, so that until animals are closely studied it will be best to refer the species to *Glyptosepia*. The type measured 77.5 mm. by 22.7 mm. by 6.2 mm. thick, two specimens from Cottesloe measured 51 by 13.5 by 4.2 mm., and 76.5 by 24.2 by 7,3 mm. thick, Whitley's specimens measured: Pelsart Island, 80 by 25 mm.; Princess Royal Harbour, 88 by 26 mm.; Dirk Hartog Island, 93 by 26 mm.; and Rottnest Island, 92 by 26 mm.

Arctosepia braggi Verco.

A notable section of the cuttles, as seen in their bones, includes many very narrow lengthened species which are easily separable at sight. It was suggested that in this section two series could be distinguished, and the name *Arctosepia* was introduced for the small forms found on the New South Wales coast. A larger bone has been named *Sepia braggi* (25) from South Australia, and this larger form is not able to be confused with the typical *Arctosepia* It has been given a range of Victoria, Tasmania, South Australia and Western Australia, and now I add it to the New South Wales faunula, as Whitley has collected a specimen at Narooma, on the south coast. The complex *braggi*, as admitted above, may be capable of subdivision, when studied geographically. Cotton (7) has recorded *braggi* as being common along the coast of South and South-west Australia, the type measuring 60 mm. by 4.75 mm. thick, a Cottesloe specimen reaching 64.5 by 11 by 41.7 (sic) [=4.7]. Chapman has recorded (5) that many scores of the bones of *braggi* were washed up at Torquay, Victoria, at Easter time, 1903, and again at Easter time in 1912, the measurement of the largest specimen being given as 62 mm. by 13 mm. by 5.5 mm., with the spine 2.25 mm. long.

North-western Tasmanian bones, collected by Whitley, grow to a larger size, and are named subspecifically *A.b.xera*, subsp. nov., the type measuring 78 mm. in length and 16 mm. in breadth. This is figured on Plate V, figs. 19, 20, 21. It is obviously larger, and all the specimens agree ranging from 57 by 14 mm., 68 by 15 mm., 73 by 16 mm., 74 by 15 mm. to 80 mm. by 17. A smaller one from Strahan measures 51 mm. by 12 mm., the typical series being from Stanley, North-west Tasmania. Compared with *braggi*, it is more elongate, with a wider posterior area, which shows a median linear groove its whole length, even on the last loculus The dorsal rib is very faint posteriorly, but well indicated anteriorly, while the horny margin is easily seen throughout its length. The posterior horny hood is small.

Arctosepia limata, Iredale.

The species of *Arctosepia* are the smallest of all Cuttlefish bones, and as well as being small, they are quite narrow, and are easily recognisable. This refers to the Australian species, but elsewhere there appears to be two distinct narrow shells, and some are of comparatively large size, and the relationships of these are obscure. It is possible in Cuttlebones that similar bones have developed independently in different areas, and that apparently resembling bones are sometimes not closely related.

The dimensions of this small bone are given as 36 mm. by 8 mm., the type (15) from Manly Beach. Hundreds have been collected, but the majority have been broken, as the bones are brittle, while none exceeding these measurements has been collected in the Sydney district, and specimens have been secured on the north coast of New South Wales, and South Queensland. These small bones may occur further north, as they are easily overlooked, and the northern bones might belong to different species. A bone was picked up at Low Isles, but was not secured by me, and its exact identity is unknown. This small species has been listed from Victoria by Macpherson and Chapple (18).

Arctosepia versuta, Iredale.

Many specimens were secured on Manly Beach, New South Wales, of a bone differing at sight, but not much in measurements, the type giving 33 mm. by 7 mm. (15). It is probable that the animals may show greater distinction than the bones, as varied accounts have appeared about the animals referred to the apparently allied genus *Doratosepion*. In Southern Australia, large shells (for the group) occur with the name *braggi*, and it would appear that these small New South Wales shells are degenerate representatives of the larger ones. Thus, Whitley collected a series of *braggi*-like bones in North-western Tasmania, and while most of these are obviously of the true *braggi* style, some others are of the *versuta* form, and appear to be far larger relatives. In order to attract attention this is here named, as it may occur on the Western Victorian and South Australian shores. The northern *versuta* was separated from *limata* as being "smaller, the growth lines more closely packed, the posterior end much less rapidly tapering, the anterior ventral more swollen, less excavate posteriorly, and with more numerous striae."

The Tasmanian specimens measure 51 by 10 mm. and 48 by 10 mm., and are elongate and narrow, the width never increasing rapidly, the ventral surface elevated, the median furrow in one specimen elevated into a rib, in the other normal, the striae rather coarse, the hood small, the spine short and thickened, the dorsal area smoothish, the median rib scarcely indicated. This may have been confused elsewhere with *braggi*, passing as the male or immature, but it is here named *Arctosepia treba* sp. nov., from Stanley, North-western Tasmania.

It should be noted that bones of the *Arctosepia* type, referred to *Doratosepion*, have been taken from animals showing quite distinctive features, so that this may be the case in Australia also.

Arctosepia rhoda sp. nov. Plate iv, figs. 10, 11, 12.

All southern specimens of *Arctosepia* have been regarded as *braggi*, including those from Western Australia, but probably two or three forms are there represented. Meyer (20) received an animal from Garden Island, and figured the bone with the posterior end missing. The remainder measures 35 mm. by 8 mm., suggesting a small specimen. Whitley secured a few bones, but only one is worthy of recognition, as it is definitely not *braggi*, and is here named as new. It was collected at Point Cloates, Mid-western Australia, and measures 52 mm. long, 12 mm. broad, and 6 mm. in thickness. It will be seen from the figures how different this species is, having a comparatively short, broad posterior area, well elevated and showing, instead of a linear groove, a raised rib along the striated area, but the linear groove appears in the last loculus. Practically the whole ventral area, save the extremities, is elevated. The dorsal area is comparatively smooth, with a narrow median elevated rib, and with a large amount of horny margin on the sides exposed. The spine is of the usual rounded style, while the hood is small. Altogether it is unmistakeable.

Cotton (6) recorded a Cottesloe specimen of *braggi* as 64.5 mm. by 11 mm. by 41.7 (sic) mm. [=4.7], and the above is obviously separable from the measurements alone.

Tenuisepia mira, Cotton. Plate v, figs. 7, 8 .

This beautiful little bone, described from the Capricorn Group, Queensland (7a), is very fragile, and broken bones have been found as far north as Low Isles, while it has been collected in New South Wales at Trial Bay by Melbourne Ward. So far it has no known relative in the Australian series. The type measured 55 mm. in length, 10.6 mm. in breadth, and 4 mm. in thickness. The specimen, here figured, was collected at Trial Bay, New South Wales, by Mel. Ward, and measures 48 mm. by 10 mm. It is small, elongate, five times as long as broad, with the inner cone coincident with the inner limbs; the spine is not keeled, and the dorsal surface is finely pustulose, almost smooth, and there is no ventral sulcus.

Acanthosepion whitleyanum, Iredale.

This tropical species was described (15) from Port Macquarie, New South Wales, but it is not known whether it lives in New South Wales waters. Drifted bones have occurred as far south as Sydney, but it has been commonly found on the Queensland Coast and the Great Barrier Reef. A notable feature of this species is the broad smooth band at each side of the striated area, the broad shallow sulcus of this area occupying more than half its breadth, while there is a very short non-striate area or last loculus. The characters seem to be common to the species of *Acanthosepion (sensu lato)*. The type measured 168 mm. by 56 mm., and in the figure the broad band at the side is not emphasized. Another notable feature is the constant recurving of the spine, which sometimes is seen split on the dry bone, even as in the allied *Crumenasepia*. Mel. Ward collected a fine series, opposite Bribie Island, Queensland, ranging from the typical measurement to the fine size of 235 mm. by 78 mm. In drying, as noted previously, the horny covering at the base of the spine contracts, and causes the spine to break off, carrying the horny hood with it. A series from Michaelmas Cay measured 26 mm. by 10 mm., 30 mm. by 14 mm., 34 mm. by 18 mm., 43 mm, by 20.5 mm., 50 mm, by 21 mm. to 90 mm. by 34 mm., 102 mm. by 41 mm., and 114 mm. by 42 mm. Thence as above from 168 mm. by 56 mm. to 235 mm. by 78 mm. The smallest show the characteristic thickening of the inner cone, but not until over 30 mm. does the chitinous hood appear.

Acanthosepion pageorum sp. nov. Plate iv, figs. 7, 8, 9.

When large collections of bones were made at various points in Queensland, on the coast and the Great Barrier Reef. a bone similar in most respects to the preceding one was noted and easily separated, though superficially it agreed in most features. Some shells are notably narrower than others, but whether this is sexual or not is unknown. When a common species is well known it has been found that the sexual variation is small and inconstant, and bones cannot be separated into male and female. Apparently in the species of *Acanthosepion* and allied genera there are, however, in many cases, narrow and broad shells, and until animals are studied in series no decision can be made. At the present these are not separated, but regarded as belonging to one species, although this conclusion is open to doubt.

Shell medium, elongately oval, anteriorly a little narrowed, more than twice as long as broad, striated area very long, leaving only a short "last loculus," the striated area being depressed medially into a broad shallow sulcus more than half the whole breadth of the area, which is bounded on each side by a smooth band; the differential feature separating this from *whitleyanum* is the development of the inner cone into a cup-like, smooth-edged, calcareous rim, which is built up of layers as the shell grows, but is present in the very small bones. The dorsal surface is coarsely pustulose and is scarcely separable from that of *whitleyanum*, save that a median rib is obsoletely seen; this rib may be noted in small *whitleyanum*, but is missing in the larger shells; a large chitinous edge is exposed, and the outer cone is covered with a chitinous hood, which does not surround the spine, so that this is not detached in drying. The spine is strongly recurved and round as in *whitleyanum*. The type, from Keppel Bay, Queensland, measures 135 mm. in length by 50 mm. in breadth; a series from Lindeman Island, Queensland, measuring 58 by 24 mm., 90 by 33 mm., 124 by 42 mm., and 146 by 51 mm. The bone collected by Mr. and Mrs. R. Page at Bucasra Beach, near Mackay, Queensland, measured 110 mm. by 43 mm., and is not used as type, as the horny hood is glistening white, and may even represent a different form, for all the others from Queensland, which have been collected at eleven localities, show a yellow hood.

As above noted, bones vary in breadth, so that the differentiation into forms must be left to the examination of animal features. Thus, the species has been collected at Melville Island, Northern Territory, Timor Sea, Broome, North-west Australia, Port Cloates, North-west Australia and Shark Bay, the Western specimens collected by Whitley. The Timor Sea bone, found floating, is a narrow one, measuring 120 mm. by 39 mm., while the Point Cloates specimen is a broad one, measuring 140 mm. by 50 mm., an immature from Shark Bay measuring 60 mm. by 25 mm.

Acanthosepion ellipticum, Hoyle.

Hoyle described (12) this species from "Challenger" Station 188 in the Arafura Sea, but included in Queensland waters. It is a small species for the series, and is remarkable for the formation of the inner cone which produces a cup-like effect, but the outer edge of the cup is thin and almost, as it were, hinged in front. This is so different from the other forms of *Acanthosepion* that a sub-genus *Fiscisepia* (16) has been introduced for it. The bones from the Capricorn Group, at the southern end of the Great Barrier Reef, were found to be larger and the dorsal sculpture less pronounced, and as the variation of the form was unknown, were given a sub-specific name *adjacens* (16). Specimens have been secured at all collecting grounds from Keppel Bay northward in Queensland as well as in the Pellew Group, Gulf of Carpentaria; Melville Ieland, Northern Territory, and along the north-west of Australia as far south as Broome. Measurements of the bone of the type specimen were not given, but the figure (13), natural size, measures 72 mm. by 31 mm., while that of *adjacens* was 105 by 46 mm. Large collections, since received, allow more measurements, the largest of a large series from Melville Island measuring from 47 mm. by 20 mm. to 97 by 37 mm., 98 by 42 mm. and 99 by 43 mm. A series from Low Island, Queensland, ranged from 49 by 23 mm. to 99 by 45 mm., to 101 by 45 mm., and 106 by 44 mm. Three from Broome, Western Australia, measured 68 by 32 mm., 80 by 35 mm., and 80 by 37 mm., thus approaching nearer the measurements of the typical form.

A collection of cuttlebones made recently by Mrs. Joy Kerslake at the Clarence River beaches included a specimen of *A. e. adjacens*, a new record for New South Wales.

Acanthosepion glauerti, Cotton.

The description and figure (6) of this species from Rottnest Is., Western Australia, suggests that it might be an immature of a species of *Acanthosepion*. The general characters of the genus are displayed in the figures given by Cotton. No specimens have yet been recognised in Whitley's collection, which indicates that it might be a wanderer south only. The type was 50 mm. by 23 mm., and 6 mm. thick.

Acanthosepion smithi, Hoyle.

This is another of the species described (12) from "Challenger" Station 188 in the Arafura Sea, but this one has not yet been recognised. Adam (3) has made the name a synonym of *aculeata*, which from the figure and description it certainly is not. These species (of *Acanthosepion)* do not differ from the juvenile to the adult. The immature of *aculeata* shows an inner cone cup, as in the adult, but *smithi* does not show any signs of such a cup in the figure (13). However, the description states that the inner cone is well developed, with a thickened rounded margin, enclosing a deep pit. The type was not measured, but the measurements of another bone were given as 84 mm. by 30 mm.

Crumenasepia hulliana, Iredale.

The large corneous inner cone was given as the distinctive feature of this group, when the species was described (16) from North Queensland, while it was noted from the Capricorn Group, and the Pellew Group in the Gulf of Carpentaria. Later Cotton added an allied form (6) from Cottesloe, Western Australia, naming it C. *ursulae*, and specimens have been seen from Geraldton, and also from the Timor Sea, Whitley collecting some floating bones in the lastnamed locality. Mel. Ward also secured it at Melville Island, Northern Territory. The eastern form has been received from Lord Howe Island and New Caledonia. Adam (1) has lumped all the species of *Crumenasepia* under the name *rouxii*, given to a bone from Bombay, India, supposing a range from Somaliland to Japan, although differences have been recorded in the animals from various localities, and names proposed by efficient students.

The type of *hulliana* from Howick Island measures 180 mm. by 65 mm., and all sizes from 53 by 20 mm., 120 by 39 mm., 120 by 44 mm., reaching over 220 mm. by 75 mm. have been measured.

In the very small ones the corneous inner cone is present and recognisable. Whitley collected some very large bones of *ursulae* at Geraldton measuring 290 mm. by 107 mm.

Ponderisepia eclogaria, Iredale.

This large shell was decsribed (16) from the Capricorn Group, South Queensland, and noted from North Queensland, New Caledonia, New Hebrides and Fiji. This species has been synonymised with *latimanus* and *hercules* by Adam (3), but it does not agree with the description of *latimanus,* and it is a smaller shell, with minor differences, than *hercules,* a Japanese species. No long series has been secured from the various localities, but, in the few bones available, the Fiji bone suggests separation. The type measured 326 mm. by 128 mm., and is almost the limit so far seen, one reaching 330 by 130 mm., others ranging from 120 by 43, through 130 by 45, 190 by 65, and 240 by 90 mm., in a series collected by Mel. Ward in Queensland. Although Whitley collected extensively in Western Australia, he did not find any specimens, neither did Mel. Ward in North-western Australia.

Metasepia pfefferi, Hoyle.

The formation of the bone in this genus is quite unlike that of any other *Sepia,* being small and diamond-shaped. It was described (12) and figured (13) from Station 188 of the cruise of the "Challenger," just inside Queensland waters, west of Torres Strait, and the broader shell found at the southern end of the Great Barrier Reef, the Capricorn Group, was given a sub-specific name *laxior* (16). It has been found at other places along the Queensland coast, at Stradbroke Island, North Keppel Island, Lindeman Island, Michaelmas Cay and Low Isles while Whitley collected specimens at Denham Bay, Shark's Bay, Western Australia. At the introduction of *laxior,* it was mentioned that Hoyle's type measured 45 by 24 mm., while the three *laxior* were 51 by 32, 36 by 24, 27 by 16 mm.; "also that the largest showed a calcification suggesting formation of a spine." The collections abovementioned show the presence of a spine, but it is scarcely calcified, the chitonous dorsal covering being produced as seen in the figure. This genus is the only one yet known which shows the retention of the chitin, which is seen only at the edges in the rest of the group, uncovered by calcination. In some genera such as *Ponderisepia* the calcine covering is thick, and can be flaked off, but in others, as *Amplisepia,* it is so thin that it is almost fused with the chitin.

The Denham Bay form, figured on Plate v, figs. 9, 10, 11, may be called *M.p. wanda,* subsp. nov. The specimen figured is a small one measuring 32 mm, by 20 mm. with 8 mm. in depth. The long horny spine is shown, and there is no calcification present, but a larger one shows a very slight touch, but not as much as in the eastern form. The western one, moreover, shows little calcification of the inner limbs, while in the eastern the inner limbs are well calcified. The ventral surface becomes more swollen with age and size, and a deep median furrow is developed. A larger specimen measured 38 mm. by 23 mm., while a specimen from Stradbroke Island, South Queensland, measured 43 mm. by 27 mm.

Sepiella m.elwardi sp. nov. Plate v, figs 1-6.

The bones of the group known as *Sepiella* are notably different from any of the *Sepia* bones, and there appears to be a number of species, not one, as claimed by some workers. Species have been named from various places, from the Red Sea to the Moluccas, and the animals have been reviewed by Adam (3). The animals are superficially similar to those of other Cuttlefishes, but the anatomy differs, a superficial character being the existence of a glandular pore at the posterior extremity between the fins. The bone differs at sight in the production of a chitinous fan at the posterior end, and there seems to be a wide difference in the bones, attributed to sexual features. Adam (3) has reviewed the named species, amalgamating some forms irrespective of geographical distribution and then naming a new species, *S. weberi* from the Moluccas. This was a small species, the male bone measuring 57.5 mm. by 17 mm. by 7 mm. thick, with the last loculus 21 per cent. of the bone, the female bone measuring 67 mm. by 20.5 mm. by 7 mm. thick, with 25.5 per cent. for the last loculus.

Melbourne Ward collected at Condon Bay, Melville Island, Northern Territory, over fifty bones, mostly broken posteriorly, but all of them, when complete, would be smaller than the above figures They are roughly separable into two series which are here accepted as male and female, the smaller (male) showing a notch in the horny posterior fan, the larger (female) lacking such a notch. The type female measures 53 by 18 mm. by 6.5 mm. thick, and the male 44 mm. by 14 mm. by 6 mm. thick. The figures are explanatory, the dorsal area being medially ribbed, being much more curved in the female, in which the horny fan is more extensive. The female is much wider and proportionately less elevated, the last loculus also varying, being much longer in the female. There is a slight circular depression toward the end of the last loculus in the female, while it is larger and more notable in the male.

An animal was dredged in 40 fathoms S.E. of Lesueur Island, North-western Australia, and the bone was decalcified by the preservative, but it almost certainly will belong to this species.

Rejected Species.

Two Indian species have been recorded from Australia, *Sepia Indica* Orb, and *S. rostrata* Orb. Neither occurs, the records being based on *Acanthosepion*-like species. In a note on southern India *Sepia*, Winckworth recognised three species of the genus as being common, with a new one of which only two specimens had been found, while *Sepiella* was also abundant. Hornell (11) stated that during the months of February-March bones occurred so numerously that "a woman can collect several hundreds a day." Winckworth (27) admitted. "*Sepia rouxii* with three syonyms; *Sepia aculeata* of which *indica* had a narrower shell; and *Sepia rostrata,* which has also two forms." The new species was named *S. prashadi,* without comparing it with its apparent congeners. Now Adam (2) has named the "*rostrata*" shell of Winckworth, as different, calling it *winckworthi,* but also included *smithi* as a synonym of *aculeata,* though the illustrations are nothing much alike.

The African species, *capensis,* has also figured in connection with Australian bones, but does not occur here. The correct specific name is *australis,* and while sometimes *Glyptosepia* bones have been mistaken, at others very unlike bones, as those of *Decorisepia rex,* have been referred to *capensis.*

The Southern Australian bones sometimes appear from figures to resemble closely South African species, but no close relationship of animals has yet been established.

REFERENCES.

1. ADAM, W. (1939).—Bull. Mus. Hist. Nat. Belg., vol. xv, No. 18.
2. ADAM, W. (1939).—Bull. Mus. Hist. Nat. Belg., vol. xv, No. 32.
3. ADAM, W. (1939).—Siboga-Expeditie, livr. 135, pp. 1-122, pls. i-iv, table, and text-figs.
4. BERRY, S. (1918).—Biol. Res. Fishing Exper. "Endeavour," vol. iv, pt. 5, pp. 258-276, pls. lxxi-lxxvii, text-figs. 48-61.
5. CHAPMAN, F. (1912).—Victorian Naturalist, vol. xxxix, pp. 23-25, pl. 1.
6. COTTON, B. C. (1929).—Journ. Roy. Soc. W. Austr., vol. xv, pp. 87-94, pls. xiv-xvi.
7. COTTON, B. C. (1931).—South Australian Naturalist, vol. xii, pp, 39-41, figs. 1-8.

7a. COTTON, B. C. (1932).—Rec. S. Austr. Mus., vol. iv, p. 546, figs. 7-9,

8. COTTON, B. C., & GODFREY, F. K. (1940).—Molluscs of South Australia, part ii, pp. 417-442, figs. 406-428.
9. COTTON, B. C., & GODFREY, F. K. (1940).—Malac. Soc. South Austr., publ. No. 2, Syst. List Pelecypoda, etc., Cephalop., pp. 20-21.

9a. COTTON, B. C. (1946).—South Australian Shells, pl. iii, figs. 48-51 (animals and bones.
10. GRAY, J. E. (1849).—Cat. Moll. Ceph. Coll. Brit. Mus. 1, pp. 96-112.
11. HORNELL, J. (1922).—Common Molluscs of South India (Madras Fisheries Bull., vol. xiv, pp. 206-208, figs. 59-60).
12. HOYLE, W. (1885).—Ann. Mag. Nat. Hist., ser. 5, vol. xvi, pp. 189-199.
13. HOYLE, W. (1886).—Challenger Reports, vol. xvi, pp. 1-245, pls. i-xxv, text-figs. 5-6.
14. HOYLE, W. (1909).—Proc. Roy. Phys. Soc. Edinb., vol. xvii, p. 266.
15. IREDALE, T. (1926)—Australian Zoologist, vol. iv, pp. 186-196, pls. xxi-xxiii, text-figs. 5-6.
16. IREDALE, T. (1926).—Australian Zoologist, vol. iv, pp. 237-240, pl. xxxv.
17 IREDALE, T. (1940).—Australian Zoologist, vol. ix, p. 442.
18. MACPHERSON, H., & CHAPPLE, S. H. (1951).—Mem. Nat. Mus. Melbourne, No. 17, p. 156.
18a. MAY, W. L. (1923).—Ill. Index Tasmanian Shells, pl. xiii, figs. 1-3.
19. McCOY, F. (1889).—Prodrom. Zool. Victoria, dec. xix, pls. 188, 189 and 190; text pp. 325-327.
20. MEYER, W. T. (1909).—Fauna Sudwest. Austr., vol. ii, pp. 332-335, figs. 4-11.
21. ORBIGNY, A. (1848)—Hist. Nat. Cephal. acet.
21a. OWEN, R. (1881).—Trans. Zool. Soc. Lond., vol. xi, p. 134, pls. xxiv-xxv.
22. PFEFFER, G. J. (1884).—Abhandl. Geb. Naturwissen. Ver. Hamburg, vol. viii, heft ii, pp. 63-90, pls. i-iii.
23. QUOY, J. R. C., & GAIMARD, J. P. (1832).—Voy. Astrolabe, Zool., vol. ii, p. 68, pl. ii, figs. 3-11.
24. ROCHEBRUNE, A. T. (1884).—Bull. Soc. Philom. Paris, ser. 7, vol. viii, pp. 74-112.
25. VERCO, J. (1907).—Trans. Roy. Soc. South Aust., vol. xxxi, p. 213, pl. xxvii, fig. 6.
26. VERCO, J., & COTTON, B. C. (1928).—Rec. South Austr. Mus., vol. iv, pp. 125-133.
27. WINCKWORTH, R. (1936).—Proceed. Malac. Soc. (Lond.), vol. xxii, pp. 16-17, pl. iv.

EXPLANATION OF PLATES.

Plate iv.

	Length.	Breadth.	Thick.	
Figs. 1 & 2—*Amplisepia parysatis* Iredale	195 mm.	70 mm.		Type
Figs. 3 & 4—*Mesembrisepia irvingi* Meyer	142 mm.	40 mm.	16 mm.	
Figs. 5 & 6—*Mesembrisepia ostanes* Iredale	140 mm.	50 mm.	10 mm.	Type
Figs. 7, 8, 9—*Acanthosepion pageorum* Iredale	135 mm.	50 mm.		Type
Figs. 10, 11, 12—*Arctosepia rhoda* Iredale	52 mm.	12 mm.	6 mm.	Type

Plate v.

	Length.	Breadth.	Thick.	
Figs. 1, 2, 3—*Sepiella melwardi* Iredale	53 mm.	18 mm.	6.5 mm.	Type
Figs. 4, 5. 6—*Sepiella melwardi* Iredale	44 mm.	14 mm.	6 mm.	
Figs. 7, 8—*Tenuisepia mira* Cotton	48 mm.	10 mm.		
Figs. 9, 10, 11—*Metasepia pfefferi wanda* Iredale	32 mm.	20 mm.	8 mm.	Type
Figs. 12, 13, 14—*Blandosepia baxteri* Iredale ...	83 mm.	37 mm.		
Figs. 15, 16—*Blandosepia bartletti* Iredale	73 mm.	36 mm.		Type
Figs. 17, 18—*Solitosepia genista* Iredale	67 mm.	23 mm.		Type
Figs. 19, 20, 21—*Arctosepia braggi xera* Iredale	78 mm.	16 mm.		Type

CHECK LIST.

Class CEPHALOPODA.

Sub-class DIBRANCHIA.

Order DECACERATA (DECAPODA)

Family SEPIIDAE. Sub-family SOLITOSEPIINAE.

Solitosepia liliana Ired. 1926.—N.S.W., Q.
Solitosepia mestus Gray 1949.—N.S.W., Q., L.H.I.
Solitosepia papuensis Hoyle 1885.— N.Q., N.T.
Solitosepia submestus Ired. 1926.—Q.
Solitosepia lana Ired. 1954.—N.Q.
Solitosepia galei Meyer 1909.—M.W.A.
Solitosepia occidua Cotton 1929.—S.W.A.
Solitosepia genista Ired. 1954—N.W.A.
Solitosepia rozella Ired. 1926.—N.S.W.
Solitosepia rozella peregrina Ired. 1926.—Q., L.H.I.
Solitosepia plangon Gray 1848.—N.S.W., L.H.I.
Solitosepia plangon adhaesa Ired. 1926.—Q.
Blandosepia baxteri Ired. 1940.—L.H.I.
Blandosepia bartletti Ired. 1954—Misima, Louisiade Archipelago.
Mesembrisepia novaehollandiae Hoyle 1909=*dannevigi* Berry 1918.—S.A., Vic., Tas.
Mesembrisepia irvingi Meyer 1909.—S.W.A.
Mesembrisepia ostanes Ired. 1954.—N.W. Tas., S.A., S.W.A.
Mesembrisepia macandrewi Ired. 1926.—S.N.S.W.
Mesembrisepia chirotrema Berry 1918.—S.A., S.W.A.
Amplisepia apama Gray 1849.—S.A., Vic., Tas., S.W.A.
Amplisepia verreauxi Rochebrune 1884.—N.S.W., S.Q., L.H.I.
Amplisepia parysatis Ired. 1954.—M.W.A.
Amplisepia palmata Owen 1881.—Norfolk Island.
Decorisepia rex Ired. 1926.—N.S.W., S.Q., E. Tas., L.H.I.
Decorisepia jaenschi Cotton 1931.—S.A., Vic.
Decorisepia cottesloensis Cotton 1929.—S.W.A., Vic.
Glyptosepia opipara Ired. 1926.—N.S.W., Q., L.H.I.
Glyptosepia cultrata Hoyle 1885.—S.N.S.W.
Glyptosepia hedleyi Berry 1918.—S.A., S.W.A., W. Tas.
Glyptosepia gemellus Ired. 1926.—N.S.W., S.Q., Vic., E. Tas. L.H.I,
Glyptosepia macilenta Ired. 1926.—N.S.W., S.Q.
Glyptosepia hendryae Cotton 1929.—S.W.A.

Sub-family DORATOSEPIONTINAE.

Arctosepia braggi Verco 1901.—S.A., Vic., S.N.S.W., N. Tas., W.A.
Arctosepia braggi xera Ired. 1954.—N.W. Tas.
Arctosepia limata Ired. 1926.—N.S.W., S.Q., Vic.
Arctosepia versuta Ired. 1926.—N.S.W.
Arctosepia treba Ired. 1954.—N.W. Tas.
Arctosepia rhoda Ired. 1954.—M.W.A.

Sub-family TENUISEPIINAE.

Tenuisepia mira Cotton 1932.—Q., N.N.S.W.

Sub-family ACANTHOSEPIONTINAE.

Acanthosepion whitleyanum Ired. 1926.—N.S.W., Q.
Acanthosepion pageorum Ired. 1954.—Q., N.T., W.A.
Acanthosepion glauerti Cotton 1929.—S.W.A.
Acanthosepion smithi Hoyle 1885.—N.Q.,
A. (Fiscisepia) ellipticum Hoyle 1885.—N.Q., N.T., W.A.
A. (Fiscisepia) ellipticum adjacens Ired. 1926.—S.Q., N.N.S.W.
Crumenasepia hulliana Ired. 1926.—Q., N.T., L.H.I,
Crumenasepia hulliana ursulae Cotton 1929.—S.W.A.
Ponderisepia eclogaria Ired. 1926.—Q.

Family METASEPIIDAE.

Metasepia pfefferi Hoyle 1885.—N.Q.
Metasepia pfefferi laxior Ired. 1926.—S.Q.
Metasepia pfefferi wanda Ired. 1954.—N.T., N.W.A.

Family SEPIELLIDAE.

Sepiella melwardi Ired. 1954.—N.T., N.W.A.

Key to Abbreviations.—E. Tas., eastern Tasmania; L.H.I., Lord Howe Island; M.W.A., mid-western Australia; N.N.S.W., northern New South Wales; N.Q., north Queensland; N.S.W., New South Wales; N.T., Northern Territory; N.W.A., north-western Australia; N.W. Tas., north-western Tasmania; Q., Queensland; S.A., South Australia; S.N.S.W., southern New South Wales; S.Q., southern Queensland; S.W.A., south-western Australia; Tas., Tasmania; Vic., Victoria; WA,. Western Australia; and W. Tas., western Tasmania.

All the references necessary may be traced through the reference list here given The distribution of the species in the different States is not yet well known, the number of species recorded being as follows: New South Wales, 17; Queensland, 20; Victoria, 7; Tasmania, 7; South Australia, 7; Western Australia, 18; and Northern Territory, 5. As Torres Strait and the Northern Territory have not yet been thoroughly explored for these bones, probably most additions will be made from these localities. All the types and series studied are in the Australian Museum, the new names proposed in this paper being *Solitosepia lana*, *S. genista*, *Blandosepia bartletti*, *Mesembrisepia ostanes*, *Amplisepia parysatis*, *Arctosepia braggi xera*, *A. treba*, *A. rhoda*, *Acanthosepion pageorum*,, *Metasepia pfefferi wanda*, and *Sepiella melwardi*.

BOOK REVIEWS.

"General Zoology," by Tracy I. Storer Second Edition, 1951; pp. 1-832+xii. Profusely illustrated. McGraw-Hill Book Company, Inc., New York. Price, £3/4/3.

This second edition of Storer's "General Zoology" brings up to date and improves a textbook that is already deservedly popular in many countries. The book is arranged in a simple, clear fashion, and is well illustrated, so that it is especially suitable for anyone studying zoology for the first time.

Professor Storer uses the classical approach to the subject. In part I he deals in some detail with the frog, as a representative animal, and then passes to a brief but excellent survey of comparative animal biology. This leads naturally to discussion on heredity, genetics, ecology, distribution and evolution. The history of zoology is also dealt with most interestingly, and the first section of the book concludes with a clear account of animal classification and nomenclature.

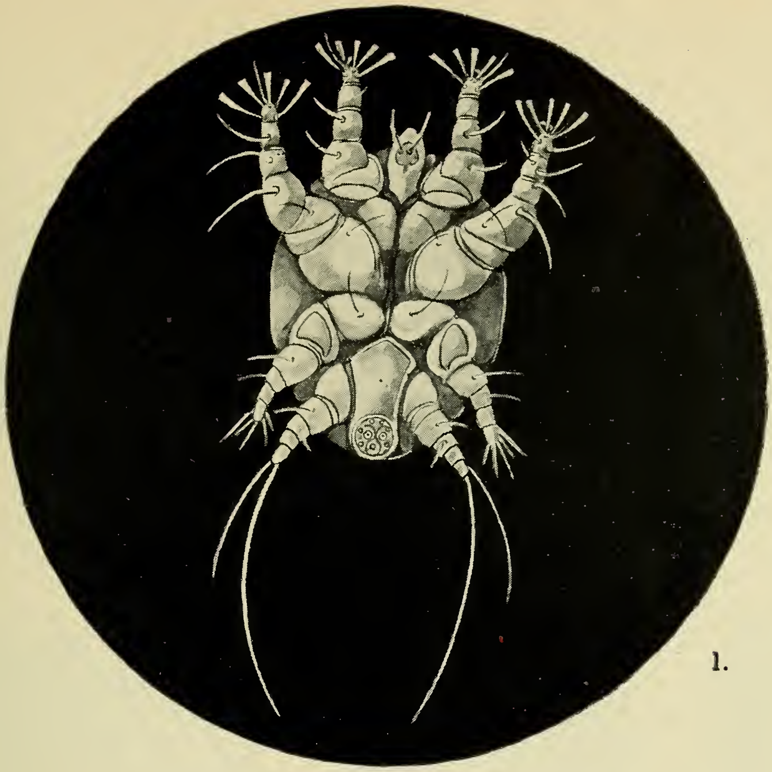
The second and larger section of the book is devoted to a survey of the animal kingdom, and gives a synopsis of this fascinating subject in a surprisingly small space. The illustrations in this section are excellent and deserve special mention, since they would be such a help to the beginner trying to classify his collection. Some of the obscure and smaller groups, generally omitted from elementary text-books as being too difficult for a beginner, are most clearly explained, so that the conspectus of the animal kingdom is complete. Because of this, the book is an excellent one for the amateur naturalist and a splendid reference book for school and private libraries. It can be recommended for any zoologist from school grade to senior University standard.

—E. Pope.

"Bees of the Portland District." By Tarlton Rayment. 8vo. Published by the Portland Field Naturalists' Club, Victoria, Australia, on the Coronation Day of Queen Elizabeth II, June, 1953; pp. 1-39, 1 pl., 3 figs.

This brochure treats with the native bees found in the historic district of Portland, Victoria. Over twenty new species are described, and sub-species and allotypes of other forms recorded. In addition the author gives interesting notes on the biology of certain species. Among the parasites and commensals the author records a new species of mutillid wasp, *Ephutomorpha auricrucis*, parasitic on the larvae of *Euryglossa maculata* Sm., and refers to other species of mutillids which frequent the nests of bees. As references to these, and other insects, are made only in the general description of the bees, they are apt to be overlooked by workers specialising in groups other than the bees themselves. Where insects of other orders or families are thus mentioned, it would be in the best interests of entomology for the author to provide a brief précis at the beginning of the paper.

—A. Musgrave.



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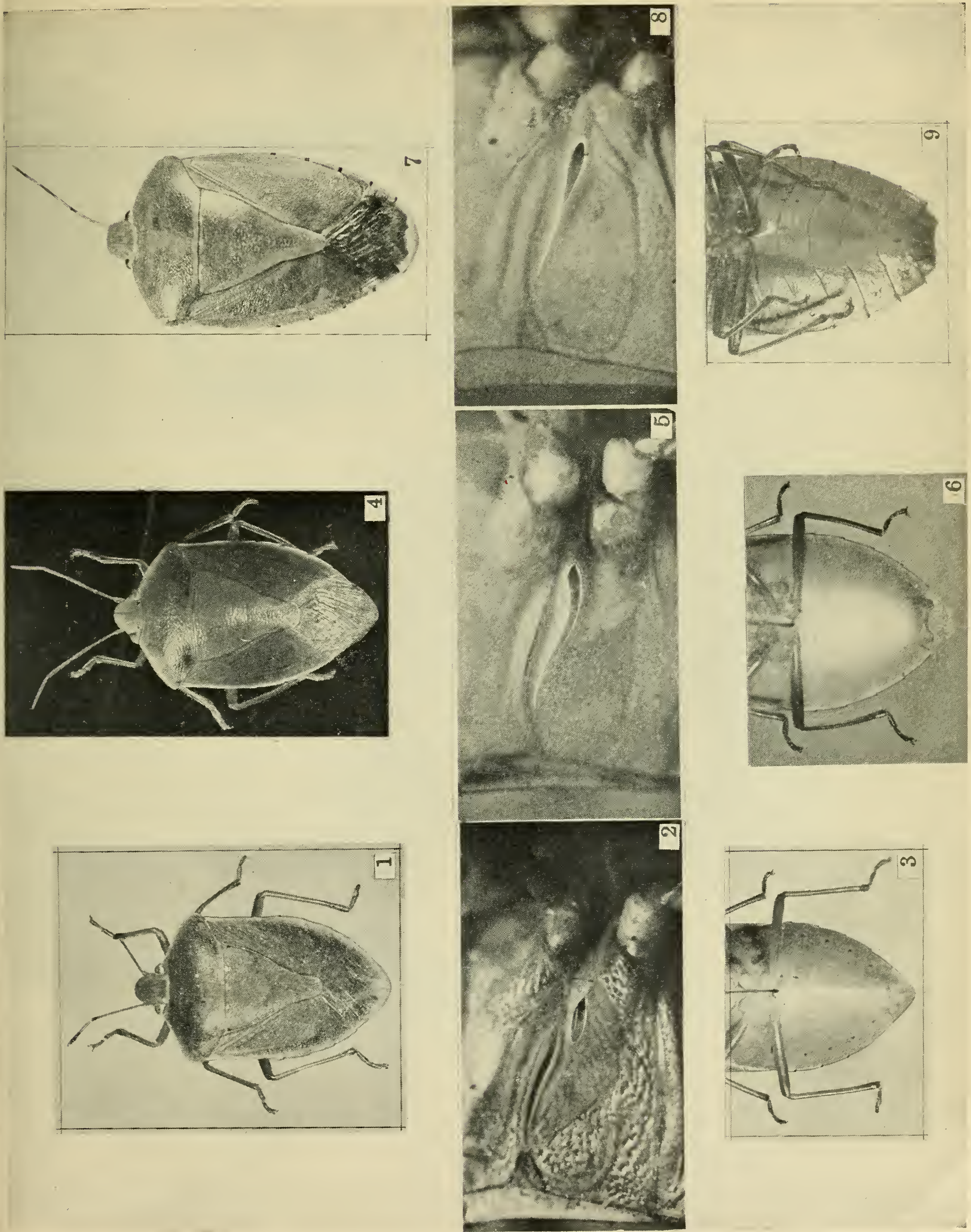

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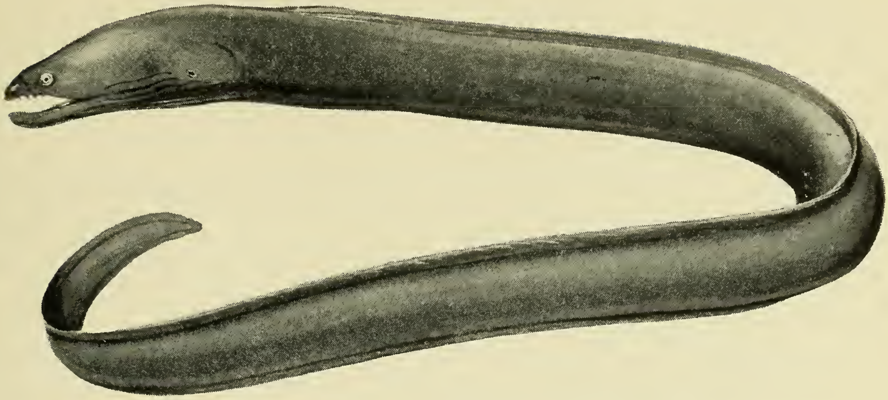

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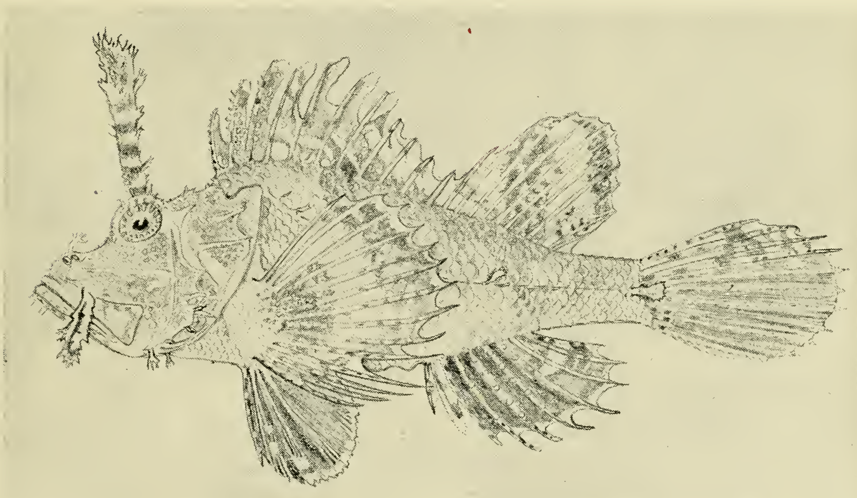

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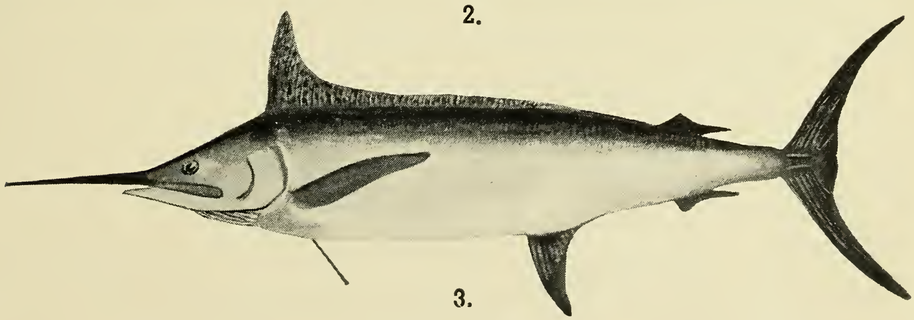

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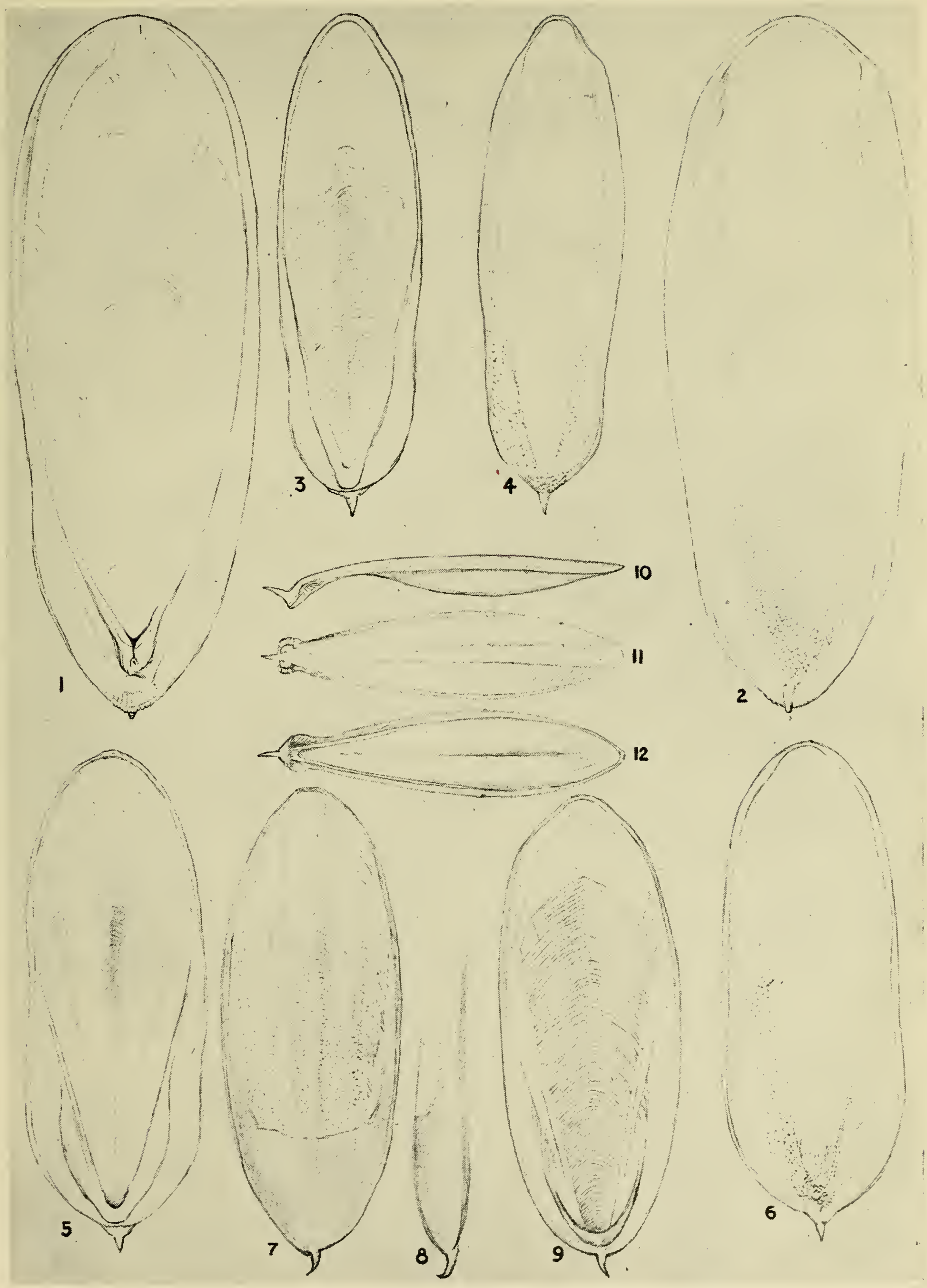
A. Fraser-Brunner, J. Beeman and G. P. Whitley del.



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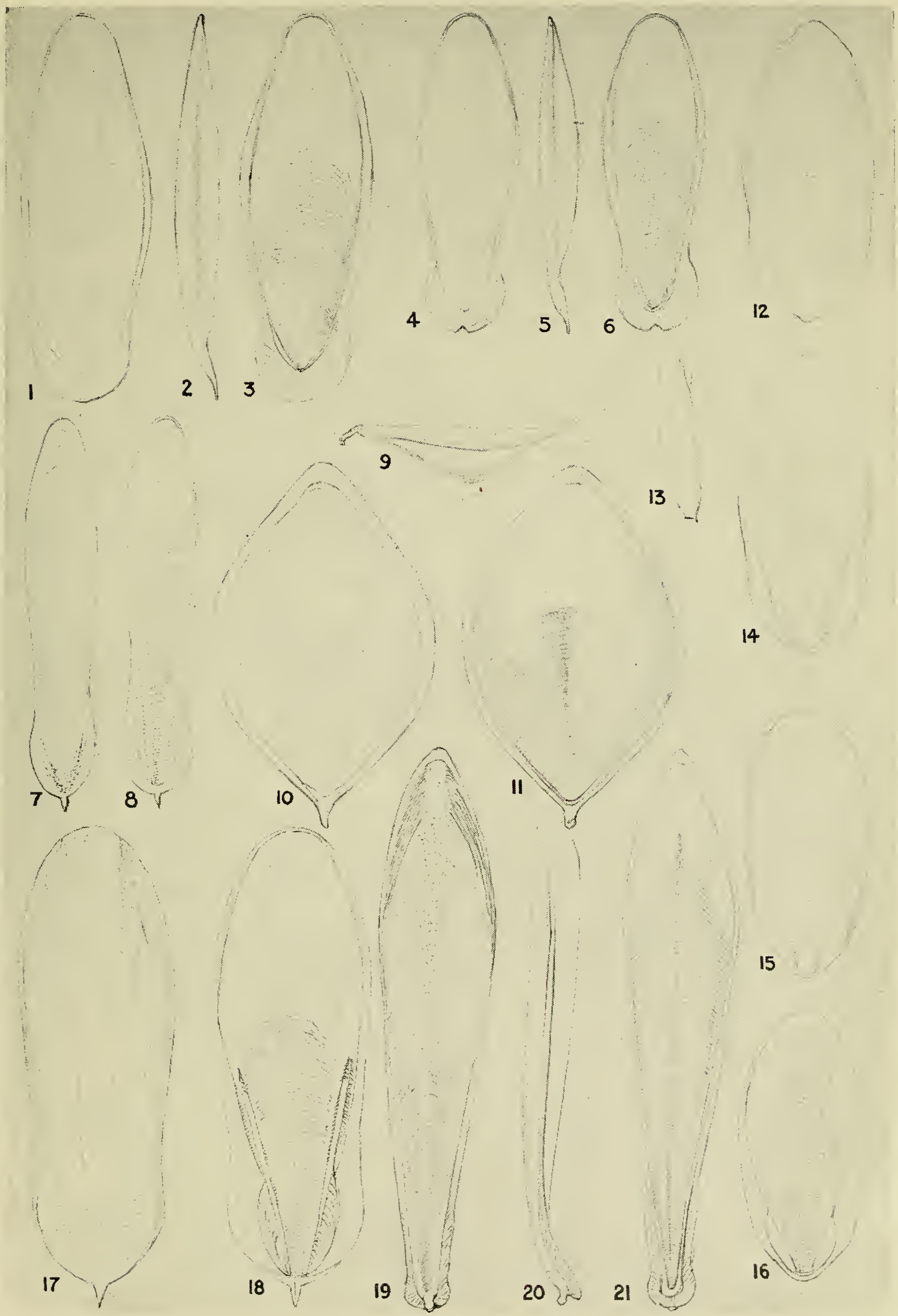

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The females of the vernal (Sept.) generation are indubitably virgins, beautifully colored, with head and thorax of lustrous metallic-green; the abdomen and legs bright apricot. They never leave the parental home because there is no sexual urge driving them forth. They only extend the parental shafts; provision the cells, and deposit eggs, but none lives to see the progeny emerge.

The mid-summer generation (Dec.) is a bisexual one of jet-black males and females which, after mating, depart from the parental home to found new colonies. The males die shortly after. The autumnal (Mar.) generation are all virgins, but black like their mothers, and their progeny will hibernate over winter, and emerge in spring as the colorful virgins.

Color page printed and donated by The Argus, Melbourne

THE AUSTRALIAN ZOOLOGIST

Vol. XII. Part 2.

Revision of the New South Wales Eulimoid Shells

By CHARLES F. LASERON, F.R.Z.S.
Honorary Correspondent, Australian Museum, Sydney

(Figures 1-78.)

This research has been assisted by a grant from the Science and Industry Endowment Fund.

INTRODUCTION.

Shells attributed to the family Eulimidae from the Peronian Zoogeographical Province are long overdue for a complete revision. The group has never been studied as a whole, and previous authors have contented themselves with describing some of the numerous species, using a few long established generic names, often in a wide and sometimes in a very loose fashion. A very great number of species occurs in the Australian provinces, in New Zealand, and in the tropics, and the older classifications, adapted from the comparatively few European species, are quite inadequate to cope with the wealth of material elsewhere. Such names for instance as *Eulima, Leiostraca, Strombiformis, Melanella* and *Stilifer* have little meaning when applied to Australian forms. This can be seen when different authors have placed the same species sometimes in one, sometimes in others of these genera. Hedley in his Check List used *Eulima, Melanella, Strombiformis* and *Stilifer* for most of the species then described, and May in his Tasmanian list used the same genera, but often differently for the same species. Powell in New Zealand used *Balcis* and *Eulima* to cover similar groups, but with quite a different interpretation, and so the whole classification of the family in southern waters is in a confused state, with no means of checking its possible relationship with the rest of the world.

No differentiation is here made between the Eulimidae proper and the Stiliferae, though most conchologists now consider them as distinct families. The critical shell difference between the two families is that the Eulimidae possess an operculum, the Stiliferae do not. Most of the latter appear to be wholly parasitic, and the fact that some of the undoubted Eulimidae are also parasitic has led some authors wrongly to include them with the Stilifers. It is doubtful if any true Stiliferae have yet been found in the Peronian Province. In Hedley's Check List, the so-called *Stilifer brazieri* possesses an operculum, and is here considered a true eulimid under the new generic name of *Chryseulima*. *Stilifer lodderae* and *S. petterdi* are of very doubtful classification; they are now given the new name of *Stilimella*, but their affinity with any other recognized group is unknown. The shell listed by May from Tasmania as *Stilifer brazieri* is certainly not that species, but has a shell much closer in form to a true *Stilifer* than any of our species. One or two Flindersian forms may also belong to this family. The deep water species, *Eulimoda munita* Hedley, has characters which also somewhat approach the Stilifers, and it also generally resembles the Queensland shell which Hedley named *Scalenostoma striatum* (Proc. Linn. Soc. N.S.W. 1900, p. 507, pl. 36, figs. 15-17). As this species has no operculum, a link with the Stiliferae is suggested.

The difficulties of providing an adequate classification are great. The comparative simplicity of the shell affords few prominent characters to separate the different groups of species. It is obvious when studying the

SEP 1 6 1958

species of a particular province that many such groups exist, often numerically small, but so similar that the conclusion is inevitable that there is a common ancestry, and that such groups of species should have a distinctive generic or subgeneric name. Such genera or subgenera may be represented in adjoining provinces, but the farther away from the locus of ancestral origin, the less likely is relationship between shells of even the same apparent general form.

As far as is known the Eulimidae have no free swimming larval stage, and consequently the geographical range of species is comparatively small. Though many species have been considered as common to the Peronian, Maugean (Tasmanian) and Flindersian Provinces, investigation has in nearly every case shown that the original identifications were wrong, and that different species are indicated. A few species may be temporarily retained as common to the different provinces, but further comparison may show that even here there are differences, at least racial if not specific.

Though many small groups of closely related species can be recognized, it is more difficult to link these groups into larger units. No one or more characters can be found which will link several groups or divide the whole family into a few recognizable divisions. This means that either one genus is used for the whole, or there must be a great number of genera, each with a few species. Faced with the alternative the latter course, though drastic, seems to be nearer the natural truth, and it should also facilitate further study. Whether the new names be considered generic or subgeneric is immaterial, as neither a genus nor subgenus is a natural unit, the degree of relationship of species which decides their use being merely a matter of personal opinion and convenience. Any hesitation in proposing this new subdivision was removed when Mr. Tom Iredale showed me a classification he had prepared many years before. This so coincided with my own that it was hard to realize they had been prepared independently. Some of the new names used, *Curveulima*, *Stricteulima*, *Cuspeulima*, *Hebeulima* and *Eulimoda* were those Mr. Iredale had originally selected.

Of the new genera here proposed, most of the Tasmanian and Southern Australian species will fit within them, though some are not represented south of the Peronian Province. Some definitely extend into Queensland, but in that State, as might be expected, are many others which will need new generic names. A revision of the Queensland forms will be a task of considerable magnitude, for the majority are unnamed, but when in the future this is done, it will be a step towards establishing the relationships and differences of the different provinces of the Australian marine fauna as a whole.

One important shell feature of the Eulimidae seems, curiously enough, to have been entirely overlooked by previous authors, and I can find no reference to it in literature. This is the sinuosity of the outer margin of the aperture when viewed laterally. So constant is this feature in all the species examined, that it can probably be taken as a family characteristic. The sinus is never deep nor slitlike as in the Turridae, but the thin margin of the aperture is typically rounded, bending back both anteriorly and posteriorly where it again recurves upwards to make a shallow recess below the suture.

There is little difference in the general form of the protoconch throughout the family. The initial whorl is in the form of a flat dome, varying greatly in size, and sometimes a little tilted. No sinusigera protoconchs have been seen, nor any terminated by a varix. Nor has any sinistral coiling, as in the Pyramidellidae, been observed. The mucronate apices of *Hypermastus* and the tropical *Mucronalia* are distinctive, but in the other genera the difference is largely one of size, and the possession of either a blunt or acicular apex is very useful for specific and sometimes for generic separation.

Shell texture is also very important. Nearly all the species have thin shells which may be nearly opaque, but which are generally translucent or even quite transparent. Most of the parasitic forms and some of the others have porcellanous shells which are highly polished. Or the texture may be so vitreous that the shells appear to be formed of clear glass. The colour of many species is a milky white, others may be quite colourless, others again are uniformly yellow or brown, or are spotted or banded with brown. This feature seems very constant in the species, and unless the specimens are old and faded is very useful in identification.

The animals and habitats of most of the species are unknown. Only three species in the Peronian Province are known to have a parasitic or commensal existence, and of these one is found on a common starfish, the other two on holothurians. A few other species have been taken alive when dredging, and others in kelp roots or mussel beds, but no observations of their animals have been made. The majority, in fact, have been found in shell sand on the beaches, and many evidently live in the sand below low water on the outer coast.

Most of the material used in this research has been collected by my son John and myself over many years, either directly or picked from samples of shell sand procured by our shell collecting friends. In the preparation of the paper itself I am once again under a deep debt of gratitude to Mr. Tom Iredale, formerly conchologist of the Australian Museum. Completed at a time when sickness has prevented me from leaving the house, he has frequently visited me, discussed problems as they arose, helped me from his great experience and knowledge of literature, and looked up types and references at the Australian Museum itself. In my life I have known no other scientist who has so generously, enthusiastically and unselfishly gone out of his way to help another.

All the types, as well as specimens illustrated, have been presented to the Australian Museum, where they will be kept intact for future reference.

DESCRIPTION OF SPECIES

EULIAMAUSTRA, gen. nov.

Genotype, *Eulima proxima* Sowerby.

Shell elongated, conical and acuminate, whorls numerous and flattened, aperture short, inner margin sometimes slightly reflected. Texture porcellanous, translucent, white, and highly polished.

In the past this well known genotype has been called *Eulima*, and various authors have been content to leave it there without comment. Unfortunately *Eulima* has a long and complicated career in literature, and it has been variously used to include many shells of obviously different relationship. Different authors have even quoted didfferent species as the genotype, but apparently the true *Eulima* is more akin to vitreous shells with long apertures, some of which are listed in Hedley's Check List under *Strombiformis* da Costa. Under the circumstances it seems best to cut the Gordian knot, and propose a new genus for Australian shells with the characters given above.

Nothing is known of the animal, but apparently they live in sand below the limit of low tide.

Eulimaustra proxima (Sowerby).

Plate 1, figs. 1, 2.

Eulima proxima Sowerby, Conch. Icon., xv, 1866, pl. 6, fig. 48.

The type locality is Port Jackson, and it is a well defined species, not uncommon on the outer beaches, and ranging down onto the continental shelf. The specimen figured came from 30-35 fathoms off Crookhaven, its length 11 mm. and width 3.8 mm. The operculum is brown and thin, but too far retracted for examination. Mature specimens have the body whorl rounded, but in immature individuals it is distinctly angular. The shell is porcellanous and very highly polished, the colour pure white, though sometimes appearing brown from the dried animal within.

Eulimaustra anomala, sp. nov.

Plate 1, figs. 3, 4.

Shell elongate, conical, acuminate, apex slightly bent, white, translucent, highly polished. Apex slightly bent, with a minute, oblique protoconch of 1½ whorls. Mature whorls ten, regular, flattened, sutures not distinct, body whorl rather long, rounded anteriorly. Aperture short, pyriform, acuminate posteriorly, not produced anteriorly, outer margin straight, viewed laterally with a slight curve, rather flattened anteriorly and slightly angled with the inner margin which is slightly recurved. Length 5.5 mm., width approximately 1.7 mm.

Locality:—One mature and one juvenile found crawling on a holothurian at Woolgoolga.

Remarks:—It is with some doubt that this is placed in *Eulimaustra*, as its association with a holothurian suggests those species dealt with later under *Chryseulima*. It lacks however, the rounded whorls, and indented sutures of those species. The short but rather elongate aperture also suggests other relationship than with *Eulimaustra*. Its inclusion here can be considered provisional. Its nearest relation is probably the Tasmanian species *Eulima mayii* Tate to which it bears close resemblance.

Genus HYPERMASTUS Pilsbry.

Genotype, *Hypermastus coxi* Pilsbry.

Shell like *Eulimaustra*, white porcellanous, highly polished and with flat whorls and short aperture, but more cylindrical with a convex spire and a peg-like protoconch. Habitat unknown, but generally found in shell sand in deeper water.

This is a well defined group easily recognized by the convex spire and protoconch. Amongst species from beyond Australia I should say that *pervegrandis* Powell from New Zealand undoubtedly comes here.

Hypermastus coxi Pilsbry.

Plate 1, figs. 6, 7, 8.

Pilsbry, Proc. Acad. Nat. Sci., Philad., 1899, p. 258, pl. 11, f. 3-4.

This is not a common species, but a good series was obtained from a sandy bottom, 6-9 fathoms, Sow & Pigs, Reef, Port Jackson. It is rather variable in width and a few specimens have the spire slightly bent, but it is otherwise constant. The specimen illustrated is slenderer than many others, its length 12 mm., and width 2.8 mm.

Hypermastus mucronatus (Sowerby).

Plate 1, figs. 9, 10, 11.

Sowerby, Conch. Icon., xv, 1866, pl. 6, f. 42.

This species is not uncommon in shell sand on the outer beaches, and a good series was obtained from the Ocean Beach, Manly, the specimen figured being 4.7 mm. in length and 1.5 mm. wide. Like *H. coxi*, its range extends to Tasmania, and there seems no difference in specimens from that State. It is very close to *H. coxi* but is less than half the length and relatively much broader.

Hypermastus (?) spp.

Plate 1, figs. 12, 13.

Two minute specimens, each 1.5 mm. in length were sorted from shell sand at Port Stephens; they are of such distinctive appearance that they are here illustrated for future reference. The peg-like apex is of about the same size as and matches that of *Hypermastus* and it is possible that they may be juveniles of two species of that genus. The next two whorls, however, are rounded with an indented suture and do not quite match the smooth summits of either the two species *coxi* or *mucronatus*. If they are mature then they represent two different species of a quite new genus, but much more material must be available before this question can be determined.

CHRYSEULIMA, gen. nov.

Genotype, *Stilifer brazieri* Angas.

Chryseulima is here used tentatively for one of the groups of Eulimidae which are either parasitic or have a commensal association with echinoderms, but excluding *Stilifer* which has no operculum. The bulk of such species are tropical, and the limited data available from the Peronian Province are insufficient to attempt any full revision here. This particular genetic problem needs a much wider field. For instance in northern Australian waters are many molluscs which may belong to the Eulimidae but more likely to the separate family of the Stilifers, and which are completely parasitic within echinoderms particularly the holothurians. These probably have complicated life histories, for it is known that in development towards maturity, such degeneration sometimes takes place that not only the shell virtually disappears but many of the anatomical features of the gasteropod also. This problem is practically untouched, and provides a wide field for future specialized research. It is probable, however, that each species of parasitic mollusc is associated with one species only of asteroid, echinoid or holothurian.

From the tectonic point of view the shell of *Chryseulima* as here used is like that of *Eulimaustra*, white, porcellanous, and highly polished, but is relatively broader, the whorls are rounded and inflated, and the sutures indented. The operculum is thin, almost transparent and pale yellow. The animal has the long anterior extension of the foot characteristic of the Eulimidae, and when crawling the head is kept within the shell, through which the eyes are clearly visible. Slight varices may be present on the shell, extending continuously up the spire.

In southern Australia several species are probably congeneric with *Chryseulima*. Of these one is listed in May's Tasmanian Check List as *Eulima munita* Hedley, and is described as living attached to sea-urchins. It is certainly not Hedley's species which is discussed later in this paper as *Eulimoda munita*, but is apparently an unnamed species of *Chryseulima*. Some of the Queensland species will belong to the same genus; others are of such varied shell-characters that new generic names will be necessary. *Mucronalia* Adams is available for one distinctive group. These range from the Indian Ocean over North Australia, and my son John Laseron has collected undescribed species from Thursday Island and Bowen in Queensland. *Mucronalia* has a very inflated shell and a mucronate apex.

Chryseulima brazieri (Angas).

Plate 1, figs. 14, 15.

Stilifer brazieri, Angas, Proc. Zool. Soc., 1877, p. 173, pl. 26, f. 12.

This is the only local species definitely associated with starfish, and it is quite common, crawling on the ventral surface or even quite within the mouth of the common *Cosinasterias catimaria*. When removed from its host the animal remained alive and active in a jar of seawater for upwards of 24 hours. The specimen figured came from Long Reef, its length being 6.8 mm. and width 2.7 mm. From Shark Island, Port Jackson, in addition to specimens found on *Cosinasterias* a single specimen was found crawling on a brittle star, but this is probably an accidental association. The species is apparently truly parasitic, and feeds on the secretions of its host. In Queensland allied species are found actually encysted in the arms of starfish. It is probable that they find access through an accidental wound or abrasion and then feed on the tissue of the starfish which by further growth completely encloses them.

The shell of *brazieri* is perfectly smooth, lustrous, and sometimes has a slight bend in the spire. The species also appears on the Tasmanian Check List (May 999), as from deep water, but the specimen figured is quite a different shell, and is more akin to the shell of a true *Stilifer*.

Chryseulima solitaria sp. nov.

Plate 1, figs. 16, 17.

Shell small, broadly conical, white, porcellanous, translucent, highly polished. Apex acicular, at a slight angle, of 3½ whorls. Remaining whorls six, short, rounded, a very slight shelf below the sutures, body whorl inflated, sutures indented. Aperture short, prolonged anteriorly, outer margin rounded, flattening a little anteriorly, when viewed laterally round, and very slightly sinuate below the suture. Inner margin nearly straight, reflected. Length 5.5 mm., width 2.2 mm.

Locality:—Crawling on a holothurian, Long Reef (type collected by Mr. D. McAlpine).

Remarks:—This is very close to *C. brazieri*, but apart from living on a different host, it is a shorter, broader shell, the whorls are shorter, slightly flattened, the aperture is slightly a different shape, and the apex is much more acuminate. Unfortunately the specific identity of the host was not noted, but it gives some confirmation to the expectation that each species of echinoderm will harbour its particular species of parasitic mollusc.

Genus CURVEULIMA gen. nov.

Genotype *Curveulima cornuta* Laseron.

Curveulima is here proposed for a well defined group of Australian and Antarctic shells which have been formerly placed under *Melanella* Bowdich. *Melanella* was proposed as long ago as 1822, preceding *Eulima* by four years, and in a broad sense can be applied to most of the European species which are called *Eulima*. In 1889 Dall (Bull. Mus. Comp. Zool., xviii, p. 376) suggested the use of *Melanella* for eulimids with bent spires. It is very doubtful if the Australian shells have any real relationship with the European forms, and the loose usage of *Melanella* can be very deceptive, suggesting as it does a world-wide distribution and possible relationships which do not really exist.

The characters of *Curveulima* as here used are as follows. All the species are small, more or less conical, vitreous and transparent, white to colourless, with bent and twisted spires. The apertures are short and exert, the outer margin thin and viewed laterally rounded and sinuate below the suture. The inner margin is generally slightly reflected. The habitat is not known, but they probably live in sand below the limit of low tide. The form suggests that they might be parasitic, but as they are quite common in shell sand on the outer beaches, and have never been noticed in association with any other organism, this is unlikely. One specimen which was dredged alive shows what is apparently a thin operculum, but it was too far retracted for examination.

Separation into species has not been easy, owing mainly to individual variation. Very little work has been done previously. Two or three species have been described from Tasmania and South Australia, and subsequent authors have been content to give these names to Peronian species without critical examination. Thus the Tasmanian species *petterdi* was identified by Hedley from the "Thetis" Expedition, while *commensalis* and *petterdi* were identified by Tate from Port Stephens. These two species were included in Hedley's Check List in 1917.

Examination of long series collected from the ocean beaches shows, however, that many more species exist. Seven have so far been sorted out, and as none of these can be identified either with *petterdi* or *commensalis* all are proposed as new. In order to clarify the identification of *commensalis* I wrote to Mr. B. C. Cotton of the South Australian Museum, and he kindly sent me typical specimens of Tate's species for comparison. These were commensal or parasitic on echinoids. These resemble the species I have called *litoris* but are broader at the base and have a much deeper sinus in the margin of the aperture. I am satisfied the true *commensalis* has not been found in New South Wales. (See figs. 76, 77). Though there is some degree of variation within each species, there are certain characters, not always obvious, which are constant enough to be definitely specific. The chief of these characters is the apex, which may be very broad and rounded as in *obtusa*, intermediate in two other species, or acuminate in three more. The relative length of the body whorl and aperture, the rotundity or otherwise of the whorls, and the texture are other useful features for recognition. The following key will give a guide to the N.S.W. species.

A. Aperture and body whorl long.	1. *cornuta*
B. Aperture and body whorl short.	
a. Apex very blunt.	2. *obtusa*
b. Apex intermediate.	
Shell broad and pyramidal.	3. *lata*
Shell narrow, flattened whorls.	4. *subobtusa*
c. Apex acuminate.	
Medium width, rounded aperture.	5. *litoris*
Narrow, aperture flattened anteriorly.	6. *abrupta*
Slender, colourless and transparent.	7. *manifesta*

Another character shown in the drawings is important and constant, that is the relative curvature of the aperture when viewed laterally and the depth of the subsutural sinus.

It is probable that *Curveulima* is confined to southern waters. Outside Australia at least one species occurs off the Antarctic continent, *Melanella laseroni* having been described by Hedley.

Curveulima cornuta, sp. nov.

Plate 1, figs. 18, 19.

Shell of average size for the genus, conical with the spire strongly and regularly curved, white to nearly colourless, vitreous and quite transparent. Apex rounded, and of intermediate obtuseness. Whorls eight, flattened, sutures not impressed and sometimes hardly visible. Body whorl very long, about half the total length, evenly rounded to the base. Aperture long and lunate, not produced anteriorly, outer margin regularly curved and arcuate, making a sharp angle with the nearly straight inner margin, which is only very slightly reflected. Outer margin laterally evenly curved with a narrow sinus below the suture. Length 4.5 mm., width 1.5 mm. approximately.

Localities:—Ocean Beach, Manly (type); common also on other ocean beaches, Port Stephens, Cronulla, etc.

Remarks:—This is apparently the species previously identified with *petterdi* which has the same long body whorl and aperture. The true Tasmanian *petterdi* has, however, a slenderer and more elongate shell with a greater number of whorls.

Curveulima obtusa, sp. nov.

Plate 1, figs. 20, 21.

Shell of average size for the group, conical, with bent spire, white, texture vitreous and shining, translucent. Apex blunt, the protoconch a single, broad, dome-shaped whorl. Remaining whorls seven, generally slightly rounded but occasionally nearly flat, sutures slightly indented, body whorl rounded. Aperture short, slightly produced anteriorly, outer margin rounded, laterally only slightly rounded and very slightly sinuate below the suture. Inner margin curved and slightly reflected. Length 4.5 mm., width 1.7 mm. approximately.

Localities:—Ocean Beach, Manly (type); Port Stephens and other beaches (fairly common).

Remarks:—The very blunt apex at once distinguishes this from all other local species. It is somewhat variable, particularly in width, and some specimens have the whorls flatter and the sutures less indented than others.

Curveulima lata, sp. nov.

Plate 1, fig. 22.

Shell broadly conical, spire curved, white, semi-porcellanous, translucent. Apex blunt, but not so much as in *C. obtusa*, the protoconch a single, dome-shaped whorl. Remainder of whorls seven, short, slightly rounded, sutures slightly indented. Body whorl large, inflated, slightly angled at the base. Aperture short and wide, extended anteriorly, outer margin rounded, inner margin curved and slightly reflected. Length 3.6 mm., width 1.6 mm. approximately.

Locality:—14 fathoms off Long Reef.

Remarks:—This most resembles *C. obtusa*, but the apex is not so blunt, the shell is much wider, the body whorl is slightly angled at the base, and the texture is rather heavier and not so transparent.

Curveulima subobtusa, sp. nov.

Plate 1, fig. 23.

Shell comparatively large, conical, narrow, spire regularly curved, white, translucent. Apex rounded, obtuse but not broadly so. Whorls eight, short, nearly flat, sutures faintly impressed but distinct. Body whorl short, flat to the periphery, sub-angled and curved to the base. Aperture ovate, broad, short, slightly produced anteriorly. Outer, anterior and inner margins rounded, the latter slightly reflected. Outer margin of type slightly imperfect, but apparently laterally sinuate. Length 3.9 mm., width 1.3 mm. approximately.

Locality:—From seaweed washings, Long Reef.

Remarks:—With *C. lata* this species forms a group within the genus with moderately blunt apices. It differs from *lata* mainly by being much narrower, and by having more and flatter whorls. The aperture is also rather different in shape, and less rounded.

Curveulima litoris, sp. nov.

Plate 1, figs. 24, 25.

Shell small, conical, spire bent, white, vitreous and transparent. Apex acuminate with a small dome-shaped protoconch. Remaining whorls 9, slightly rounded with slightly indented sutures, but this character is variable as some specimens have the whorls nearly flat. Body whorl inflated, rounded. Aperture short, not extended anteriorly, expanded, outer margin rounded, laterally very rounded with a short sub-sutural sinus. Inner margin rather straight, slightly reflected. Length 3.5 mm., width 1.3 mm. approximately.

Locality:—Manly Beach, fairly common.

Remarks:—Though somewhat variable both in width and in the rotundity of the whorls, the acute apex at once distinguishes this from *C. obtusa*, which it generally resembles in form. This is probably the species previously identified as the South Australian *Eulima commensalis* Tate, but comparison with specimens of typical *commensalis* show that it is not that species.

Curveulima abrupta, sp. nov.

Plate 1, figs. 26, 27.

Shell small, slender, pale white, vitreous and transparent. Spire curved. Apex acuminate with a single-whorled dome-shaped protoconch. Remaining whorls nine, nearly flat, sutures hardly indented. Body whorl not inflated, flat and rounded on the base. Aperture short, extended anteriorly, rather narrow, outer margin rounded but flattened anteriorly, making nearly a right angle with the straight, slightly reflected inner margin. Outer margin laterally rounded, sinuate below the suture. Length 2.9 mm., width .8 mm. approximately.

Locality:—Ocean Beach, Manly.

Remarks:—This is the second species with an acuminate apex, and at the same time it is the narrowest of the species discussed. The form of the aperture also differs from the other species.

Curveulima manifesta, sp. nov.

Plate 1, figs. 28, 29.

Shell small, very thin, elongate, spire curved, colourless and quite transparent. Animal brown, showing through the shell, and with apparently a thin brown operculum, but too far retracted for examination. Apex acuminate, protoconch as in the other species. Mature whorls nine, slightly curved, sutures indented. Body whorl rounded and slightly inflated. Aperture oval, extended anteriorly, outer margin rounded, rounded anteriorly, inner margin also rounded and slightly reflected. Outer margin viewed laterally strongly rounded and bent back towards the sub-sutural sinus. Length 3.3 mm., width 1 mm. approximately.

Locality:—30-35 fathoms off Crookhaven.

Remarks:—This is another slender, acuminate species, but it differs from *abrupta* in the form of the aperture, and from this and all the other species by its very thin shell and vitreous, colourless and quite transparent texture.

STICTEULIMA, gen. nov.

Genotype *Sticteulima cameroni* Laseron.

Shell sub-porcellanous, translucent, form like *Curveulima* with a bent spire, but of irregular growth and irregularly spotted with chestnut. Inner margin strongly reflected and a layer of callus on the body whorl.

This forms a small natural group of species akin probably to *Curveulima*. There is a species from the Hope Islands, Queensland; the genotype is from northern New South Wales, and other species are found in the Indian Ocean.

Sticteulima cameroni, sp. nov.

Plate 2, figs. 30, 31.

Shell slenderly conical, of irregular growth, spire bent, sub-porcellanous, tranuslucent, white, irregularly covered with chestnut dots. The disposition of the coloured spots varies in individual shells, they are sometimes isolated, at other times segregated into irregular patches, or they may be partially confluent in lines. Apex rather acuminate, whorls nine, their curvature varying in the one specimen, of irregular growth, the overlap of previous whorls varying considerably, body whorl rather long, extended anteriorly, moderately inflated. Aperture rather long, outer margin curved, inner margin strongly reflected, a thin layer of callus on the body whorl. Outer margin viewed laterally curved with a shallow wide sinus below the suture. Length 5.5 mm., width approximately 1.9 mm.

Localities:—Angowrie, Clarence River (type collected by Mr. A. Cameron); shell sand, Port Stephens.

Remarks:—This comes very close to *S. piperita* Hedley from the Hope Islands, Queensland, but is more than twice the size, is relatively slenderer, and has the inner margin of the aperture more strongly reflected. It is possible that the difference is racial and not specific.

CUSPEULIMA, gen. nov.

Genotype *Leiostraca acutissima* Sowerby.

Elongate slender shells with flattened whorls, sutures not indented, body whorls long, apices acicular, apertures long narrow and acutely angled posteriorly, outer margins with a shallow sub-sutural sinus. The texture is vitreous, generally quite transparent and colourless, but sometimes coloured yellow and rarely with pale brown bands. Surface smooth.

Species of *Cuspeulima* have generally been attributed to either *Strombiformis* da Costa, *Leiostraca* H. & A. Adams, *Eulima* Risso or even to *Stilifer* Broderip. With none of these do they seem to have anything in common. Within the Peronian Province six species so far form a fairly natural group conforming to the above definition with the exception of *iredalei* which has a shorter aperture and may have dfferent relationship. A key for their identification is as follows.

A. Shell relatively large, up to 15 mm., very slender. *acutissima*
B. Medium size, 6-9 mm.
  1. Very slender, yellow or banded. *lodderae*
  2. Slightly stouter, yellow. *sobrina*
  3. Shorter aperture, yellow. *iredalei*
C. Very small, 2-3 mm.
  1. Sutures indented, contracted at the summit. *portensis*
  2. Whorls flat, apex exceeding acuminate. *incidenta*

Cuspeulima acutissima (Sowerby).

Plate 2, figs. 32, 33.

Leiostraca acutissima Sowerby, Conch. Icon., xv, 1866, pl. 2, f. 10.

The type is in the British Museum and came from Port Jackson. Angas described *L. lesbia* also from Port Jackson, but Hedley, who examined the types in London, considers that *lesbia* is merely a half grown *acutissima.* The name *acutissima* has also been wrongly applied to species from outside Australia. In a recent paper by Jean Risbec (Bull. Mus. Nat. D'Hist. Nat., Paris, xxvi, 1954, p. 109), the anatomy of *Eulima acutissima* Sowerby is described in detail, but the published figure shows this to be of quite a different species, more akin to *Eulimaustra* as here defined.

The species is not uncommon in shell sand on the outer beaches, and the specimen illustrated is one of a good series obtained from a sandy bottom 6-9 fathoms, Sow and Pigs Reef, Port Jackson. Its length is 15.5 mm., and width 2.7 mm. It can be easily recognized not only by being by far the largest of the group, but by its very slender form and colourless transparent shell. Another feature to be noticed is that the outer margin of the aperture is not laterally nearly so sinuate as in most of the family. It is nearly straight, but the sub-sutural sinus, though very shallow, is visible. The aperture is also twisted anteriorly.

Cuspeulima lodderae (Hedley).

Plate 2, fig. 34 (after Hedley) .

Leiostraca lodderae, Hedley, Mem. Aust. Mus., iv, 1903, p. 360, fig. 82.

The type locality is 41-50 fathoms off Cape Three Points, and it has also been recorded from North Queensland (this may be another species) and from Tasmania. Apparently *E. vitrea* is a synonym. The dimensions given by Hedley are length 7.7 mm., width 1.2 mm.

In form this is almost exactly like *C. acutissima*, of which it may well be the deep water representative. It is however less than half the length and is generally coloured pale yellow, and some specimens are not as transparent as others and may have two bands of pale orange on the body whorl, one on the others. A specimen from 30-35 fathoms off Crookhaven lacks these bands and is just over 8 mm. in length .

Cuspeulima sobrina, sp. nov.

Plate 2, figs. 35, 36.

Shell small, elongate, acicular, vitreous and transparent, colour pale honey. Apex acuminate, the initial whorl dome-shaped. Mature whorls nine, flattened, sutures hardly impressed but distinct. Body whorl long, nearly half the total length, evenly rounded to the base. Aperture long, acuminate posteriorly, not extended anteriorly. Outer margin thin, rounded anteriorly, the inner margin nearly straight and reflected. Outer margin laterally slightly curved with a wide, very shallow sinus below the suture. Length 5.5 mm., width 1.6 mm.

Localities:—Shell sand, Port Stephens (type), common: also common on the Manly ocean beach and other beaches on the coast; and from dredgings from a sandy bottom within Port Jackson.

Remarks:—This is the species that has generally been known as *Stilifer aciculus* Gould, appearing in Hedley's Check List as *Strombiformis aciculus*. Gould's species, however, collected by the Wilkes U.S. Exploring Expedition, came from Fiji, and though described without a figure, is obviously different from the New South Wales one. *C. sobrina* is a very distinctive species, about half the size of *C. acutissima*, and relatively broader, and it can easily be picked out by its pale honey colour.

Cuspeulima iredalei, sp. nov.

Plate 2, figs. 37, 38.

Shell of medium size, conical, elongate, acicular, vitreous and transparent, buff, apex and spire in some specimens slightly bent. Apex fine but rounded, the initial whorl dome-shaped, followed by 11 mature whorls, short, nearly flat, sutures hardly indented but distinct, body whorl comparatively short for the genus, not inflated, evenly rounded at the base. Surface smooth and shining. Aperture pyriform, extended anteriorly, comparatively short, narrowed posteriorly. Outer margin thin, rounded, sub-angular with the inner margin, which is nearly straight and reflected. Outer margin laterally slightly curved, sloping back anteriorly, with a very slight sub-sutural sinus. Length 8 mm., width 2.2 mm.

Locality:—Shell sand, Point Halliday (type), a number of specimens; The Spit, Port Jackson.

Remarks:—This species in texture, colour and form is close to *C. sobrina* but it is larger, with more numerous and shorter whorls, and the body whorl and aperture are relatively much shorter. The species is named after Mr. Tom Iredale, who has helped me so much with this and other papers.

Cuspeulima portensis, sp. nov.

Plate 2, figs. 39, 40, 41.

Shell minute, conical, spire contracted towards the acuminate apex, yellow but many specimens faded to milky white, apex acuminate, protoconch of 1½ whorls, the next 3 whorls increasing rapidly, the remaining 5 whorls regular, very slightly curved, sutures distinct, body whorl long, slightly inflated, rounded evenly to the base. Aperture pyriform, well extended anteriorly, outer and anterior margins rounded, inner margin curved and reflected. Outer margin laterally regularly curved, sloping anteriorly and also posteriorly to a very small sinus below the suture. Length 2 mm., width .6 mm. approximately.

Localities:—South-west Arm, Port Hacking (type collected by Mr. J. Kitchen); also fairly abundant in Port Jackson from 6-9 fathoms, Sow & Pigs Reef and from reclamations at The Spit.

Remarks:—This is probably the species called *Strombiformis perexiguus* Tate in Hedley's Check List, No. 1066. Unfortunately the specimen so labelled in the Australian Museum has deteriorated and is unidentifiable. It is doubtful, however, if the Tasmanian species is actually found in New South Wales, and therefore the question whether the name *minutissima* Tenison Woods should be restored in place of that of Tate need not be discussed here. The small size, and the curious contraction of the spire at the apex make this species easily recognized.

Cuspeulima incidenta, sp. nov.

Plate 2, figs. 42, 43.

Shell minute, conical, apex exceedingly acuminate, white to yellowish, texture vitreous and transparent. Protoconch minute, a microscopic tilted nucleus followed by a long slightly rounded whorl. Mature whorls eight, flattened, sutures hardly impressed, body whorl long, flat, sub-angled at the periphery. Aperture pyriform, fairly long, extended anteriorly, rather wide. Outer and anterior margins rounded, angled with the curved and slightly reflected inner margin. Outer margin viewed laterally regularly curved, with a shallow but distinct sub-sutural sinus. Length 2.8 mm., width .8 mm. approximately.

Locality:—Weed washings, 2-3 fathoms, North Harbour, Port Jackson.

Remarks:—This species was at first taken for *C. portensis*, and it was only when they were placed beneath the microscope together that the differences were apparent. *C. incidenta* has an even more acicular apex, the whorls are flatter, the spire is not contracted towards the summit, the body whorl is shorter and angular at the periphery, and the aperture is wider. Two specimens of a still smaller shell were obtained from Pittwater which are identical in shape with *incidenta* and may be that species or still another new one. The main difference noted is the lustrous vitreous shell which is quite transparent. Further material is needed to decide this question.

EULIMITRA, gen. nov.

Genotype *Eulimitra vittata* Laseron.

Shell minute, allied to *Cuspeulima*, transparent and vitreous, with coloured bands, aciculate, with flattened whorls, long aperture acutely angled posteriorly, but relatively much broader, with fewer whorls, the body whorls more than half the total length. The aperture has the inner margin slightly reflected, and laterally is curved with a broad shallow sinus below the suture.

The species so far known have been found living in kelp roots or on seaweeds in shallow water.

Eulimitra vittata, sp. nov.

Plate 2, figs. 44, 45.

Shell minute, broadly conical, sub-aciculate, texture vitreous, thin and transparent, colourless except for three narrow chocolate bands on the body whorl and two on the penultimate whorl. Apex fine but not acicular, the protoconch of a single dome-shaped whorl. Remaining whorls five, regular, flattened, sutures hardly impressed, body whorl very long, over half the total length, evenly rounded to the base. Aperture long, ovate, narrowed and acute posteriorly, rather broad and not extended anteriorly. Outer margin thin and rounded, laterally sinuate, the sub-sutural sinus broad and shallow. Inner margin nearly straight and slightly reflected. Length 1.8 mm., width .7 mm. approximately.

Locality:—In kelp roots, North Harbour, Port Jackson.

Remarks:—The small size, broad form and chocolate bands should make future recognition easy.

Eulimitra waltersi, sp. nov.

Plate 2, figs. 46, 47.

Shell minute, conical, finely acicular, vitreous, transparent, colourless but with traces of a brown band. Protoconch of 1½ whorls, nucleus tilted. Mature whorls five, regular, flattened, sutures distinct but not indented. Body whorl long, more than half the total length, curving evenly to the base. Aperture long, not extended anteriorly, narrowed and acute posteriorly. Outer margin slightly curved, bending sharply posteriorly and sub-angular with the inner margin which is curved and slightly reflected. Outer margin laterally rounded with a broad shallow sinus below the suture. Length 2.3 mm., width .6 mm. approximately.

Locality:—Washings from seaweed, four fathoms, Woollahra Point, Port Jackson (type collected by Mr. A. C. Walters).

Remarks:—Compared with *E. vittata* this species is narrower, has a more acicular apex, flatter whorls, and a differently shaped body whorl and aperture.

FUSCEULIMA, gen. nov.

Genotype, *Fusceulima jacksonensis* Laseron.

Shell minute, conical with small taper, apex broad and domed, few whorled, the whorls nearly flat with the sutures slightly impressed, body whorl long, more than half the total length, apertures short and wide, the outer margin laterally curved and with a wide shallow sinus below the suture. Texture vitreous and transparent, coloured yellow or brown, often with a white band below the suture.

In Peronian waters three closely related species form a small but natural group, each with a different habitat. The littoral species was taken alive in mussel beds between tide marks; another is from 40-50 fathoms on the continental shelf and the third just off the north coast in from 8-10 fathoms. Fortunately the number of specimens is sufficient to show that the differences though small are constant, but it is possible that geographical races are indicated rather than full species.

Fusceulima jacksonensis, sp. nov.

Plate 2, figs. 48, 49.

Shell minute, conical with blunt apex, vitreous and translucent, shining, brown with lighter band below the suture, and lighter patch on the base. Apex broad and dome-shaped, mature whorls four, regular, slightly curved, sutures slightly indented. Body whorl more than half the total length, slightly inflated, regularly curved to the base. Aperture large, ovate, acute posteriorly, extended anteriorly. Outer margin rounded, the anterior margin acutely bent to the rounded inner margin which is slightly reflected. Outer margin laterally rounded with a broad shallow sinus below the suture. Length 2.5 mm., width 1 mm. approximately.

Localities:—North Harbour, Port Jackson (type living in beds of the common mussel between tide marks); also from weed washings and beneath rocks in the same locality.

Remarks:—This is the first of the three species which are very closely related, so close indeed that it might be held that the differences are racial rather than specific. *F. flava* from the continental shelf is pale yellow and not brown in colour, slightly narrower and with flatter whorls and the apex is even broader. *F. sucina* from 10 fathoms on the north coast is about the same size and shape, but is also yellow in colour, has an extra whorl, and the body whorl is not quite so long.

Fusceulima flava, sp. nov.

Plate 2, figs. 50, 51.

Shell minute, broadly conical with very blunt apex, vitreous transparent, shining, pale yellow, darker below the suture, below which is a lighter band. Apex very broad and domed, mature whorls four, flattened, sutures very slightly indented, body whorl long, more than half the total length, not so inflated as in *F. jacksonensis*. The aperture is also relatively smaller, ovate, well produced anteriorly. Outer margin rounded, anterior margin bent sharply to join the inner margin which is curved and slightly reflected. Outer margin laterally as in *F. jacksonensis*, rounded, with a wide shallow sinus below the suture. Length 2.5 mm., width .8 mm. approximately.

Locality:—40-50 fathoms off Twofold Bay, 11 specimens.

Remarks:—The number of specimens show that this species is quite constant. Only for the colour it could easily be taken for *F. jacksonensis* and it is only by comparing them side by side beneath the microscope that the differences become apparent.

Fusceulima sucina, sp. nov.

Plate 2, figs. 52, 53.

Shell minute, broadly conical, apex broad, texture vitreous and translucent, colour yellow to amber brown, with a pale band below the periphery. Apex broad and domed, mature whorls five, regular, flattened, sutures very slightly impressed. Body whorl about half the total length, flattened to the periphery, below which it is rounded to the base. Aperture ovate, relatively short, well extended anteriorly. Outer margin nearly straight, rounded anteriorly, and bent sharply to the inner margin which is curved and reflected. Outer margin laterally curved with a shallow sinus below the suture. Length 2.5 mm., width .8 mm. approximately.

Locality:—8-10 fathoms off Point Halliday.

Remarks:—This is the third of the three closely related species, its main difference being the extra whorl, and the relatively shorter body whorl.

EULITOMA, gen. nov.

Genotype *Eulitoma nitens* Laseron.

Shell elongated, many whorled, the spire even and flat, apex blunt and dome shaped, body whorl long, aperture pyriform, relatively short and expanded beyond the line of the spire, laterally rounded with a wide shallow sinus below the sutures. Texture subvitreous and translucent, colour white, surface highly polished.

The highly polished surface and long smooth spire resemble *Eulimaustra*, but the long body whorl, blunt apex and expansion of the aperture beyond the line of the spire give a very distinctive facies.

Eulitoma nitens, sp. nov.

Plate 2, figs. 54, 55.

Shell of medium size, conical, elongated, sub-vitreous, translucent, smooth, white and highly polished. Apex blunt, with a rounded, dome-shaped protoconch. Mature whorls seven, even, flattened, sutures not impressed. Body whorl long, evenly rounded to the base. Aperture relatively short, pyriform, not extended anteriorly, but expanded laterally beyond the line of the spire. Outer and anterior margins rounded, the latter bent sharply to join the inner margin which is slightly reflected. Outer margin laterally rounded with a broad shallow sinus below the suture. Length 4.2 mm., width 1.1 mm. approximately.

Localities:—6-9 fathoms, Sow & Pigs Reef (type); dredged Pittwater; shell sand, Port Stephens.

Remarks:—This species is very distinctive, and does not closely resemble any other from New South Wales. In southern waters also, no species seems even congeneric, but there are undescribed species in Queensland which will probably come in the same group.

Eulitoma castanea, sp. nov.

Plate 2, figs. 56, 57.

Shell of medium size, conical, elongate, of even growth, texture subporcellanous and slightly translucent, colour bright yellow brown with a darker band below the sutures. Apex blunt and dome-shaped. Mature whorls seven, regular, very slightly rounded, sutures faintly impressed but distinct, body whorl regularly rounded to the base. Aperture pyriform, comparatively short, extended anteriorly. Outer, anterior and inner margins rounded, the last reflected. Outer margin laterally rounded with the usual shallow sinus below the suture. The aperture is not extended beyond the line of the spire. Length 5 mm., width 1.3 mm. approximately.

Localities:—Dredged between heads, Port Jackson, 15 fathoms (type); 15 fathoms off Clarence River; Twofold Bay, 15-25 fathoms.

Remarks:—In general form this is close to *E. nitens*, but it can be readily separated by its colour, and shorter body whorl. The position of the aperture which does not extend beyond the line of the spire also gives it a quite different facies, and it may indeed have little relationship, and ultimately need generic revision.

HEBEULIMA, gen. nov.

Genotype *Leiostraca inusta* Hedley.

Cylindrical to conical shells, elongated, many whorled, of irregular growth, the early whorls sometimes distorted, and the penultimate whorl often swollen. Whorls rounded, sutures impressed. Body whorl moderately long, and aperture ovate and relatively short. Apex blunt and sometimes mamillate. Texture vitreous to sub-vitreous and transparent to nearly opaque. Colourless or white, or yellowish with brown on the base. Size generally from 4-6 mm.

The group of species placed here have sufficient characters in common to link them together under the above fairly broad definition, but have individual differences which suggest they may not be very closely related. Further comparison with species both from northern and southern Australia will probably show that more than one group will be found to justify still more generic names. Amongst the Tasmanian species, *Eulima columnaria* May, *Strombiformis kilcundae* Gatliff & Gabriel, and *S. perexiguus* Tate & May tentatively may be included.

Hebeulima inusta (Hedley).

Plate 3, figs. 58, 59.

Leiostraca inusta Hedley, Proc. Linn. Soc. N.S.W., xxx, 1906, p. 525, pl. 33, fig. 43.

The type came from Manly Beach, but the species is actually fairly common and well distributed. The specimen illustrated is from 8-10 fathoms off Point Halliday, its length 3.6 mm., and width .9 mm. approximately. Ready recognition points are the long narrow spire, the long swollen penultimate whorl, the yellow colour and brown base.

Hebeulima tumere, sp. nov.

Plate 3, figs. 60, 61.

Shell small, cylindro-conical, vitreous, transparent, white but almost colourless. Apex blunt, dome-shaped. Mature whorls five, long, penultimate whorl swollen, rounded, sutures impressed. Body whorl long, about half the total length, evenly rounded to the base, and slightly swollen below the aperture. Aperture ovate, fairly long, not produced anteriorly. Outer and anterior margins rounded and curved to join the inner margin which is curved and slightly reflected. Outer margin laterally broadly rounded, with a narrow, fairly deep sinus below the suture. Length 3.5 mm., width 1 mm. approximately.

Localities:—Shell sand, Port Stephens, a number of specimens (type); Manly Ocean Beach.

Remarks:—In general form this resembles *H. inusta*, but it differs in colour, in having fewer whorls and a longer body whorl, in being relatively slightly broader and in the details of the aperture.

Hebeulima fricata (Hedley).

Plate 3, fig. 62 (after Hedley).

Eulima fricata Hedley, Rec. Aust. Mus., vi, 1907, p. 290, pl. 55, fig. 14.

I have not seen this species which came from 80 fathoms off Narrabeen, but in general characters it comes within the definition of *Hebeulima* and may tentatively be retained there. The dimensions given by Hedley are length 4.25 mm., width 1.15, and it is thus relatively broader than the last two species, the spire has hardly any taper, the apex is broader, and the penultimate whorl not so swollen.

Hebeulima crassiceps, s.p nov.

Plate 3, figs. 63, 64.

Shell of medium size, elongated, sub-vitreous, white and shining, translucent. Apex swollen, protoconch of 1½ whorls, the first dome-shaped and tilted. Remaining whorls seven, of rather irregular growth, particularly the early whorls, the penultimate whorl slightly swollen, remainder slightly rounded, the sutures slightly impressed. Body whorl relatively not as long as in the previous species, regularly curved to the base. Aperture ovate, comparatively short, slightly produced anteriorly. Outer, anterior and inner margins rounded, the last very slightly reflected. Outer margin laterally rounded with a broad shallow sinus below the suture. Length 5.4 mm., width 1.3 mm. approximately.

Locality:—8-10 fathoms, Point Halliday.

Remarks:—The tumid apex affords a ready recognition point. Though fitting into the broad definition of *Hebeulima*, some of the characters suggest other relationship, and its position may later have to be reviewed.

PICTOBALCIS, gen. nov.

Genoype, *Eulima articulata* Sowerby.

Shell very large for the group, conical, elongate, many whorled, whorls flattened, aperture short. The texture is porcellanous, but unlike *Eulimaustra* and others of the family it is opaque and not highly polished, the shell itself is massive and the coloration is yellowish with brown patches.

The large, heavy shell, and its opacity, at once differentiate this genus, and beyond the general form it probably has little relationship with the rest of the family.

Pictobalcis articulata (Sowerby).

Plate 3, fig. 65.

Eulima articulata Sowerby, Proc. Zool. Soc., 1834, p. 8, and Conch. Illustr., f. 12.

The type locality is given as Australia, and it probably came from Moreton Bay. Fortunately there can be little doubt of the species, as it is easily recognized by its large size, coloration and solid opaque shell. It is not common on the New South Wales coast, but more or less worn specimens are occasionally found on the outer beaches. The specimen figured came from Shellharbour; its length is 21 mm., and width 5.8 mm.

EULIMODA, gen. nov.

Genotype, *Eulima munita* Hedley.

Shell comparatively large, pyramidal with a broad base, acuminate, whorls short and numerous with irregular varices, flattened, contracted at the suture and angled at the base. Aperture subquadrate, oblique, laterally sinuate, a broad callus on the inner margin. Shell texture thin, translucent and glossy, colour white, tinted orange from the animal within.

The oblique subquadrate aperture and broad pyramidal form at once separate this from all other genera in the family. In general form it recalls *Scalenostoma strictum* Hedley from Queensland, and may be nearer the true Stiliferae than the Eulimidae.

Eulimoda munita (Hedley).

Plate 3, figs. 66, 67 (after Hedley).

Eulima munita Hedley, Mem. Aust. Mus., iv, 1903, p. 358, text fig. 81.

I have not seen this species, which was collected alive by the "Thetis" Expedition from two stations on the continental shelf, the type coming from 41-50 fathoms off Cape Three Points, the dimensions given being length 8 mm., width 3.75 mm. The characters given above in the generic description should make its recognition easy.

Genus MENON Hedley 1900.

Genotype *Menon anceps* Hedley.

Menon is quite unlike any of the normal Eulimidae, though it resembles the true *Leiostraca* in having the shell compressed from back to front and in having strong varices on either side continuous up the spire. It also has the typical eulimid sinus on the outer margin of the aperture. It has, however, a solid opaque shell, is umbilicate, and has an extraordinary apex which is planulate and fits like a cap on the summit of the spire. Hedley thought this apex may be a plug formed after the shedding of earlier whorls.

In the same year as he proposed *Menon*, Hedley (Proc. Linn. Soc. N.S.W., 1900, p. 505) withdrew the name on Professor Tate's suggestion in favour of *Chileutomia* Tate & Cossman, a Tertiary fossil from Muddy Creek, Victoria. Though the two have many features in common, in view of the great difference in time, the other differences particularly in the protoconch, are I think sufficient to justify the retention of *Menon* as a genus, and it is here restored to literature.

Menon anceps Hedley.

Plate 3, figs. 68, 69, 70.

Menon anceps Hedley, Proc. Linn. Soc. N.S.W., 1900, p. 90, plate 3, figs. 5, 6, 7.

The type locality is from shell sand at Little Coogee Beach, near Sydney. It is not a very common shell, but we have it from several of the outer beaches. The specimen illustrated came from 14 fathoms off Long Reef; its length is 6 mm. and width 2 mm. approximately. Its characters are so distinctive that it cannot be confused readily with any other species on the coast.

Genus STILAPEX Iredale.

Genotype *Stilapex lactarius* Iredale.

Generic characteristics which may be selected from Iredale's description, are the globose shell of vitreous texture, with rounded whorls, the body whorl about two thirds of the total length, and the acuminate apex. The operculum is thin, horny and paucispiral, the outer margin of the aperture is also slightly sinuate posteriorly.

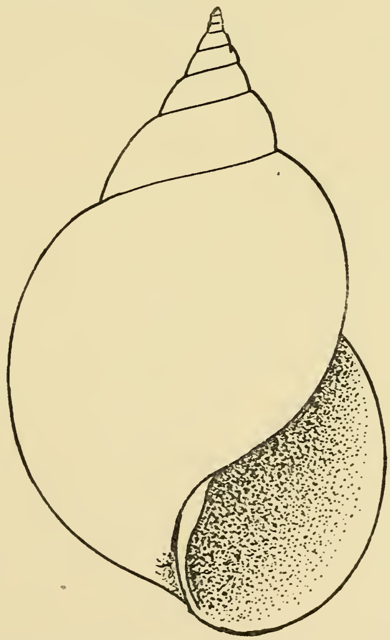

Fig. 78: *Stilapex lactarius* Iredale.

Stilapex lactarius Iredale.

Text figure 78 (after Iredale).

Rec. Aust. Mus., xiv, 1925, p. 270, pl. xliii, fig. 20.

The type locality is 70 fathoms, 20 miles east of Babel Island, the dimensions given being length 8 mm., width 5 mm. This species is unlike any other on the New South Wales coast, but resembles that called *Stilifer brazieri* in May's Illustrated Check List of Tasmanian Shells. It may well be congeneric with that species, which however is not *brazieri* of Angas, and is at present undescribed.

SPECIES OF DOUBTFUL CLASSIFICATION.

SYNTHARELLA, gen. nov.

Genotype, *Eulima topaziaca* Hedley.

Shell minute, broadly conical, apex blunt, few whorls, body whorl long, more than half the total length, aperture pyriform, acutely angled posteriorly, sometimes slightly separating from the body whorl, peristome complete, outer margin rounded, laterally quite straight with no trace of a sinus. Texture sub-porcellanous, shining, opaque to sub-translucent, smooth, slight traces of growth lines.

Though placed in *Eulima* by Hedley, he at the time expressed doubts of its systematic position and suggested it might belong to the Rissoidae. The complete peristome and entire absence of a sinus separates it at once from the typical Eulimidae, but there is also no genus in the Rissoidae with which it can be appropriately linked. It is included here provisionally, but its correct classification is still in abeyance.

Syntharella topaziaca (Hedley).

Plate 3, fig. 71.

Eulima topaziaca Hedley, Proc. Linn. Soc. N.S.W., xxxiii, 1908, p. 470, pl. x, fig. 29.

The type is a single specimen from Middle Harbour, Port Jackson, but we have it in abundance from reclamations at The Spit in the same locality. The specimen figured came from there; its length is 3 mm., and width 1.2 mm. approximately. A number of specimens were also found in mud clinging to an anchor in Eden on the south coast, and a single specimen was found in 30-35 fathoms off Crookhaven. The characters given in the generic description make it very easy of recognition.

STILIMELLA, gen. nov.

Genotype, *Stilifer lodderae* Petterd, Jour. of Conch., iv, 1884, p. 140.

Stilimella is here proposed for a curious group of shells whose systematic position is still obscure. It is certain that they cannot be called *Stilifer* even within the widest application of that genus. Unfortunately specimens are not common, and are only found on the outer beaches at rare intervals, generally in a more or less damaged condition and with the apices missing. They are comparatively large, from 9 mm. to 12 mm. in length, thin, vitreous and translucent, white in colour, conical with concave finely tapering spires. Growth is, however, very erratic, and one specimen here illustrated (fig. 74) has the two whorls before the body whorl greatly swollen to as much as the diameter of the body whorl itself. Both spiral and transverse sculpture is present, but is not apparent except with a lens. It then gives the surface of the shell a facetted appearance. The aperture is rhomboidal, the lip thin, the columella straight and reflected.

Of seven specimens examined, none is quite perfect, and the variation is such that no two are exactly alike. Whether more than one species is present it is at present impossible to say, but the general facies is so similar that it is probable that all are one species which is extremely variable. This suggests that the living mollusc is either nesting in habitat, commensal or parasitic.

It is difficult to suggest the relationship of *Stilimella* with any other genus, either Australian or foreign. It may constitute a new family near the Eulimidae, but this is purely conjectural. Comparison may also be made with the Atlantic family Aclidae which include many shells with somewhat similar characters. *Stilimella*, however, fits none of the genera of that family, which was monographed by Paul Bartsch (Smithsonian Misc. Collections, Vol. 106, Number 20, 1947).

Stilimella lodderae (Petterd).

Plate 3, figs. 72, 73, 74.

Stilifer lodderae Petterd, Jour. of Conch., iv, 1884, p. 140.

May in his Check List of Tasmanian shells lists *Stilifer lodderae* Petterd and *S. petterdi* Tate & May, and synonymizes *S. crotaphis* Watson under *lodderae*. Both *lodderae* and *petterdi* have been recorded from the New South Wales coast from single worn specimens, and it is stated that the species differ in that *petterdi* is larger and much broader than *lodderae*. Whether one, two or more species occur is, however, still very doubtful, and until more and better material is available, it is wise I think to consider them under one name, and to use that of a Tasmanian species until such time as separate identity can or cannot be established. *S. lodderae* is therefore chosen as the oldest available name, and by selecting it as the genotype it will avoid any confusion and possibility of synonymy. The three shells illustrated represent the extremes in variation. Fig. 72 and fig. 73 came from Huskisson, the former having a length of 9 mm. and a width of 3.5 mm., the latter being 9.5 mm. long and 4.5 mm. wide. Fig. 74 came from Long Reef and is an obvious abnormality. Its length is 11 mm., and width both of the penultimate and body whorls, 3.5 mm.

MACERTEXTA, gen. nov.

Genotype, *Macertexta ovitesta* Laseron.

Small white, many whorled shells, broadly conical, thin, opaque with rather a matte texture. The whorls are rounded, the sutures deeply impressed, the apex acuminate, with a very small initial whorl. Aperture thin and rounded, not laterally sinuate but straight, inner margin straight, raised and reflected, a layer of callus on the body whorl.

Though of the general form of the Eulimidae, the lack of a sinus on the outer margin of the aperture and the texture of the shell suggest other relationship, possibly even with the Rissoidae and such a genus as *Diala*. Pending knowledge of the animal the exact systematic position must be left in abeyance.

Macertexta ovitesta, sp. nov.

Plate 3, fig. 75.

Description mainly as given for the genus. Whorls seven excluding the minute apical whorl, the body whorl fairly long. Aperture nearly round, short, extended anteriorly, the inner margin raised above the body whorl and reflected, the layer of callus on the body whorl broad and continuous to meet the posterior end of the outer margin. Laterally the outer margin is straight and there is no trace of a sinus. Length 7 mm., midth 3 mm.

Localities:—North Harbour, Port Jackson (type); also common from the reclamations at The Spit, in dredgings from 6-9 fathoms, Sow & Pigs Reef, and from reclamation at Bay View, Pittwater.

In general form this is very close to *Chryseulima brazieri*, but has quite a different texture, and of course the lack of a sinus in the outer margin of the aperture at once separates it.

REFERENCES.

Hedley, C. (1918).—A Check List of the Marine Fauna of New South Wales. Part I. *Jour. Roy. Soc. N. S. Wales* li, 1917, Suppl., pp. M. 1-M. 120.

May, W. L. (1921).—A Check List of the Mollusca of Tasmania (Govt. Printer, Hobart), pp. 1-114.

May, W. L. (1923).—W. L. May's Illustrated Index of Tasmanian Shells (Govt. Printer, Hobart), pls. i-xlvii.

New genera here proposed:—*Eulimaustra, Chryseulima, Curveulima, Sticteulima, Cuspeulima, Eulimitra, Fusceulima, Eulitoma, Hebeulima, Pictobalcis, Eulimoda, Syntharella, Stilimella, Macertexta.*

Plate 1.

Fig.

1. *Eulimaustra proxima* Sowerby.
2. *Eulimaustra proxima* Sowerby, Profile.
3. *Eulimaustra anomala* Laseron.
4. *Eulimaustra anomala* Laseron, Profile.
5. *Eulimaustra anomala* Laseron, Apex.
6. *Hypermastus coxi* Pilsbry.
7. *Hypermastus coxi* Pilsbry, Profile.
8. *Hypermastus coxi* Pilsbry, Apex.
9. *Hypermastus mucronata* Sowerby.
10. *Hypermastus mucronata* Sowerby, Profile.
11. *Hypermastus mucronata* Sowerby, Apex.
12. *Hypermastus* sp. ? juvenile.
13. *Hypermastus* sp. ? juvenile.
14. *Chryseulima brazieri* Angas.
15. *Chryseulima brazieri* Angas, Profile.
16. *Chryseulima solitaria* Laseron.
17. *Chryseulima solitaria* Laseron, Profile.
18. *Curveulima cornuta* Laseron.
19. *Curvelima cornuta* Laseron, Profile.
20. *Curevulima obtusa* Laseron.
21. *Curveulima obtusa* Laseron, Profile.
22. *Curvelima lata* Laseron.
23. *Curveulima subobtusa* Laseron.
24. *Curveulima litoris* Laseron.
25. *Curveulima litoris* Laseron, Profile.
26. *Curveulima abrupta* Laseron.
27. *Curveulima abrupta* Laseron, Profile.
28. *Curveulima manifesta* Laseron.
29. *Curveulima manifesta* Laseron, Profile.

Figs. 1-29: Eulimoid shells of New South Wales.

C. F. Laseron del.

Plate 2.

Fig.

30. *Sticteulima cameroni* Laseron.
31. *Sticteulima cameroni* Laseron, Profile.
32. *Cuspeulima acutissima* Sowerby.
33. *Cuspeulima acutissima* Sowerby, Profile.
34. *Cuspeulima lodderae* Hedley.
35. *Cuspeulima sobrina* Laseron.
36. *Cuspeulima sobrina* Laseron, Profile.
37. *Cuspeulima iredalei* Laseron.
38. *Cuspeulima iredalei* Laseron, Profile.
39. *Cuspeulima portensis* Laseron.
40. *Cuspeulima portensis* Laseron, Profile.
41. *Cuspeulima portensis* Laseron, Apex.
42. *Cuspeulima incidenta* Laseron.
43. *Cuspeulima incidenta* Laseron, Profile.
44. *Eulimitra vittata* Laseron.
45. *Eulimitra vittata* Laseron, Profile.
46. *Eulimitra waltersi* Laseron.
47. *Eulimitra waltersi* Laseron, Profile.
48. *Fusceulima jacksonensis* Laseron.
49. *Fusceulima jacksonensis* Laseron, Profile.
50. *Fusceulima flava* Laseron.
51. *Fusceulima flava* Laseron, Profile.
52. *Fusceulima sucina* Laseron.
53. *Fusceulima sucina* Laseron, Profile.
54. *Eulitoma nitens* Laseron.
55. *Eulitoma nitens* Laseron, Profile.
56. *Eulitoma castanea* Laseron.
57. *Eulitoma castanea* Laseron, Profile.

Figs. 30-57: Eulimoid shells of New South Wales.

C. F. Laseron del.

Plate 3.

Fig.

58. *Hebeulima inusta* Hedley.
59. *Hebeulima inusta* Hedley, Profile.
60. *Hebeulima tumere* Laseron.
61. *Hebeulima tumere* Laseron, Profile.
62. *Hebeulima fricata* Hedley.
63. *Hebeulima crassiceps* Laseron.
64. *Hebeulima crassiceps* Laseron, Profile.
65. *Pictobalcis articulata* Sowerby.
66. *Eulimoda munita* Hedley.
67 *Eulimoda munita* Hedley, Profile.
68. *Menon anceps* Hedley.
69. *Menon anceps* Hedley, Profile.
70. *Menon anceps* Hedley, Apex.
71. *Syntharella topaziaca* Hedley.
72. *Stilimella lodderae* Petterd.
73. *Stilimella lodderae* Petterd, Variation.
74. *Stilimella lodderae* Petterd, Abnormality.
75. *Macertexta ovitesta* Laseron.
76. *Curveulima commensalis* Tate (S. Aust.).
77. *Curveulima commensalis* Tate, Profile.
78 (in text). *Stilapex lactarius* Iredale (after Iredale).

Figs. 58-77: Eulimoid shells of New South Wales.

C. F. Laseron del.

A New Subspecies of Scallop from Byron Bay, New South Wales

By C. A. FLEMING, New Zealand Geological Survey.

The inequivalve scallops that inhabit the shores of Australia and New Zealand have long been known from paleontological evidence to be comparative newcomers (Tate, 1887). They are members of two Mediterranean Tertiary groups which spread across the Indian Ocean probably in the early Pleistocene, to colonize southern waters that had previously lacked scallops of this type (Fleming, 1951). They left only fragmentary evidence of their migration paths.

The group of *Pecten benedictus* Lk. (a Mediterranean fossil), contains the Red Sea *erythraeensis* Sow., the Australian *fumatus* Rve. and *albus* Tate, and the New Zealand fossil *marwicki* (Fin.). The other group of scallops that came to Australasia consists of relatives of *Pecten jacobaeus*, the St. James' scallop of the Mediterranean. Colonising stocks of this group gave rise to the Tasmanian *meridionalis* Tate, to the New Zealand fossil *toi* Flem. and a succession of later forms leading to the living *novaezelandiae* Rve. Evolution in isolation together with some hybridisation due to changes of distribution controlled by Pleistocene climatic changes (see, e.g., Hodge Smith and Iredale, 1924) led to the present distribution of the half dozen Australian and New Zealand forms that have been distinguished taxonomically.

Judged by the characters of the New Zealand fossil *Pecten toi* (Fleming, 1951, figs. 2, 5), the early Australasian population of the *Pecten jacobaeus* group resembled the parent Mediterranean form very closely. Living scallops from Byron Bay, New South Wales, described below are so similar to *Pecten jacobaeus* that they may be ranked as a subspecies of the Mediterranean shell.

Wide-ranging species, consisting of subspecies thousands of miles apart, are rare among shallow-water animals of south temperate seas. They have been recognised among tropical mollusca (Schilder, 1938) and echinoids (Mayr, 1954) and probably occur in other groups with long lived pelagic larvae.

Genus *Pecten* Muller 1776.

Pecten maximus (L.), type species of *Pecten*, is so closely related to *P. jacobaeus* and derivative forms that use of Finlay's genus *Notovola* for the Australasian scallops can no longer be justified.

Pecten jacobaeus byronensis subsp. nov. Fig. 1.

Right valve similar in all essential characters to *P. j. jacobaeus*, differing in its smaller size, weak pigmentation, slightly higher shell and narrower angle between dorsal valve-margins. Ribs 19 (including lesser ones on the flanks), square-cut, high, separated by flat-bottomed interspaces a little more than half their width, each bearing 2 to 4 spaced secondary threads, beginning about 15 mm. from beaks. Concentric sculpture of prominent lamellae, conspicuous in intercostal spaces but also extending across the secondary interspaces and threads of the main ribs. Ears relatively large, bearing fine radiating threadlets, crossed by incremental lamellae. Left valve not seen.

Length 35 mm.; height 33 mm. (holotype).

Locality:—Byron Bay, New South Wales.

Holotype and two paratypes in the Australian Museum, Sydney (C. 5243), collected and presented by C. Hedley.

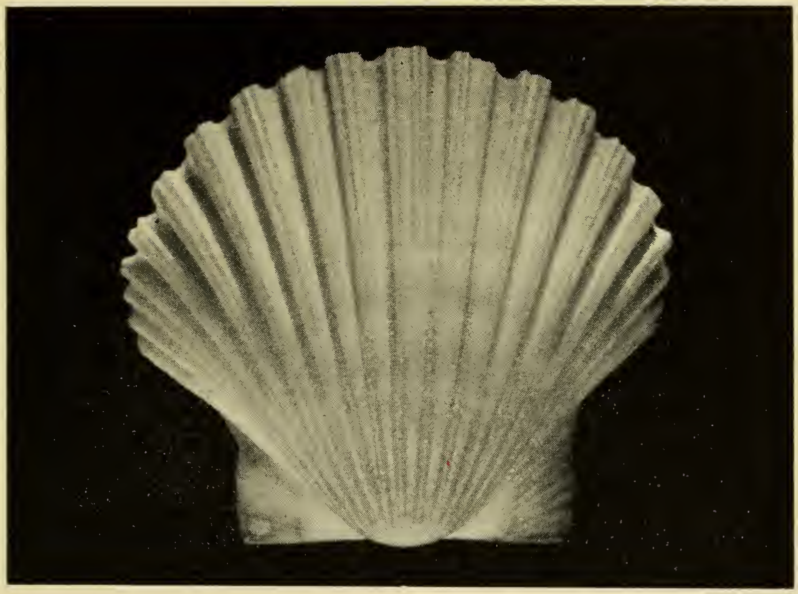

Fig. 1. *Pecten jacobaeus byronensis* Fleming. Holotype, Byron Bay, N.S.W. (Aust. Mus. C5243). X2.

Judged by its rarity in collections, this form is restricted in distribution. It is probably a relict population surviving from a period before *Pecten fumatus* colonised New South Wales. Its presence may help to explain the variation in New South Wales scallops generally classed as *fumatus*. Typical *fumatus* (like Reeve's types, with high beaks, rounded ribs, and no intercostal lamellae) is rather rare, occurring at Port Jackson and Jervis Bay (Thetis Station 54). Many other east Australian samples have squarish ribs and intercostal lamellae, at least on the flanks, characters that may be due to past or present gene flow from *byronensis* into the nearby population of *fumatus*.

ACKNOWLEDGMENT.

I am grateful to Miss Joyce Allan for facilities to examine collections in 1952 and to Dr. A. B. Walkom and Mr. D. F. McMichael for lending the type specimens for description.

REFERENCES.

Fleming, C. A. (1951).—*J. de Conch.*, XC: 276-82.

Hodge Smith, T., and Iredale, T. (1924).—*J. Proc. Roy. Soc. N.S.W.*, LVIII: 157-68.

Mayr, E. (1954).—Geographic Speciation in Tropical Echinoids. *Evolution*, VIII (1): 1-18.

Schilder, F. A. and M. (1938).—*Proc. Malac. Soc. Lond.*, XXIII (3): 119-80.

Tate, R. (1887).—*Proc. Roy. Soc. Tasmania*, 1886; 113-6.

Sidelights on New Zealand Ichthyology

By GILBERT WHITLEY, F.R.Z.S.

(Contribution from the Australian Museum, Sydney.)

(Plate vi.)

Anyone studying Australian fishes, particularly the southern temperate species, soon finds that the fishes of New Zealand have to be taken into consideration as well. Not only are the species closely related, but many are identical, and some of them were discovered by Cook and other early visitors to New Zealand before they were found in Australia. For many years, therefore, I have been interested in New Zealand ichthyology, have analysed all the literature on the subject, compiled in manuscript a check-list which is being submitted for publication elsewhere, have identified specimens, sometimes in consultation with colleagues, and have visited New Zealand for field work. There is a great deal to be placed on record about the fishes of New Zealand and adjacent seas. The purpose of the present paper is to shed a little light on some obscure taxonomic aspects; it is divided into two parts: (1) New names and synonyms, and (2) Steindachner's New Zealand Fishes.

(1) NEW NAMES AND SYNONYMS.

Family RETROPINNIDAE.

STOKELLIA, gen. nov.

Orthotype, *Retropinna anisodon* Stokell (Rec. Canterb. Mus. iv, 7, Sept. 10, 1941, p. 371, pl. lv, fig. 2 and text-fig. 1, from Waiau River) = *Stokellia anisodon.*

The characteristic long premaxillary underlying four-fifths of the toothless maxillary separates Stokell's species so markedly from the others in the genus that a new generic name seems advisable.

Family MURAENICHTHYIDAE.

Genus MURAENICHTHYS Bleeker, 1864.

MURAENICHTHYS BREVICEPS HALITUNA, subsp. nov.

The Worm Eel from Tasman Bay, Nelson, described and figured as *Muraenichthys breviceps* by Griffin (Trans. N. Zeal. Inst. liii, Aug. 31, 1921, p. 351, pl. liv, fig. 1) differs from the Tasmanian type of Gunther (Ann. Mag. Nat. Hist. (4) xvii, May 1, 1876, p. 401) as follows: Length of head about one-half of the distance from the gill-opening to the vent, or one-tenth total length; teeth in a triple series on the palate and uniserially on jaws. Griffin's fish may be subspecifically named *halituna*, nov.

Family SYNGNATHIDAE.

NOVACAMPUS, gen. nov.

Orthotype, *Syngnathus norae* Waite (Proc. N. Zeal. Inst. 1910, i, p. 25 and Rec. Canterb. Mus. i, 3, 1911, p. 173, pl. xxvii, fig. 1, from Stewart Island to Pegasus Bay) = *Novacampus norae.*

Snout long, sloping gently into interorbital. Orbits not prominent. Opercular keel reduced, with radial lines, or absent. Superior ridges of trunk and tail discontinuous below dorsal fin. Inferior ridges of trunk and tail continuous. Median ridge of trunk continuous with superior ridge of tail, thus the arrangement accords with No. 7 of Duncker's scheme. Brood-pouch subcaudal, one-fifth of tail. A median ventral carina. Dorsal, anal, pectoral and caudal fins present. Base of dorsal fin not elevated, situated mostly over tail. Caudal fin shorter than postorbital. D. 37 to 40; P. 12 to 13. Rings 18 to 20 plus 48 to 51; subdorsal 10 to 11.

Differs from *acus*, the type-species of *Syngnathus*, in having the opercular keel reduced or absent, the median ridge of the trunk continuous with the superior one of the tail, much smaller size, and more numerous tail-rings (48 or more instead of less than 47).

Family MULLIDAE.

Genus UPENEICHTHYS Bleeker, 1855.

UPENEICHTHYS POROSUS (Cuv. & Val.).

Atahua clarki Phillipps (Proc. Roy. Soc. N. Zeal. lxxi, Dec. 1941, p. 243, pl. xli, fig. 5, from Hawke Bay) is apparently synonymous with *Upeneus porosus* Cuvier & Valenciennes (Hist. Nat. Poiss. iii, April 1829, p. 455 from the River Kiddi Kiddi, Bay of Islands).

Family GIRELLIDAE.

Genus GIRELLA Gray, 1835.

GIRELLA TRICUSPIDATA (Quoy & Gaimard).

Sparus hamiltoni Phillipps (Trans. N. Zeal. Inst. lviii, Aug. 15, 1927, p. 130, pl. v, fig. 4, from Hauraki Gulf and Poor Knights Islands) is not a Sparid but should be added to the synonymy of *Boops tricuspidatus* Quoy & Gaimard (Voy. Uranie Physic., Zool., 1824, p. 296) which was said, probably erroneously, to have come from Shark's Bay, Western Australia, where I have never seen the species.

Family LABRIDAE.

TIRICORIS, gen. nov.

Orthotype, *Cymolutes sandeyeri* Hector (Trans. N. Zeal. Inst. xvi, May, 1884, p. 323, from Tiritiri Island, Auckland; name emended to *sandageri* by Sandager in 1888 and Phillips in 1927) = *Tiricoris sandeyeri.*

The type-species, with its indirect synonym *Coris rex* Ramsay & Ogilby, 1886, differs from the genera with which it has been associated as follows:

A. Lateral line continuous.

B. Hind canines obsolete. Sc. less than 70. Dark blue or black with a humped head in fullgrown specimens. Caudal concave .... *Coris* (*aygula*).

BB. Hind canines developed. Sc. *c.* 100. Variously coloured body banded. No hump on head. Caudal subtruncate, *Tiricoris, nov.*

AA. Lateral line interrupted. Sc. *c.* 80. No hind canines. Grey to greenish, often with oblique bars on head, body and fins .. *Cymolutes.*

Family ACANTHOCLINIDAE.

Genus ACANTHOCLINUS Jenyns, 1841.

TAUMAKOIDES, subgen. nov.

Orthotype, *Acanthoclinus trilineatus* Griffin (Trans. N. Zeal. Inst. lxiii, June 1933, p. 330, pl. xxxiv & text-fig. 2, from Bay of Islands and Great Barrier Is.) = *Taumakoides trilineatus.*

Differs from typical *Acanthoclinus* in having the lowermost lateral line on each side simple, not anteriorly bifurcated.

Family ALEUTERIDAE.

PARIKA, gen. nov.

Orthotype, *Balistes scaber* Bloch & Schneider (Syst. Ichth., 1801, p. 477, from Queen Charlotte Sound, type-locality by present designation) = *Parika scabra.*

The type-species of this new genus comes down to the group of genera numbered 8 to 10 in Fraser-Brunner's key (Ann. Mag. Nat. Hist. (11) viii, 1941, p. 177), being nearest *Navodon.* Characteristics: Gill-opening below eye. Dorsum gently convex. The outwardly directed postero-lateral barbs of the slightly compressed dorsal spine are larger than the obsolescent ones on its anterior face; the spine depressible into a groove. Dorsal and anal fins not elevated anteriorly, their bases about opposite. Ventral flap little developed, supported by pelvic projection. Caudal peduncle without bristles or hooks.

(2) STEINDACHNER'S NEW ZEALAND FISHES.

Ichthyologists in New Zealand have been hampered through not having access to an important paper by Franz Steindachner, published many years ago in Vienna, which dealt with a number of fishes from New Zealand and the Chatham Islands, some of which were named as new species. The full title of the work, which I have translated from the German, is:—

Steindachner, Dr. Franz

"Fische aus dem Stillen Ocean. Ergebnisse einer Reise nach dem Pacific (Schauinsland 1896-97)." It appeared in

Denkschriften der Kaiserlichen Akademie der Wissenschaften, Math.—Naturw. Classe (Wien), lxx, 1900 (1901), pp. 483-522, pls. i-vi.

Or, in English:

"Fishes from the Pacific Ocean. Results of a voyage to the Pacific (Schauinsland 1896-97)." By Dr. Franz Steindachner, Active Member of the Royal Academy of Science (with 6 plates). Placed before the meeting of 21 June 1900.

The paper dealt with fishes collected by Schauinsland in various parts of the Pacific, so I translate merely the Introductory remarks of Steindachner and only his accounts of fishes from New Zealand, and the Chatham Islands. I comment in footnotes on a few obvious errors in the original.

He commences (p. 483) as follows:—

The ichthyological collection forwarded to me for revision by the Museum in Bremen, which I allow myself to report upon here, was made by the Director himself, Professor Schauinsland, during a voyage to the South Seas in the years 1896 and 1897. It contains about 160 species of fishes, of which by far the greater part—117 species—came from the coasts of the Sandwich Islands (Oahu and Laysan), the latter a small uninhabited coral island, about 800 nautical miles north-west of Honolulu.

Although the Sandwich Islands have several times been investigated in connection with ichthyology, particularly by Garrett, Professor Schauinsland's collection contained a by no means insignificant number of new and rare forms, for example one specimen each of *Apogon maculiferus* Garr. and *Chilodactylus vittatus* Garr. of which the types have probably been lost, and it is therefore not to be underrated from a faunistic standpoint. The remaining species cited in the present paper were collected from the coasts of the Samoan Islands and the Chatham Islands (about 560 nautical miles eastward of New Zealand) as well as in New Zealand itself; of these, two, if not three, species are new to science. Finally there are five already well-known species from Bare Island near Vancouver, of which an example of *Xiphidium mucosum* Girard of unusual size (40.1 cm. long) lies before me.

p. 487. *Haplodactylus schauinslandii* n. sp.

Plate i, fig. i [Plate vi, fig. 1 of present paper].

Br. 5. D. 16/1/7.* A. 3/7. P. 16 (9+7). L. 1. 99-100.

The greatest depth of the body is contained about 4½ times in the total length and a little more than 4-4/5 times in the length of the body, the length of the head goes about 5 times in the total length, the length of the snout nearly 3 times, the diameter of the eyes 5-4/5 times, and the breadth across the flat forehead 4 times in the length of the head.

The snout is concave in profile above the lower nostrils, however, the forehead swells into a weak pad; it then dips very slightly before the but very slightly straightened profile line of the nape and shoulder ascends to the dorsal.

The horizontally situated mouth-opening is overtopped by the bluntly ovally rounded end of the snout. In the upper as well as the lower jaw there are twenty-two teeth in an external row; they end in three cusps, of which the middle one is longer and stronger than the laterals.

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* Should be 1/17.—G.P.W.

The hinder end of the upper jaw lies under the vertical of the anterior border of the hinder nostril.

Both nostrils are of moderate size, circular; the lower pair carry a high flap on the hinder margin.

p. 488. The hind and under skinny margins of the preoperculum form a regularly rounded, wide arch. A broad skinny flap fringes the concave upper margin and the tip of the opercular spine. There is not the slightest perceptible development of a second opercular spine. Cheeks, opercle and interopercle covered with very small scales. Snout with the inclusion of the preorbital, forehead and forward part of the nuchal region naked. The pectoral fin is just a trifle longer than the head; the six* lowermost rays are not split, they are thickened and the uppermost of them is a little shorter than the preceding split ray.

The fifth [and] highest spine of the first dorsal fin, as well as the highest third and fourth articulated rays of the second dorsal are a little shorter than the head, excluding the snout.

The second dorsal spine is scarcely half as long as the fifth, the first is about $2\frac{1}{2}$ times shorter than the second spine and about two-thirds of the diameter of the eye. The origin of the dorsal is situated vertically over the tip of the skinny opercular flap. The two dorsal fins are [more or less] separated from one another by a deep notch.

The caudal fin is weakly concave at its hinder border, but shorter than the head and thickly covered all over with scales which, with the exception of those lying over the smallest anterior third of the length of the fin, are extremely small.

In the pectoral fin there is only an arched excision in about the basal third of the fin's extent, and it is likewise covered with only very small scales indeed.

The anal fin ends in a downward point. The third spine goes about $2\frac{1}{2}$ times in the length of the head, whereas the second hardly equals the diameter of the eye. The third, highest, articulated ray of the fin is equal to $\frac{7}{8}$ of the length of the head.

A thick, densely scaled fold of skin overlies the base of the spinous first dorsal, the anterior third of the second dorsal and the anal. Towards the middle of the proximal parts of both these fins they disappear by degrees in the nature of a fold.

The scales of the anterior part of the flanks are small, further back to about the end of the middle third of the length of the body they increase but little, finally but perceptibly suddenly becoming large towards the caudal.

The scales on the abdominal part of the body are much smaller than those of the flanks and the scales of the thoracic region hardly noticeably larger than those scales which cover the operculum. A little larger, finally, are the scales of the abdomen between the ventrals and the anal.

The head, flanks and all the fins are deep violet and spangled with orange-yellow spots; the ventral surface of the body is orange-yellow with some brownish dots thereon, and unspotted between the ventrals and the anal. The yellow spots increase in size on the sides of the body down below the lateral line and the spots of the undermost rows unite themselves here and there into large blotches with darker violet spottings or into a more or less long band. The breast is indistinct violet, etcetera, wavy, streaked, and spotted upon the dirty bright-golden-brown ground colour. Three narrow violet cross-bars are situated on the under surface of the head.

One example 30.5 cm. long from New Zealand.

p. 490. *Chilodactylus macropterus* (Forst.) Gthr.

2 Examples, about 25 and 25.8 cm. long, from New Zealand.

p. 491. *Latris ciliaris* Forst.

1 Example, 26.7 cm. long, from New Zealand.

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* Six in the text, but seven in the figure; but this might vary on two sides of the same fish.—G.P.W.

D. 16/42. A. 3/34. L. l. 90 (as far as caudal). Pectoral with eight simple rays. Length of the head contained 4½ times in the total length.

Sebastes percoides (Sol.) Richards.

2 Examples, 25.9 and 26.3 cm. long, from New Zealand.

p. 496. *Anema monopterygium* (Bl. Schn.) Gthr.

1 Example, 29 cm. long, from New Zealand.

p. 497. *Percis nictymera* C.V.

Two specimens, 23 and 30.1 cm. long, from New Zealand. Length of head about 3¾, depth of body 5-1/3 times in the total length. Diameter of eye contained 5¼ times, length of snout nearly 2¼, interorbital 4, length of the pectoral slightly more than 1½ times, and that of the ventrals about 1-1/3 times in the length of the head.

Vomer toothed. The short dorsal spines increase in height to the last and are united with the soft rays into one fin. The ventrals, with the exception of their innermost rays, thickly integumented, reach back just a little past the anal orifice.

Scales lying partly isolated on the hinder part of the cheeks, lacking on the anterior portion of the cheeks.

Ten scales between the first dorsal spine and the lateral line.

P. 20. D. 5/20. A. 16.

p. 498. *Trigla kumoides*, N. Sp. (near *Trigla kumu*, Var.).

Plate 1. Figs. 2, 2a [Plate vi, fig. 2 of present paper].

One example, 38.5 cm. long, from New Zealand.

D. 9/16. A. 15. P. 11.

Body scales small, scales of the lateral line smooth-edged. Length of the head contained somewhat more than 4 times, length of the pectoral 3½ times (in *Trigla kumu* about 3 times), that of the ventrals rather more than 5 times (in *Trigla kumu* 4¾ times) in the total length; length of the snout contained 2-1/5 times, of the eye 4-3/5 times (in *Trigla kumu* 5 times) in the length of the head, and mean interorbital width a little more than 1½ times in the diameter of the eye.

Preorbital broad at the anterior margin, obtusely rounded, not surpassing the anterior border of the interoperculum and without projecting serrations. Ridges absent along the preorbitals and on the cheek-region, as in *Trigla kumu*. Interorbital concave. Two short pointed spines at the anterior end of the supraorbital margin.

The pectoral, whose hind margin is broadly rounded [according] to that of the description of the example lying [before me is] on the left side of the body a little longer than on the right since it reaches back on the left side to the fifth, on the right side to the second ray of the second dorsal, or left to the third anal ray, and on the right side to the beginning of the anal fin.

Pectoral without blackish spot on the inner side (there also sometimes missing in *Trigla kumu*) yet with one or two bright, very small dots on the sixth ray of the right pectoral fin. Inner side of the fin deep bluish violet, with the exception of the two lowermost rays, which are tinged whitish; outer side of the same fin lead-coloured nearest the base, thenceforth darker grey-violet.

Without inspecting a greater number of equal-sized specimens of *Trigla kumu*, I had hardly dared to separate it here specifically as the representative of a questionable new species from the described example *Trigla kumu*, since the relationship of both species is doubtless very close, yet I find in *Trigla kumu* the pectoral, which is ovally rounded at the hinder margin, is always longer, the eye considerably smaller, the preorbital more strongly ovally rounded at its anterior end and somewhat more extensively overhanging the mouth-opening than in *Trigla kumoides*.

p. 499. *Tripterygium medium* Gthr.

Many specimens up to 7.6 cm. long, from the Chatham Islands, Maunganui, Teone (Red Blufl) also from French Pass (Waikawa, Flemming) in fresh water.

Brown marbled with darker. Upper margin of eyes without tentacle; the hinder end of the upper jaw often reaches backwards in the older specimens to under the middle of the eyes.

The teeth of the lower jaw increase a little in length in the outer rows towards the anterior ones and those farthest forward are sometimes proportionally strikingly large, caniniform and curved.

D. 4/15-16/12-13. A. 20, 21 (seldom 22-23). P. 9-10/6 (unsplit). L. 1. 45-46.

p. 500. *Acanthoclinus littoreus* (Forst.) Gthr.

Many specimens from D'Urville Islands and French Pass, 3.1-12 cm. long

D. 20/4-5. A. 9/5-4. L. Lat. above 76-85+3. L. lat. middle 90-97. L. lat. inferior 107-116.

Very indistinct, blurred, yellow brown, rounded spots on the body, on a dirty dark violet ground. A darker spot on the operculum, two dark stripes start from the eye and slope obliquely backwards.

Lepidopus caudatus (Euph.) White.

One example, 62.7 cm. long, from New Zealand.

Length of head 7 times in that of the body, eye-diameter contained somewhat more than 5½ times in the length of the head, twice in that of the snout, the latter a little more than 2½ times in the length of the head. Interorbital about 7-2/5 times, depth of body rather more than twice in the head.

Length of head 8.55 cm., eye-diameter 1.5 cm., length of snout measured from the tip of the lower jaw nearly 3.5 cm., depth of the body over the anal origin 4.5 cm.

p. 501. *Diprocrepis puniceus* (Richrds.) Gthr.

Many specimens from the Chatham Islands, D'Urville Islands and French Pass.

p. 503. *Pseudolabrus cossyphoides*, n. sp.

Plate II, fig. 1 [Plate vi, fig. 3 of present paper].

Snout produced, triangular. Cheeks with 6-7 rows of small scales. Opercular scales large. Rest of head naked. A strong well-developed canine tooth next to the corner of the mouth on each side of the symphysis. Anterior canines [in the upper jaw] at the symphysis stronger and longer than in the lower jaw.

Dorsal with numerous dot-like violet spots in oblique rows. Anal immaculate. A moderately broad dark brown cross-band at the hinder part of the caudal peduncle, for the most part encroaching upon the base of the caudal fin.

A row of very small scales extends a little way onto the bases of the soft parts of the dorsal and anal fins. Lateral line [scales] strongly ramified.

D. 9/11. A. 3/10. P. 12. L. Lat. 26+1 (on the caudal). L. tr. 2½/1/8 (to ventral).

In the form of the head this species approaches more the species of the genus *Cossyphus* rather than those of *Pseudolabrus*. The upper profile of the head is weakly concave, the snout acutely produced.

p. 503. The length of the head inclusive of the broad dermal flaps at the opercular margins is a little more than three times in the length of the body, about 3-2/3 times in the total length, the greatest depth of the body somewhat less than 3½ times in the total length, the length of the snout contained nearly 2-4/5 times in that of the head, the diameter of the eyes twice in the length of the snout, the length of the pectoral about 1-1/3 times, of the ventrals about 2¼, and the length of the caudal very slightly more than 1½ in the length of the head.

Upper lip with numerous oblique folds on the inner side; under-lip ~~over~~-hanging laterally, anteriorly crumbling below. The corner of the mouth falls vertically under the anterior nostrils. Nasal openings small. The spines of the dorsal fin increase in length to the last, the articulated rays up to the penultimate gradually increase in height; the stiff part of the last, ninth, spine is about 1-1/3 times shorter than the last ray.

Dorsal and anal pointed at their hinder ends. The caudal is weakly concave at its posterior margin, the marginal rays, above and below, surpass but slightly the hinder limits of the [dorsal and anal] fins.

p. 504. The smaller anterior portion of the caudal fin is scaly, the squamation reaches further back only on the upper and lower rays.

Head and body in life considered to be rosy coloured; dorsal and anal said to be yellow. Band at the base of the tail and upper and lower margin of the caudal brown-violet.

1 Specimen, 24.5 cm. long. Locality, New Zealand.

[I have already demonstrated in my "Studies of Ichthyology, No .7," published in Rec. Austr. Mus. xix, 1, Aug. 2, 1933, p. 86, that *Pseudolabrus cessyphoides* is a synonym of *Pseudolabrus* (*Lunolabrus*) *miles* Bloch and Schneider.—G.P.W.]

Pseudolabrus bothryocosmus (Richrd.) Gill.

(*Labrichthys bothryocosmus* Gthr.)

Many examples, 13.9 to 18 cm. long, from New Zealand.

Pseudolabrus celidota (Forst.) Gill.

(*Labrichthys celidota* Gthr.)

One example, 17.6 cm. long, from New Zealand.

Six rows of scales on the cheeks. A dark blotch under the last spine and first ray of the dorsal fin. A darker transverse mark at the base of each scale on the body. A curved streak runs from the snout to the eye and beyond that to the posterior margin of the operculum.

D. 9/11. A. 3/10. L. l. 26+1.

p. 509. *Coridodax pullus* (Forst.) Gthr.

One example, 37.4 cm. long, from New Zealand.

D. 14/20, A. 3/12. L. lat. 80+2 on the caudal. L. tr. 12/1/25 to ventrals.

Lotella grandis Rams.

(Proc. Linn. Soc. N. S. Wales, vol. v, p. 462.)

Two specimens, 31 and 34.2 cm. long, from New Zealand.

Length of the head 3-2/3 to 3-5/12 times in the length of the body, about 3-5/6 to 4 times in the total length. Diameter of the eyes contained 5 to 5½ times in the length of the head snout 3-2/5 to somewhat more than 3-4/5 times, interorbital 3-3/5 to 3½ times, length of mouth-opening about twice, length of the pectorals somewhat less or exactly twice, and length of the ventrals 1½ to a little more than 1-2/3 times in the length of the head.

The greatest breadth of the head equals one-half, and the maximum height of the head almost goes 5/7 in the length of the head in the larger example; the greatest depth of the body attains nearly 1/5 of the total length, 2/9 of the length of the body, or about ¾ of the length of the head.

The upper profile of the head rises as a rounded obtuse oval, moderately projecting over the border of the mouth to the symmetrical end of the snout, without noteworthy curvature to origin of the first dorsal, and is even in the region of the snout very weakly concave.

p. 510. The posterior end of the mouth-opening falls quite an insignificant distance behind the vertical of the eye. The lower jaw is overhung in front by the symphysis of the upper jaw. The teeth in the jaws are delicate, brush-like, very numerous. The band of teeth in the upper jaw is broader than that of the lower jaw and attains, at its most anterior portion, to the width of about one-quarter of an eye-diameter. There are no larger or stronger teeth in the outer rows of the bands of teeth in the jaws. Barbel on the chin about as long as the diameter of the eye.

The two outer ventral rays are moderately thickened, the second longest, contained about 1½ to 1-2/3 times in the length of the head, the first ray less than 2 to 2-1/9 times in same.

The tip of the ventral falls about a length of the snout before the origin of the anal or about under the end of the first fourth of the length of the pectorals.

Head and body dull golden brown; scaleless part of the dorsal, caudal, and anal blackish blue-grey. A darker stripe, not distinctly demarcated superiorly, along the under margin of the sides of the snout to the corner of the mouth.

D. 9/56-57. A. 53-58. Scales above the lateral line about 134.

Lotella rhacinus (Forst.) Gthr.

One example, 26.1 cm. long, from New Zealand.

D. 5/63. A. 58. V. 6.

Dusky brownish violet.

Length of head a little more than four times in that of the body, contained 4½ times in the total length; greates height of the body about 5 times in the total length, snout hardly less than 3½ times, length of eye about 5-2/5 times, interorbital space more than 4-1/3 times, length of the pectorals about 1-3/5 times, length of the second threadlike produced ventral rays nearly twice, and length of the median caudal rays contained about 2-3/5 times in the length of the head.

Snout rounded obtusely ovally anteriorly, projecting like a nose over the margin of the lower jaw. The hinder end of the upper jaw falls, when the mouth is closed, under a vertical from between the centre of the eye and the hinder ocular margin.

The moderately thick barbel on the chin is about as long as the eye, the inner ventral ray is half as long as the second and longest ray. About 244 scales lie along the upper part of the lateral line as far as the base of the middle caudal rays and about 19-20 between the base of the first dorsal fin and the lateral line.

The tip of the adpressed pectoral falls vertically over the anal origin, caudal ovally rounded.

Ventrals with finer delicate rays; both the outer ones are moderately produced, not thickened; the first ray is about half an eye-diameter shorter than the second, longer, ray of the fin.

p 511. *Galaxias fasciatus* Gray.

Many examples from Waikawa, French Pass, New Zealand; 16-21.1 cm. long.

Galaxias attenuatus (Jen.) C.V.

Many specimens, juveniles, from French Pass.

p. 513. *Scopelus* (*Myctophum*) *novae seelandiae* n. sp.

One example, about 5.6 cm. long, from New Zealand.

D. 12 to 13. A. about 18. V. 8. L. lat. 41. L. tr. 2½/1/2½ (to the ventrals).

Height of the body somewhat more than 4 times, length of the head contained 3-2/5 times in that of the body, eye-diameter about 3 times, length of the mouth-opening about 1-2/3 in that of the head. Snout very short, steeply sloping in an arc to the mouth-opening. Mouth-opening moderately ascending anteriorly; the hinder end of the upper jaw which is not widened reaches back almost to the angle of the preoperculum. The interorbital width is about 2/3; the length of the snout 1/3 of the eye-diameter.

The origin of the dorsal falls about more than one eye-diameter nearer to the anterior end of the head than to the base of the caudal; the origin of the anal is removed quite as far from the hinder ocular margin as from the base of the caudal. The jointed part of the ventral is situated below the vertical of the dorsal origin.

The length of the caudal peduncle, measured from the end of the adipose dorsal fin, is contained about 3-3/5 times in the length of the body and the minimum height of the peduncle about four times in the maximum height of the body.

Scales with entire margins, lateral line projecting like a keel. A row of photophores on each side of the ventral margin, 5 as far as the ventrals, 4 between the latter and the origin of the anal, next come 9-10 above the base of the anal to the caudal. Two or three photophores next to the shoulder-girdle up to the beginning of the lateral line, 1 between the ventral and the lateral line and 3 in an obliquely placed row between the tip of the adpressed ventral and the lateral line (the uppermost of this row lies on the lower part of the eighteenth scale of the lateral line).

The scales lying above the scale-row of the lateral line are almost completely absent in the example under examination; also the pectorals are only partly preserved.

p. 514. *Anguilla aucklandii* Richds.

One example, 45 cm. long, from New Zealand.

Length of the tail 24.4 cm., head 7.85 cm., distance between the gill-opening and the anal orifice 13.3 cm., distance of the gill-opening from the origin of the dorsal 7.9 cm., consequently about equal to the length of the head.

Some quite young specimens from freshwater at Waikawa (French Pass) probably also belong to the same species.

Muraena thyrsoidea Richds.

One large example (skin) from the South Sea, French Pass.

p. 516. *Stigmatophora gracilis* Macleay.

One example, young, about 10 cm. long (end of tail missing to the extent of 1 mm.) from French Pass.

D. about 63-64. Scutes 20+85 to 90. End of tail filiform.

Head 14 mm., snout 9 mm. A very delicate longitudinal ridge, running backwards somewhat over the middle of the height of the operculum.

The whole body is of a golden brown ground-colour, seen under the lens to be thickly dotted with blackish.

At the Vienna Museum are preserved three large examples, male and female, of this same species, up to about 20.7 cm. long, in which the tail comprises 70-75 rings and the dorsal fin 63-70 rays. Snout twice as long as the rest of the head.

Locality:—New South Wales to New Zealand.

Solenognathus spinosissimus Gthr.

One dried specimen, with a damaged snout, otherwise about 40 cm. long, from the Chatham Islands. D. 35. P. 24. Osseous scutes 26+55.

p. 517. *Monacanthus rudis* Rchds.

Three examples, 26, 26.5, and 28.7 cm. long, from New Zealand.

D. 33-34. A. 33-34.

p. 519. *Scyllium chilense* Guich.

One example, female, 81 cm. long, from French Pass.

Bdellostoma cirrhatum (Bl. Schn.) Gthr.

Many examples, 51 to 60 cm. long, from New Zealand.

Seven gill-openings.

The modern names for Steindachner's species are as follows:—

Haplodactylus schauinslandii is now *Dactylosargus arctidens* (Richardson).
Chilodactylus macropterus is now *Nemadactylus macropterus.*
Latris ciliaris is now *Latridopsis ciliaris.*
Sebastes percoides is now *Helicolenus papillosus* (Bl. Schn.).
Anema monopterygium is now *Genyagnus monopterygius.*
Percis nictymera is now *Parapercichthys colias* (Bl. Schn.).
Trigla kumoides is now *Currupiscis kumu* (Cuv & Val.).
Tripterygium medium is now *Helcogramma medium.*
Acanthoclinus littoreus is now *Acanthoclinus quadridactylus* (Bl. Schn.).
Lepidopus caudatus is now *Lepidopus lex* Phillipps.
Diprocrepis puniceus is now *Diplocrepis puniceus.*
Pseudolabrus cossyphoides is now *P.* (*Lunolabrus*) *miles* (Bl. Schn.).
Pseudolabrus bothryocosmus is now *P.* (*Lunolabrus*) *celidotus* (Bl. Schn.).
Pseudolabrus celidota is now *P.* (*Lunolabrus*) *celidotus* (Bl. Schn.).
Coridodax pullus stands.
Lotella grandis is now *Physiculus barbatus* (Gunther).
Lotella rhacinus stands.
Galaxias fasciatus stands.
Galaxias attenuatus is now *Austrocobitis attenuatus.*
Scopelus (*Myctophum*) *novaeseelandiae* is apparently a *Myctophum.*
Anguilla aucklandii is now *Anguilla dieffenbachii* Gray.
Muraena thyrsoidea is now *Lycodontis thyrsoidea.*
Stigmatophora gracilis is now *Stigmatophora longirostris* Hutton.
Solenognathus spinosissimus is now *Solegnathus spinosissimus.*
Monacanthus rudis is now *Navodon australis* (Donovan).
Scyllium chilense probably refers to *Cephaloscyllium isabella* (Bonn.).
Bdellostoma cirrhatum is now *Eptatretus cirrhatus.*

Most of the types of Steindachner's new species, which were first described in Anzeig. Akad. Wiss. Wien xvi, 28 June 1900, pp. 174-178 (a work not available to me), survived the two World Wars and are in the Ubersee-Museum, Bremen, Germany, having been recently catalogued by Gerd von Wahlert (Veroff. Ubersee Museum Bremen, A, ii, 5, 1955, pp. 323-326, figs. 1-2). He says the type of *Scopelus* (*Myctophum*) *novaeseelandiae* is unfortunately lost and that the whereabouts of the type of *Pseudolabrus cossyphoides* is unknown.

Dr. James Stuart: Artist Naturalist

By A. MUSGRAVE, F.R.Z.S., F.R.E.S.

(Plates vii-xviii.)

James Stuart, Surgeon, is one of those artist-naturalists who has done so much to depict Australian zoology, but whose work has hitherto remained largely in obscurity, though his fine drawings in colour are housed in the Linnean Society of New South Wales.

Very little has been known of this worker's biography, apart from the information given by the late J. J. Fletcher, formerly Secretary to the Linnean Society of New South Wales. This information is contained in the following references, viz. (1) Notes and Exhibits. *Proc. Linn. Soc. N.S.W.*, 1896, xxi (4) May 31, 1897: 585, referring to an occasion on which the Stuart drawings were exhibited to the members of the Society, and (2) in his Presidential Address: The Society's Heritage from the Macleays, *Proc. Linn. Soc. N.S.W.*, 1920, xlv (4) 7 March, 1921: 609-611, in which he traces the history of the drawings. These original drawings, the fruits of Dr. Stuart's labours in New South Wales and Norfolk Island, were bequeathed to William Sharp Macleay, and, upon his death, his brother, George Macleay, inherited them and presented them to William Macleay in 1887. Sir William Macleay presented them to the Linnean Society and here they have remained. Fletcher (p. 611) lists the drawings, but this list is not strictly accurate. He says that there was only one plate of insects, whereas there are four, viz.

No. 192, Caterpillar of a Hawk Moth.

No. 194, Grasshoppers.

No. 195, Mantids, *Tenodera australasiae*. March 13, 1836.

No. 196, Larva and pupa of the Case Moth *Metura elongata*.

Fletcher is unable to tell us much of the biography of Stuart, and he writes, "I have not been able to learn anything more about this worthy man than is given by W. S. Macleay himself, in the following extracts," which are taken from the paper by W. S. Macleay, Notice of a new genus of Mammalia discovered by J. Stuart, Esq., in New South Wales, *Ann. Mag. Nat. Hist.*, viii (51) Dec. 1841, 241-243, pl. vii. This paper is a description of *Antechinus Stuartii* from Spring Cove, Port Jackson. To quote, "J. Stuart, Esq., is a surgeon in the army, who has been frequently employed by the Colonial Government in superintending the quarantine to which vessels arriving unhealthy in Port Jackson are subjected. On entering the heads of this noble frith, every vessel is boarded by the medical officers, and if found to be in a sickly state, instead of sailing up to Sydney, a distance of about seven miles, she is carried off to the right, and enters Spring Cove, where the passengers are landed at a Lazaretto, established on the north shore. Here they remain under the care of a surgeon for the necessary period; and Mr. Stuart, who has often undertaken this painful charge, has, by means of his admirable skill in drawing objects of natural history and his powers of accurate observation, been enabled to employ to the advantage of every department of science those spare hours, which otherwise, in the midst of contagion and disease, would have proved so dreary."

Brief reference to Dr. Stuart has also been made by Mr. G. P. Whitley, Early Naturalists and Collectors in Australia, *Journal and Proceedings Royal Australian Historical Society*, xix (5), 1933: 323, and Prof. J. Burton Cleland, The Archibald Watson Memorial Lecture. The Naturalist in Medicine with particular reference to Australia, *Medical Journal of Australia*, vol. i, 37th year, No. 17, April 29, 1950; 563.

THE SEARCH.

It was necessary, therefore, to try to discover if any additional information about this surgeon-naturalist might be hidden in books in the Mitchell and Public Libraries, Sydney, and it was in the former Library that search brought to light much of Dr. Stuart's official history. In this library are kept the early records of the State and in the "Colony of New South Wales" a beautifully compiled MS. list of the officials of the State, their positions and salaries, an equivalent of the Public Service Lists of the present day, we find important records of all who entered the service of the Crown. There are two distinct sets of this work in the Mitchell Library, one marked "Office Copy," the other printed on the cover "Duplicate," though the pagination is different in the two sets. Here, too, as a result of diligent combing of the newspapers published during the period when Dr. Stuart was active in Australia and Norfolk Island, I have been able, with the assistance of Mr. G. P. Whitley, who was the first to direct my attention to the Stuart paintings, to fill up many of the gaps in our knowledge of this surgeon's biography, so far as his Australian career is concerned. Mr. Tom Iredale has also been able to glean much information from the drawings themselves, the dates on the pictures providing valuable clues as to the whereabouts of the artist at the time of their execution. In 1833 he was at Kevin's Hospital, New Street, Dublin, and in Liverpool the same year.

In the Mitchell Library too are kept many official documents of historic interest, and thanks to the efforts of one of the Staff, my attention was directed to two letters relating to the Superintendent of Convict's Office written by Mr. John Ryan Brenan, then Acting Superintendent of Convicts at Sydney, and the second of these gave the clue to the date of Dr. Stuart's arrival at Sydney. These letters I have been permitted to cite herewith. The writer points out (1) that Dr. Stuart had attended him "on the voyage to the Colony," and (2) that Dr. Stuart had "not commenced the practice of his profession" since his arrival in Sydney.

It was therefore necessary to find only the date of Mr. Brenan's arrival, as previous search had failed to find that of Dr. Stuart's. Fortunately this was easily procured from the official MS. volumes of "Vessels Arrived 1834, volume 1." It appeared that Mr. Brenan, his wife and two sons had arrived in Sydney on the barque *Jessie* (314 tons), Captain James Troup, from Liverpool, whence they had sailed on 24 December, 1833, &c. No mention of Surgeon Stuart, however, appeared among the lists of passengers. The newspapers of the day, however, came to our assistance and in *The Colonist, and Van Diemen's Land Commercial and Agricultural Advertiser*, Hobart Town, vol. iii (100) Tuesday, June 3, 1834, p. [2], col. 1, we read, "Ship News. Hobart Town May 23.—Arrived barque *Jessie*, 314 tons Captain James Trow [sic], from Liverpool, which she left the 25th November [?], Falmouth 29th January, Cape of Good Hope, 8th April.—Passengers, . . . Surgeon Stewart [sic], Mr. Brennand [sic], wife and two children," &c. *The Sydney Herald*, iv (274) Thursday, June 12, 1834, p. 2 , col. 1, also records the vessel's arrival for the previous day, mentions the Brennans [sic], but does not refer to Surgeon Stuart. Other Sydney papers likewise failed to mention his arrival. We have thus the testimony of Mr. Brenan and *The Colonist* that he was on the vessel and we may, I think, safely assume that he continued with the vessel from Hobart Town to Sydney.

This view is substantiated by the date on a drawing of *Petaurus*, 26 June, 1834, which shows that he was in Sydney in the same month as the Brenans' arrival, and that already he was absorbed in the natural history of this continent.

SYDNEY: THE YEARS 1834-1836.

History is silent as to his activities during his first six months in the Colony, but reference to the "Colony of New South Wales, 1835," shows that a James Stuart was appointed a clerk in the Principal Superintendent of Convict's Office, on 20 January, 1835. The suggestion that a Surgeon should be so reduced in circumstances as to be compelled to accept so subordinate a position might seem out of place, were it not for a letter signed "Medicus" written to the *Lancet*, vol. i, 1838, pp. 716-717, and cited by Drs. J. H. L. Cumpston and F. McCallum in their work, The History of the Intestinal Infections (and Typhus Fever) in Australia, 1788-1923. *Commonwealth of Australia. Dept. of Health Serv. Publ.*, No. 36, Melbourne, 1927: 82-83, in which it is stated *inter alia*:

"However, let no man go as a surgeon without ample remuneration, bargaining also to be brought back. If he do not this, he must become a clerk or a cattle-driver or he must starve."

We learn that Dr. Stuart was first employed at a salary of £100 per annum, but from 1 February, 1836 to 26 July 1836, it was increased to £130 per annum. It was during this period that the correspondence referred to was written by his Chief, Mr. Brenan. Here, perhaps, we may digress for a moment to consider the fortunes of Surgeon Stuart's fellow-passenger on the *Jessie*.

John Ryan Brenan, solicitor, was appointed Sydney Coroner on the 13 February, 1835, to succeed Charles J. Smeathman (who had died on 15 January, 1835) at £100 per annum.(1) On the 1 January, 1836, he became Acting Principal Superintendent of Convicts and, when Mr. Frederick A. Hely, who had held the post of Principal Superintendent of Convicts for many years died on 8 September, 1836, Mr. Brenan became Principal on the following day at a salary of £600 per annum having prior to that date received only half that amount per annum.(2) His rise was thus meteoric in comparison with that of his clerk (ci-devant surgeon) James Stuart. The value of the official records will be realized when one compares them with *The New South Wales Calendar and General Post Office Directory*—1836, which gives only Brenan's position as Coroner (p. 317), and in the *Directory* section he is cited as a Solicitor and Coroner for the district of Sydney with his private residence in Kent Street and his office in George Street, Sydney. It was about four months after he had become Acting Superintendent of Convicts that he acquired the malaise which led to the writing of the correspondence previously mentioned and which, it will be seen, was the outcome of his furnishing a medical certificate supplied by James Stuart, Surgeon. These letters were addressed to The Hon. The Colonial Secretary, Alexander Macleay, who held that office from 1825-1836, and it is interesting to note that it was to his son, William Sharp Macleay, that the Stuart drawings were ultimately bequeathed.

COPY.

Kent Street, Ap. 18th 1836.

Sir

Having laboured under a severe cold for the last three weeks, my medical attendant has recommended me change of air, to recruit my health, and beg leave to enclose his certificate to that effect.

I do myself the honor to request you will have the goodness to obtain his Excellency's sanction for my absence from my official duties for ten days from Wednesday next, to enable me to proceed into the country for the restoration of my health.

I have the honor to be
Sir
Your most obedient servant.
Sgd. *Jno. Ryan Brenan.*

To
The Honorable
The Col. Secretary.

MEDICAL CERTIFICATE.

Castlereagh Street.

I hereby certify that Mr. Ryan Brenan is not in a fit state of health to continue in the prosecution of his official duties at the present. I would strongly recommend him to go into the country for 10 or twelve days, as the best means of recruiting his strength and getting rid of his complaint.

Sgd. James Stuart Surgeon.
Sydney 18th April 1836.

(1) "Colony of New South Wales, 1835," p. 55, 100.
(2) "Colony of New South Wales, 1836," p. 73, 132.

OFFICIAL COMMENT.

Leave of absence allowed. The certificate however from a clerk in the Superintendents office is certainly not regular, and it has now become necessary to intimate to Mr. Stuart that he must make his election between Govt. employment and the practise of his profession.

April 19. ? initials.

Pr. Sup. of Convicts Office.
Ap. 20th 1836.

To
The Honorable
The Col. Secretary.
Sir,

In reply to your letter of this day communicating to me His Excellency's permission to be absent for ten days, I beg to say the state of the weather did not permit of my leaving town, but hope tomorrow may be more favorable.

With reference to His Excellency's directions to point out to me that a medical certificate from a clerk in my office is by no means regular:—I do myself the honor to acquaint you for the information of His Excellency, that I was induced to have Mr. Stuart's advice from his knowledge of my constitution, having attended me on the voyage to the Colony—his attendance on me did not interfere with office hours:—under these circumstances I did consider his certificate the most regular I could transmit, not having in the early stage of my attack contemplated any such necessity, and more especially in the absence of any other medical attendant.

I have communicated to Mr. Stuart as desired relative to his election between employment in the service of Govt. and the practice of his profession.

I have the honor to report that Mr. Stuart informs me he has not commenced the practice of his profession and that should circumstances arise to induce him so to do, he will resign his situation as clerk in my office, and he requested me to add that he did not consider his attendance on me sufficient to be construed into the practice of his profession.

I have the honor to be
Sir
Your most obedient servant.
Sgd. *Jno. Ryan Brenan.*

On 26 July, 1836 Dr. Stuart resigned his clerical position in the Principal Superintendent of Convicts Office, having thus served about 18 months in that capacity, and two days later, 28 July, 1836, he became an assistant to the apothecary at a reduced salary of £91/10/- per annum and quarters. However, on 5 December, 1836, he was appointed assistant-surgeon at £136/17/6 with quarters and rations for himself and one servant (Colony of N.S.W. 1836), though in another place his salary is given at £137/5/-.

COLONIAL ASSISTANT-SURGEON, 1836-1842.

The following year, 1837, was full of incident for him and we gather from the Press of that day that he was acting as a medical officer at the Quarantine Ground. We read in *The Colonist*, Sydney, iii (114) Thursday, March 2, 1837, p. 72, under "Domestic Intelligence. Typhus Fever," that the female emigrant ship, *Lady Macnaughten*, lost 56 passengers on the voyage out to Australia, and 90, including Dr. Hawkins, the surgeon of the vessel, were on the sick list. This doctor subsequently died. When within a few days' sail of Port Jackson they fell in with H.M.S. *Rattlesnake*, and the Assistant Surgeon, Dr. Bowler, hearing that the emigrants were without medical assistance, volunteered his services to go on board. In the *Sydney Herald*, 20 March, 1837, we read, "Domestic Intelligence. The Fever Ship. The accounts from the Quarantine Ground are anything but favourable. Dr. Stuart and Capt. Hustwick have been seized with the infection during the last week." Later we learn in the *Sydney Herald*, 23 March, 1837, that

"Captain Hustwick, Mrs. Hustwick and Dr. Stewart (sic) are fast recovering." On 11 May, 1837, the *Lady McNaughten* was released from quarantine.

Prior to the release of the vessel occurred a small incident which adds a note of comedy to relieve the gloom of the Press accounts of the "Fever Ship," but it must first be appreciated that the newspapers of those days were always very acrimonious towards one another. And so we read in *The Sydney Times*, 22 April, 1837, that a number of the female immigrants who had been passengers on the *Lady McNaughten* after they had been liberated from quarantine, addressed a letter to the Colonial Secretary, "thanking him in the warmest terms of gratitude for the kindness shown to them since their arrival in harbour." This, *The Sydney Times* goes on to say, "has elicited remarks from several of our contemporaries. *The Herald*, as might be expected, is very severe upon what it terms misplaced *adulation*."

In the *Historical Records of Australia* (1) xviii, July, 1835-June 1837 (1923), 726-727, there is recorded a Dispatch from Sir Richard Bourke to Lord Glenelg, written at Government House, Sydney, on 10 April, 1837, in which is given a report on the Sickness on the *Lady MacNaughten*, and pointing out that 10 adults and 44 children died on the passage out, and four adults and nine children since arrival. The need for having experienced surgeons on emigrant ships was emphasized. In a later dispatch from Sir Richard Bourke to Lord Glenelg, dated 11 May, 1837 (*op. cit.*, pp. 758-759), thanks are expressed to the surgeons employed at the Quarantine Ground and recommendations are made for promotion and reward.

On 23 January, 1838, the ship *Minerva* arrived at Sydney with emigrants and was found to be affected with that old scourge of the past, "ship fever" or typhus, and was duly quarantined. A report on this typhus-ship's patients was made by Dr. Stuart, in which it is pointed out that 86 were attacked by the disease and of this number 24 died. This report is referred to in the Enclosures with the Dispatches from Acting Governor Snodgrass to Lord Glenelg (dated 22 February, 1838) and is cited in the *Hist. Rec. Austr.*, (1) xix, July 1837-Jan. 1839 (1923): 288-289. The original report is filed in the Mitchell Library, Sydney, 1218, pp. 173-174, 179-180. References to the *Lady MacNaughten* and the *Minerva* will also be found in the work by Cumpston and McCallum previously cited (pp. 137-143).

NORFOLK ISLAND.

In 1838 in the *Colony of N.S.W.* list for that year, pp. 105 and 220, we read under "Medical Establishments," that Dr. Stuart was still at Sydney, but that he was transferred to Liverpool [New South Wales] 1 September, 1838, and to Norfolk Island, 1 November, 1838.

Dr. Stuart was on Norfolk Island during its Second period of occupation as a penal settlement, 1825-1856, and therefore must have served under four administrators, viz.

1. Major James Anderson (17 April, 1834).
2. Major Thomas Bunbury (3 April, 1839).
3. Major Ryan (27 September, 1839).
4. Captain Alexander Maconochie (1 March, 1840).

These took charge of the settlement on the dates which follow their names according to the *Australian Encyclopaedia*, ii, M-Z, 1926, p. 211.

It was during this period that Dr. Stuart made so many of his fish and bird drawings. He remained on the Island as Assistant Surgeon until 1841 and arrived back in Sydney on the brig, *Governor Phillip*, on January 10th.

VALE..

The following year, 1842, writes "finis" to Dr. Stuart's colonial activities. While on a visit to Major Innes at Lake Innes, Port Macquarie, he died, the aftermath, we are informed, of two attacks of typhus which had undermined his constitution during that period 1837-1838, when he had caught the infection while tending his patients. Most of the newspapers of June, 1842, printed the following in their "Deaths" notices: "At Lake Innes, Port Macquarie, on the 26th ultimo, James Stuart, Esq., Colonial Assistant Surgeon, deeply regretted by a large circle of friends."

Some newspapers, however, printed small obituaries (two of them virtually the same, viz. those in the *Sydney Herald*, June 3, and the *Australasian Chronicle*. June 4, 1842).

The Australian, June 2, 1842, p. [2], col. 2, gives the following:

"Port Macquarie.—It is with deep regret we announce the death of Dr. Stuart, Colonial Surgeon, which took place at Lake Innes, on the 26th ult. Dr. Stuart had only arrived here on a visit to Major Innes, having obtained leave of absence from Sydney, in the hope of recruiting his health. This distinguished surgeon may be said to have fallen a martyr to his zeal for his profession, his death being entirely attributable to the effects of two severe attacks of typhus fever, caught during his attendance on the immigrants at the Quarantine Ground. His career as a Colonial Surgeon reflects high honour on his memory, whilst his accomplishments as a scholar, and his attainments as an artist, have long ranked highly in the estimation of the scientific and literary world. In his beautiful ornithological and botanical illustrations of Australia, the elegance and vigour of his genius were conspicuous; and his many scientific papers on various subjects of colonial interest are of much value. His death will be deeply lamented by the public, and by his numerous friends.—Communicated."

The *Sydney Herald*, June 3, 1842, p. [2], col. 7, printed the following:

"The Late Doctor Stuart.—It is our painful duty to announce in this day's *Herald* the death of James Stuart, Esq., Colonial Assistant Surgeon, which occurred at the residence of Major Innes, Port Macquarie, where he had been on a visit for the benefit of his health. The Colony has lost in Doctor Stuart one of the most talented members of its Society, whether he be regarded as an anatomist, a naturalist, or an artist. For the last five years he has sedulously devoted himself to the pursuit of natural history connected with Norfolk Island and this Colony, and his drawings on the subject, particularly those of the fishes of Norfolk Island and Port Jackson, are considered by the best judges as the most splendid and accurate of any which have yet appeared. We understand he has bequeathed them, with descriptive notes, &c., to William Sharp M'Leay, Esquire, who not only has the ability but the power to bring them before the world in a proper manner, which we hope he will do at some future period."

The *Australasian Chronicle*, in addition to printing the above, concludes by saying, "Dr. Stuart also published in the columns of this journal some very humane, talented, and philosophical letters on the subject of prison discipline."

Later in the year *The Sydney Herald*, June 14, 1842, p. [2], cols. 3-5, under the title of "Notitiae Australasianae," gives an account of the paper by W. S. Macleay on *Antechinus Stuartii*, earlier referred to, and quotes Macleay's remarks about Stuart's work and his "skill in depicting objects of natural history." Unfortunately this animal is now known by the name of *Antechinus flavipes* Waterhouse, 1838, or more popularly as the Yellow-footed Marsupial Mouse, Waterhouse's earlier name antedating that of Macleay; the specific name of *stuartii* being known only as a synonym to mammalogists.

A sequel to this biography is found in the *Historical Records of Australia*, (1) xxii, April 1842-June 1843 (1924): 593-594, in which is given a letter from Lord Stanley to Sir George Gipps, an enquiry from Capt. Thomas Stuart, R.N., of Combermere, Cork, dated March 18, 1843, about the death of his brother, Colonial Assistant Surgeon James Stuart at Sydney, with an Enclosure from Capt. Stuart to Under Secretary Hope. Later we find the reply by Sir George Gipps to Lord Stanley (*op. cit.*, (1) xiii: 161), in which the solicitor, Mr. P. Harnett, replies pointing out that Dr. Ellis and himself were the executors and that the necessary information had been forwarded.

From a record of the burials in the Parish of St. Thomas in the County of Macquarie, New South Wales, in the year 1842, and kept at the Registrar-General's Office, Sydney, we learn that he was buried in the churchyard of St. Thomas, the ceremony being performed by the Rev. John Cross, on the 27th May, 1842, and that he was 40 at the time of his death.

Earlier it was pointed out that W. S. Macleay had referred to him as an Army Surgeon but, search in the *Army Lists* of the years 1833-1842 failed to reveal any evidence of our James Stuart being in the Army.

There is a danger of confusing Dr. James Stuart with Dr. Peter Stuart, assistant surgeon to the 17th Regiment which was stationed here from 1830-1836. Dr. P. Stuart arrived in Sydney on the *Hive* (483 tons) on the 9th or 11th June, 1834, about the same time as the *Jessie*.

The complete biography of Dr. Stuart is not yet known to us (Messrs. Iredale, Whitley and myself), but it is hoped that these notes may be the means of attracting the attention of someone who may be in a better position to supply further details concerning his life in Ireland, England, or in the Colony which he so faithfully served.

ACKNOWLEDGMENTS.

In conclusion I would point out that the compilation and collating of this material has not been achieved without considerable assistance from many people, so that I would here express my indebtedness to, and appreciation of, the services rendered by the following: the Staffs of the Mitchell and Public Libraries; The Hon. T. D. A. Mutch, Trustee of the Mitchell Library, who drew my attention to information about Dr. Stuart previously overlooked; Miss Jean Tigh (Public Health Library), Miss Rolleston (B.M.A. Library); Mr. R. Gannon (R.Z.S. N.S.W.); to Australian Museum friends, and particularly to the Council of the Linnean Society of New South Wales for permission to reproduce here a selection from the Stuart drawings.

THE STUART PAINTINGS.

On 30th June 1948, an illustrated symposium on James Stuart and his paintings was held at the rooms of the Linnean Society of New South Wales. The late Dr. Frank Marshall, C.M.G., had prepared kodachrome transparencies from a number of the paintings, which were exhibited; the writer gave an account of the artist's life, and Messrs. Tom Iredale and G. P. Whitley discussed various aspects of the drawings from the standpoints of ornithology and ichthyology respectively. To give a complete catalogue of the drawings is impracticable as they would all have to be classified by experts, but the following preliminary list of the 216 items will, it is hoped, stimulate further study later. This list is followed by comments on the birds and fishes by my colleagues, Iredale and Whitley.

Drawings Nos.	
1-54.	Birds (see Plates vii-xi and T. Iredale remarks, *infra*).
55-63.	Mammals (a monstrous filly, wallabies, koala, bats, etc. One of *Antechinus* was reproduced by W. S. Macleay, Ann. Mag. Nat. Hist. viii, 1841, pl. vii).
64-66.	Turtles.
67-72.	Mammals.
73-80.	Crustacea.
81-97.	Mollusca, etc. A Sea Hare (No. 95) was reproduced from this series by Hedley, Proc. Linn. Soc. N. S. Wales xlviii, 1923, p. 314, pl. xxxiii.
98-186.	Fishes (see Whitley's catalogue, *infra*).
187-189.	Cetacea (Northern Hemisphere species).
190-191.	Fishes.
192.	Caterpillar of a Hawk Moth.
193.	Starfish. Table Bay.
194-196.	Insects (see *supra*).
197-204.	Reptiles and miscellaneous dissections, etc.
205.	Eel.
206-209.	Amphibia.
210-216.	Miscellaneous (dissected organs and mammal skulls).

JAMES STUART — ORNITHOLOGIST

By TOM IREDALE.

The preceding article by A. Musgrave must be read in conjunction with this note, as he has given a general sketch of the short life of this great naturalist who lived and died comparatively unknown, save to the small public of Sydney at that time, over one hundred years ago. As a naturalist-painter, he ranks with the best of all time, remembering that Audubon and Mrs. Gould were contemporaries, but it is almost certain that he never saw any of their work, or if he had, could not have learned much from either of them. His early life is at present quite unknown, the earliest date being 1829 when, according to the scant obituary notices at his death in 1842, where his age is given as about forty, he would be in his late twenties. He may have been interested in birds and paintings all his life as his drawings of some British birds are finished artistic paintings and further some pencil sketches of the same period are delightful miniatures with exquisite truthful details. Unlike the famous Audubon and Gould, he did not restrict his natural history paintings to birds (with perhaps the flowers and plants they frequent) but painted any subject with equal facility, covering nearly every group. In the 200 odd paintings preserved, about half are of Fishes, a quarter of Birds, the remainder showing Mammals, Reptiles, Crustacea, Mollusca, Insects and Worms. Each one of them is an artistic production, associated with accurate scientific detail.

This note has been delayed for some years because of the probability that all the subjects were as completely described, but the MS. has not been found, if it be still in existence, and it is thought that it may have perished in the Garden Palace fire in 1882.

Many of the paintings are signed and dated, the signature and date being generally hidden in the picture, and only seen through careful examination. Through these dates a little can be gleaned of his life, which has been confirmed by Musgrave's research detailed above.

Stuart was a doctor in Dublin from 1829 to 1833, leaving for Liverpool in that year. He left for Australia early in 1834, arriving at Sydney, where he

Pencil drawing by James Stuart of a male Turkey displaying.

immediately painted a Flying Squirrel in June. He had made pencil sketches of an albatross, of the head of a mollymawk, and one of the head of the Sooty Albatross on the voyage out. Only one bird, a Leatherhead, is dated 1835, but a number of Finches are dated 1836, there being none dated 1837, through his severe illness that year as reported by Musgrave. In 1838, however, he was again painting, Honey Eaters and a Cuckoo Shrike being so dated. It may be observed that the latter had been described many years previously, but that all the Finches save one were only described by Gould at the same time (1837) in England. For some unknown reason, he painted the "Digestive organs of the Swamp Pheasant, from nature, by J. Stuart, Sept. 10, 1835, Sydney, N. S. Wales" (see Plate xi, upper fig.), but not the bird itself. He later remedied this by a painting dated Nov. 29, 1840.

Of chief interest is the glorious series of paintings made at Norfolk Island. He was transferred there in 1838 and returned late in 1840. Apparently Stuart here saw an opportunity to enlarge his ideas of painting and endeavoured to depict family groups of birds, not merely single birds. He began in January 1839 with groups of sea-birds with their eggs and young and continued with the mainland birds, ignoring some of the commoner species until he was able to secure groups. Thus there is no painting of the Triller, and only pencil sketches of the Whistler and Parakeet, but finished paintings of the Owl, Long-tailed Cuckoo, Rail and Knot, as he probably realized that there was little chance of anything further in connection with these lastnamed. The Norfolk Island birds painted are here listed:

Tropic Bird (*Scaeophaethon rubricauda roseotincta*), nestling, Jan. 17, 1839.
Gannet (*Parasula dactylatra personata*), adult, juvenile, and downy young, Feb. 26, 1839.
Gannet (*Parasula dactylatra personata*), naked nestling, Jan. 5, 1839.
Noddy (*Anous stolidus antelius*), adult, nestling and egg, Jan. 2, 1839.
Wideawake (*Onychoprion fuscatus serratus*), adult, nestling and egg.
Knot (*Calidris canatus rogersi*), adult only.
Rail (*Porzanoidea plumbea tenebrosa*), adult only.
Owl (*Spiloglaux undulata*), adult only, Nov. 23, 1839.
Kingfisher (*Sauropatis sancta norfolkensis*), male and female.
Parrakeet (*Cyanoramphus novaezelandiae verticalis*), pencil sketch only.
Long-tailed Cuckoo (*Urodynamis taitensis*), adult.
Young Cuckoo in Flycatcher's nest, Oct. 16, 1839.
Blackbird (*Turdus poliocephalus*), male, female, nest and egg (see Plate vii).
Blackbird (*Turdus poliocephalus*), nestling, Oct. 27, 1839.
Robin (*Petroica multicolor*), male, female, nest and eggs (Plate viii).
Fantail (*Rhipidura flabellifera pelzelni*), adult, nest and eggs, Jan. 5, 1840.
Flyeater (*Gerygone (Royigerygone) modesta*), adult, nest and egg.
Whistler (*Pachycephala xanthoprocta*), pencil sketch only.
Silver Eye (*Neozosterops albogularis*), adult, nest and eggs.
Starling or Doctor Bird (*Aplornis fuscus*), male, female, nest and eggs, Jan. 7, 1840 (Plate ix).

When he returned to Sydney, Stuart continued painting, but not in the complete style of the above, probably on account of stress of official duties. He was at Windsor at some time and it was probably there that he painted the most intriguing of his mainland birds, the Lotus Bird (*Irediparra gallinacea novaehollandiae*)—see Plate x—a bird with a history. The painting was made in 1841-42, the bird being at that time unknown from Australia, let alone New South Wales. The species had been described from Celebes in 1828 and was reported from Port Essington, Northern Australia, in 1843, and refound at Windsor, New South Wales, in the 1930's, almost a century after Stuart had painted it.

The illustrations of his artistic ability here reproduced without colour will give some idea of Stuart's craftsmanship, but it must be remembered that his colouring is excellent. It might well be a recommendation for some Commonwealth literary or publishing Fund to endow science with the means of publishing in colour an unrivalled work of art and zoology, a folio of the paintings of James Stuart.

JAMES STUART — ICHTHYOLOGIST

By GILBERT WHITLEY.

The paintings of natural history subjects by James Stuart in the library of the Linnean Society of New South Wales have interested and delighted me for about a quarter of a century. My friends, A. Musgrave and T. Iredale have discussed his life and work in the foregoing pages. In the 1930's, about 100 years after the paintings were made, I listed the fishes represented and I still look forward to the day when these glorious drawings may be reproduced in colour, an impracticability at present because of the great expense involved. At the time they were drawn, many of the commonest fishes were not known to science, often not even generically named—e.g. the common Bream—yet no better figures of them have been published to this day. In fact, apart perhaps from the work of Ferdinand Bauer or of that "Raphael of natural history," LeSueur, which I have seen in England and Europe, there are no comparable paintings of fishes anywhere, to my knowledge. The details are meticulously painted and shaded (with what skill and beauty has Stuart solved problems of light, and with what magic do sombre minutiae loom from his shadows!): not only every fin-ray must have been counted but every articulation or branching of each ray, striation of each scale is faithfully shown. I think he must have worked quickly as, in spite of the wealth of detail, each fish looks as fresh as it was when first caught: no sunken eyes, but lifelike ones without conventional highlights, and no broken fins mar his matchless illustrations.

Manuscript scientific names were evidently written at a later date on these drawings, doubtless by Macleay, but these are not listed here as they would be stillborn *nomina nuda* or else obsolete names. Modern scientific names only are given below and I accept responsibility for the identifications; in the case of some unfinished or purely anatomical drawings exact determinations have not been possible. In a very few cases, drawings not by Stuart but of later dates and artists seem to have been mixed with Stuart's by Macleay, e.g. a drawing of a pig-footed Bandicoot by G. Krefft amongst the mammals and a black marlin swordfish (caught in 1854), "Stuart" drawing No. 173. The localities are not stipulated, but must have been Norfolk Island or Sydney.

98. *Acanthopagrus australis* Gunther.
99. *Pelates sexlineatus* Quoy & Gaimard.
100. *Amphacanthus nebulosus* Quoy & Gaimard.
101. *Chironemus microlepis* Waite.
102. *Pseudolabrus inscriptus* Richardson.
103. *Choerodon* ?
104. *Epinephelus dameli* Gunther.
105. *Centrópogon australis* White.
106. *Thalassoma lunare* Linne.
107. *Trachypoma macracanthus* Gunther.
108. *Monodactylus argenteus* Linne.
109. *Enoplosus armatus* White.
110. *Parma microlepis* Gunther.
111. *Ophthalmolepis lineolatus* Cuv. & Val.
112. *Parapercis* sp.
113. *Pleuranacanthus* sp.
114. *Canthigaster* sp.
115. *Chaetodon tricinctus* Waite.
116. *Microcanthus joyceae* Whitley.
117. *Saurida* sp.
118. *Lovamia fasciata* White.
119. *Reporhamphus australis* Steindachner.
120. *Lhotskia macleayana* Ogilby.
121. *Scobinichthys granulatus* White.
122. *Meuschenia skottowei* Whitley, with parasitic fish-lice.
123. *Brachaleuteres baueri* Richardson, and deilcate drawing of its skeleton.

124. *Parma polylepis* Gunther, adult.
125. *Moolgarda argentea* Quoy & Gaimard.
126. *Arripis trutta* Bloch & Schneider.
127. *Acanthopagrus australis* Gunther.
128. *Girella tricuspidata* Quoy & Gaimard.
129. *Chrysophrys guttulatus* Cuv. & Val. (A young Snapper).
130. *Syngnathus* sp. (dated 1831, so may be European species).
131. *Belone* sp. (dated 1831, so may be European species).
132. *Exocoetus volitans* Linne.
133. *Batrachomoeus dubius* White, viewed from below.
134. *Batrachomoeus dubius* White, viewed from above.
135. *Plotosus flavolineatus* (Stuart, MS.) Whitley.
136. *Thalassoma quadricolor* Lesson.
137. *Bathystethus cultratus* Bloch & Schneider.
138. *Pomatomus pedica* Whitley.
139. *Usacaranx nobilis* Macleay.
140. *Pseudolabrus gymnogenis* Gunther.
141. *Aleuterus* ? sp.
142. *Nelusetta vittata* Richardson.
143. *Lycodontis undulatus* Lacepede ?
144. *Lycodontis* ? sp.
145. *Scorpis lineolatus* Kner.
146. *Meuschenia skottowei* Whitley.
147. *Lethrinus chrysostomus* Richardson ?
148. *Latropiscis milesii* Cuv. & Val. Adult male, Aug. 21, 1841.
149. *Cnidoglanis macrocephalus* Cuv. & Val.
150. *Sarda australis* Macleay.
151. *Nemadactylus morwong* Ramsay & Ogilby.
152. *Zeus australis* Richardson.
153. *Nelusetta vittata* Richardson.
154. *Echeneis naucrates* Linne.
155. *Monacanthus macrolepis* Fraser-Brunner.
156. *Dicotylichthys myersi* Ogilby.
157. *Scorpis violaceus* Hutton.
158. *Hologymnosus semidiscus* Lacepede.
159. *Epinephelus dameli* Gunther.
160. *Paraplesiops bleekeri* Gunther.
161. *Iredalella cyanea* Macleay.
162. *Ruboralga cookii* Gunther.
163. *Verreo unimaculatus* Gunther.
164. *Thalassoma quadricolor* Lesson.
165. *Regificola grandis* Castelnau.
166. *Centroberyx affinis* Gunther.
167. *Ophthalmolepis lineolatus* Cuv. & Val.
168. *Acanthistius serratus* Cuv. & Val., banded colour-variety.
169. *Tiricoris sandeyeri* Hutton.
170. *Acanthistius serratus* Cuv. & Val., spotted colour-variety.
171. *Decapterus* ? sp.
172. *Aplodactylus etheridgii* Ogilby.
173. *Istiompax australis* Wall. Pencil drawing of a marlin. [Not a Stuart drawing but of a fish from Broken Bay, 1854.]
174. *Arripis* ? Unfinished pencil drawing.
175. *Kyphosus* ? Unfinished pencil drawing.
176. *Meuschenia* sp. Unfinished pencil drawing.
177. *Fistularia immaculata* Cuvier.
178. *Coris cyanea* Macleay.
179. *Achoerodus gouldii* Richardson.
180. *Planiprora fusca* Cuv. & Val. ?
181. *Brachaelurus waddi* Bloch & Schneider (shark).
182. *Pleuranacanthus sceleratus* Gmelin ?
183. *Regificola grandis* Castelnau ? Painting of portion of intestines.
184. *Heterodontus portusjacksoni* Meyer. (Port Jackson Shark.)

185. *Brachaelurus waddi* Bloch & Schneider. Ventral surface of shark's head.
186. *Achoerodus gouldii* Richardson. Intestines.
187-189. *Cetacea*—not fishes.
190. *Lethrinus chrysostomus* Richardson? Intestines.
191. Unfinished pencil drawings of two fishes, *Epinephelus* and an *Aleuterid.*
205. *Malvoliophis* (*Cyclophichthys*) *cyclorhinus.*

By courtesy of the Council of the Linnean Society of New South Wales, some of the Stuart drawings of fishes are here reproduced for the first time (plates xii-xviii). Others have been published in the Australian Museum Magazine, as follows:

		Australian Museum Magazine			
Drawing No.	Genus.	vol.	part.	year.	page.
131.	*Belone*	ix	5	1947	170
135.	*Plotosus*	vii	9	1941	311
149.	*Cnidoglanis*	vii	9	1941	310
180.	*Planiprora*	x	8	1951	248

Biology of Two Hunting Wasps

The Specific Descriptions of a New Species and one allotype of *Sericophorus*, and a new Blowfly *Pollenia*.

By TARLTON RAYMENT, F.R.Z.S.

Honorary Associate in Entomology, National Museum of Victoria.

(Plate XIX and figures 1, 2.)

INTRODUCTION.

For more than seven years the author has had several extensive and populous colonies of sericophorine wasps under daily observation, and the results of that investigation in the taxonomy, morphology, and biology of the genus *Sericophorus* Sw. et Shuck, are contained in a large monograph.

Since 1930, the author had had in his possession a unique female wasp, collected near Portland, by an old and respected member of the Victorian Field Naturalists Club, the late J. E. Dixon, but the collector could not add to the datum, "taken on the flowers of a tea-tree, *Leptospermum* sp. ?."

As the research progressed, it became advisable to study, if at all possible, the unknown male, and the author invited Clifford W. Beauglehole, Portland Field Naturalists Club, to co-operate by searching the district of Gorae West, some 9 miles from Portland, in an effort to discover the other sex.

This correspondent, fortunately, was most successful in the field, and collected not only the desired male, but also both sexes of two other species, the descriptions of which are included in the author's monograph.

With the utmost enthusiasm he then essayed the more difficult task of discovering the "nesting" sites, and the shafts in the ground. As the result of his conscientious work over three seasons, 1951-52-53, it is now possible to give a detailed account of the biology of two more species and their predatory habits. The architecture and behaviour, and indeed, the prey itself, showed remarkable deviations from the typical pattern studied by the author at Sandringham and Cheltenham, Victoria; by Norman W. Rodd, at Tallong, New South Wales; and by Rica Erickson, at Bolgart, Western Australia.

The careful observations and patient collecting of these several correspondents amply confirmed the author's contention that the sericophorine wasps are of prime economic importance to the pastoral industry, and probably are man's most efficient allies in the battle to control the pest blowfly by biological agents. The author proposed a scheme for their conservation and protection in his monograph, and there is little need to repeat the details here. The activities of the wasps resulted in the discovery of a new blowfly, the specific description of which is appended.

Although no work had been done on the taxonomy for some eighty years, the author's researches increased the number of species from five to nearly 50, and the biology of several has been exhaustively investigated. The species are in the genus *Sericophorus* Swainson and Shuckard (Hist. Ins., 1840, p. 181), Family NYSSONIDAE, Subfamily SERICOPHORINAE, and the obscure taxonomy is dealt with at length in the monograph.

However, since all the MS., and the numerous plates and text-figures, had already been completed for the press, and are awaiting publication in the Memoirs of the National Museum of Victoria, the inclusion of the new material in that medium presented insuperable difficulties. The new observations are considered to be of such a valuable contribution to our knowledge of these beneficial wasps, that it was ultimately decided to publish them separately as a nota previa, although they naturally constitute an addendum to the monograph which may or may not appear before this paper is published.

ACKNOWLEDGMENTS.

The author was able to study the many sericophorine wasps in the collections of the State institutions by the courtesy of the Directors, and he is indebted to the several collectors for many specimens taken in the field.

The author extends his thanks to his friends, Mr. R. T. M. Prescott, the director, and his colleagues, Mr. A. N. Burns, and Miss Elizabeth Matheson, all of the National Museum, for library facilities and helpful co-operation.

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Sericophorus sculpturatus, sp. nov.

Type, Male:—Length, 5 mm. approx. Peacock-blue, with fulvous legs and flagellum; hair white.

Head almost circular from the front, sericeous; face with long white hair beyond the scapes, and black laterally; frons with a short thick keel, and scattered piliferous punctures; clypeus almost circular and convex on disc, black, but laterally deeply depressed, uneven puncturing and tessellation producing a rough sculpture on the disc, anterior margin with two small teeth and a raised rim; supraclypeal area bluer, rising to a keel; vertex with depressed areas about the ocelli; compound eyes with anterior margins parallel; genae sericeous, with a few white hairs; labrum reddish; mandibulae arcuate, amber, black basally, red apically, a large outer tooth; antennae with blue scapes, and dark second segment, other segments fulvous, and wider than long, and progressively stouter, apical segment darker.

Prothorax blue, a few white hairs laterally, appressed; tubercles blackish, with a white fringe; mesothorax sericeous, blue with a metallic-green lustre, scattered shallow piliferous punctures each with a microscopic dark hair; scutellum bluer, concave, with the large compressed tubercle black; postscutellum blue, but very small; metathorax large, shining blue, the shaft of the cruciform feature lacking the transverse rugae, the "arms" lacking any rim, several longitudinal carinae laterally, with a few white hairs; abdominal dorsal segments blue, shining, a subobsolete tesselation, scattered piliferous punctures and a dusting of white hair laterally, caudal plate black; ventral segments similar.

Legs bluish, flushed with a reddish sheen, femora apically and all tibiae fulvous, with five strong spiculae, a few white hairs; tarsi fulvous, long, anterior with five long spines; claws fulvous, the pulvillus large and black; hind calcar very long, fulvous, finely serrated; tegulae piceous; wings hyaline, very iridescent; nervures dark-sepia, first recurrent entering the first cubital cell a long way short of the second cubital cell, which is almost triangular, and receiving the second recurrent at its end; pterostigma sepia, with a darker margin; humuli about nine.

Locality:—Busselton, W.A., 6th Ap., 1954, leg. Alfred Snell.

Type in the collection of the author.

Allies: The new male falls between *S. claviger* (Kohl) which has "knotted" antennal segments, and apical segments of abdomen red; *S. minutus* Raym. which has no teeth on clypeal margin, and flagellar segments dark above. *S. niveifrons* Raym. and *S. spryi* Raym. are related, but the latter has a black head.

The new wasp is a small, but very handsome species, and was obtained by the collector when sweeping over the flowers of a hedge of "potato creeper?" The small blooms were remarkably abundant, and several specimens of a small form of *S. relucens* Sm. were collected together with several hundreds of minute bees. The season was notable for the lack of other flowers, and the nectar-loving insects were concentrated on the garden hedge of a dwelling. The wasp had a number of straw-coloured spherical pollen-grains entangled in the hairs of the metathorax. The plant was later identified as *Boussingaultia baselloides*, or "madeira vine," introduced to Australia.

Sericophorus victoriensis Raym.

Allotype, Male:—Length, 8 mm. approx. Bluish-green, red legs entirely sericeous.

Head almost circular from front, dull, with white and black hair; face with considerable white hair on lower portion (on upper portion in *S. sculpturatus*); frons with vestigial line reaching ocellus, prominent; clypeus of similar colour, with two teeth on margin; some white hair; supraclypeal area with a short raised line; vertex with the black and white hair intermixed; compound eyes with anterior margins practically parallel; genae with a few white hairs; labrum reddish; mandibulae reddish, black apically, somewhat arcuate; antennae with scape and first segment of flagellum dark, other segments apricot, a black spot apically.

Prothorax not so closely appressed as in other species; tubercles blackish, with a fringe of white hair; mesothorax with the small piliferous punctures not so close as in *S. chalybaeus*, some black hair, four short deeply impressed lines anteriorly; posteriorly two short inconspicuous lines of white hair; scutellum of similar sculpture, but with a conspicuous black compressed tubercle; postscutellum rougher; metathorax bluer, brighter, with the cruciform structure very clearly defined, numerous white hairs, dorsum closely punctured, six or so lateral carinae on the declivity; abdominal dorsal segments sericeous, bluer; a dusting of fine white hair, basal tergum elevated to a tubercle, hind margins depressed; ventral segments similar.

Legs bluish, the femora on the apical half and all tibiae apricot-red; tarsi of similar colour, with six spiculae on anterior basitarsus; claws red, the webbed pulvillus very large and beautiful; hind calcar finely serrated, red, one much larger than the other; tegulae dull, and greenish; wings subhyaline, but very iridescent; nervures light-brown, the first recurrent entering the first cubital cell far distant from the first intercubitus; second cubital cell almost a trapezium; pterostigma amber, wih a dark margin; hamuli twelve, strong.

Locality:—Cape Nelson Road, Portland, Victoria, 20th Jan., 1953, Clifford Beauglehole.

Type in the collection of the author.

Allies:—Clearly closely related to *S. chalybaeus* Sm. which is bluer, and duller. In my key it falls between this and *S. sydneyi* Raym. The type female was taken by J. E. Dixon at Portland, Victoria.

It was taken by the collector together with a long series of typical females dug up out of shafts in the ground, and notes on the biology of these valuable wasps are included here.

The eggs of this species are devoured by two species of small parasitic wasps, *Nysson portlandensis* Raym., and *N. hentyi* Raym. The morphology of *Nysson* is illustrated with a Plate, and the biology is described in Victorian Naturalist, pp. 123-127, November, 1953.

A NEW BLOW-FLY.

Family CALLIPHORIDAE.

Subfamily CALLIPHORINAE.

Genus *Pollenia* Robineau-Desvoidy, 1830.

Pollenia tragica, sp. nov.

Type, male:—Length, 10 mm. approx. Blackish-bronze.

Head: eyes sub-holoptic, bare, facets uniform throughout; face concave, black on lower half, silvery above, anterior margin pallid; frontal stripe well-developed, with a curved striate sculpture laterally on the frons; parafacialia rather wide, with a few straw-coloured hairs; genae excessively small; buccae with many long golden hairs; antennae black, dull, the third segment very large, silvery, of typical form; arista black, plumose on median third, thickened at base; palpi black, with whitish hair.

Thorax: mesonotum with a dull bronze-green sheen, and a few long white hairs among the scattered black ones; pleural region has much conspicuous long light-golden hair; scutellum posteriorly has a fringe of long golden hair; metanotum not quite hidden in the middle under the fringe of the scutellum.

Abdomen: metallic-black, with a bronze sheen, covered with many long fine black hairs, and many strong black bristles; first visible segment with much long black hair, but no marginal macrochaetae; second segment with six pairs of marginal bristles; third and fourth segments with many long black macrochaetae spread over the dorsal surface; the tip of the abdomen truncate; laterally and apically there are many golden hairs among the black ones; the sternal plates bear much long straw-coloured loose hair (a few of these are scattered over the dorsal surface).

Legs: slender, black; posterior coxae with a tuft of long golden hair; anterior and posterior femora with a fringe of golden hair; posterior tibiae with eight long black bristles; tarsi black, with black hair; claws black, pulvillus large and pallid.

Wings: hyaline; neuration typical of the CALLIPHORINAE; very iridescent; the fourth longitudinal vein practically straight; stem vein hardly heavier than the others; third longitudinal vein does not turn forward on the costa; upper marginal cross-vein concave; costal bristle inconspicuous; halteres amber, very small, squama pale-amber, large.

Chaetotaxy: parafrontals 7; parafacials 7; ocellars 3; vibrissae 1; apical scutellar bristles 2; a subappical bristle; a lateral scutellar bristle; a basal scutella bristle; and three median bristles on the dorsal surface; acrostichals 2:3; dorso-centrals 2:3; intra-alars 1:3; supra-alars 4; post-alars 2; notopleurals 2; numerals 4; post-numerals 3; praesuturals 7; prostigmatic bristle present; sternopleurals 3; mesopleurals 5.

Locality:—Cape Nelson Road, Portland, Victoria, Jan. 1953, leg. Clifford Beauglehole.

Type is in the collection of the author.

The specimen was taken, along with several other victims, from a cell in the ground, and which had been provisioned by the hunting wasp, *Sericophorus victoriensis* Raym. Notes on the biology of this wasp are appended.

Many pollen-grains were entangled in the long golden hairs of the pleural region, and at least three botanical families were represented, probably EPACRIDACEAE, LEGUMINOSAE, and MYRTACEAE, and these suggest that the wasp had attacked and captured the fly whilst it was visiting flowers.

BIOLOGY.

Sericophorus victoriensis Raym.

In 1950, at the request of the author, Clifford Beauglehole, of Gorae West, began to search his district for the nesting sites of sericophorine wasps. From 1950-53 he had steadily collected a number of specimens, including *S. chalybaeus* Sm., *S. cliffordi* Raym. and *S. victoriensis* Raym.

The locality where he found the first specimens is a typical open one of heathy land, carrying *Eucalyptus baxteri; E. viminalis* var. *huberiana; E. vitrea; E. ovata,* and there are extensive areas of *Leptospermum scoparium,* and *Melaleuca squarrosa.* These myrtaceous plants were in bloom, consequently there was no lack of either nectar or pollen for the wasps.

Since *S. victoriensis* seemed to be more numerous than the others, the author sent an outline of the probable situation of the shafts, and after three years, on the 10th January, 1953, the collector was successful in discovering an extensive colony in an area of loose white sand at the side of the Cape Nelson road. It was established in a strip six feet wide, which separated the road from a small bank some three to four feet high. Loose sand continually slides down, and the wasps appear to avoid this instability, consequently, they keep to the firmer level ground.

The observer found that wind often blew loose sand over the shafts, and so masked the entrances. However, the wasps flew to and fro over the site, and each one apparently had no difficulty in returning to its own home. He counted 30 shafts, and suggested that many more were present, but had been covered by loose sand, so that probably more than 50 shafts were in the colony. "But new ones are being continually opened up."

The much smaller species, *S. cliffordi* Raym., nests in the same area, but it preys on a small black fly *Musca vetustissima* Walk [now *M. sorbens* Wied.] and it certainly would not be equal to attacking the large blowfly. Many larvae were excavated, and their gross morphology was similar to that of *S. teliferopodus* Raym.; the six lateral tubercles being equally conspicuous. There are no specific characters to separate them from the larvae of other species.

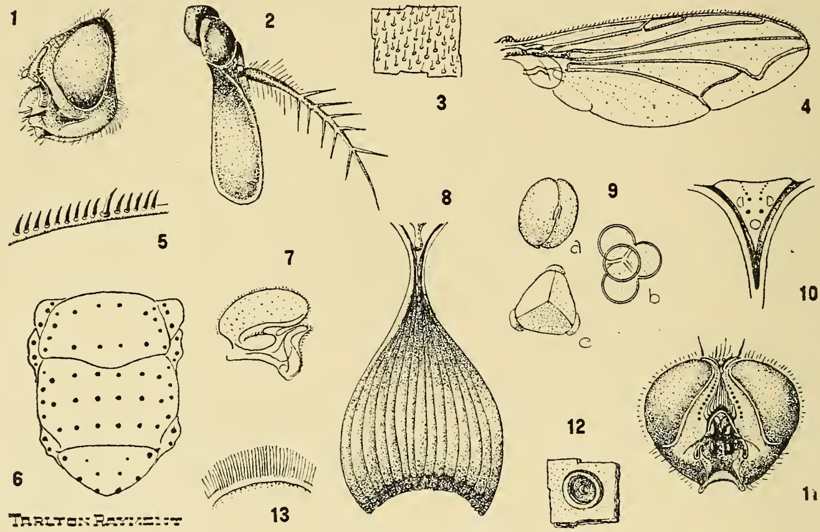


Fig. 1: Details of new Blowfly.

No.
1. Lateral view of head-capsule of male fly, *Pollenia tragica* Raym.
2. Antenna and arista much enlarged.
3. Portion of wing showing its fine hairs.
4. Wing of the male.
5. Costal spine is inconspicuous.
6. Diagram to show macrochaetae of thorax.
7. Squama and haltere are pale-amber in colour.
8. The striate sculpture of the frons is distinctive.
9. Pollen-grains removed from the thoracic hairs of the fly.
10. The ocellar triangle, or platform, much enlarged.
11. Frontal view of head-capsule.
12. A scar remains to indicate the position of any bristle that may be broken off.
13. Margin of squama more highly magnified.

At 9.30 a.m. there was considerable activity at the colony; many females were digging vigorously, and others were returning with their prey which were later identified as male flies in four genera. The hunting is continued throughout the day.

To test whether or not the prey is killed outright at the initial attack, the observer captured several wasps bearing their victims, and took the flies away. Clifford Beauglehole had no means of determining whether they were dead or merely in a coma, but the blowflies did not move for three days, and as they did not decay, it would appear that the poison injected by the sting has a preservative effect, keeping the meat "fresh" sufficiently long to enable the larva of the wasp to consume it in a wholesome condition.

It was evident that the "season" for the wasps must have opened several weeks previously, for this was demonstrated when 20 cells were excavated, and the gravid cocoons carefully removed. Of 14 cocoons removed, 10 contained female larvae and 4 male; the cocoons of the females measured 12.5 mm. at the long axis, and 5.5 mm. at the short; those of the males 10 mm. and 4.5 mm.

The shafts went down in the loose sand for an inch or two, then turned at a slight angle for six inches, and finally, as the harder subsoil was approached, the shafts took on a circular turn before the cells were finally constructed at 12 inches down. Since the red subsoil is used for the short hard turret, the entrance always forms a conspicuous splotch of dark colour on the white sand.

There is conclusive evidence that, in certain circumstances, two or more wasps will use the same shaft, and this is in marked contrast to the habit of *S. teliferopodus* Raym., where the rule is strictly one female to each shaft, although it will be remembered that Rica Erickson observed two or more shafts often close together.

The observer says—"There were several cells or cradles in the first shaft that I excavated. I am sure of this because I selected a lone shaft, so as not to confuse the contents with cells of other shafts. Altogether, I saw 20 cradles at a depth of about a foot, and of these, 14 had completed cocoons, and the others were almost finished. I'm not certain about the branching of the shafts, but will try to check this later.

"I certainly saw one wasp enter a shaft with a fly, and 10 minutes later, another wasp returned and entered with a fly. I have also seen a wasp enter with a fly, and almost immediately after, another wasp, without any prey, descend the same shaft." It will be observed that the hunting of the prey by *S. victoriensis* is done much later than the early hour favoured by the Sandringham species, 5-6 a.m.

"I excavated a shaft which was in constant use, although it was very close to another, and I found seven cradles at the bottom; they contained 36 blowflies and 2 strangers." The prey was distributed as follows:—

No. 1. 6 large blowflies—plus one strange fly (see *Pollenid*).
No. 2. 4 large blowflies—probably incomplete provision.
No. 3. 3 only large blowflies, but cell was incomplete.
No. 4. 6 large blowflies—plus one strange fly.
No. 5. 5 large blowflies—but no strange fly.
No. 6. 5 large blowflies—but no strange fly.
No. 7. 5 large blowflies—but no strange fly.

The two species of blowflies were identified as *Calliphora stygia* Fabr. and *Pollenia tragica* Raym., and it will be observed that the average number of flies stored in each cell is probably 5.

The egg is deposited on the first fly captured, and this is the habit of all the other wasps studied by the author. The egg is laid on the under surface of the thorax; on the left side in six cases out of the seven. It is attached near the articulation of the front leg, and it would seem that, in some cases, the leg of the fly is lifted up by the wasp, thus permitting her to place the egg exactly where she wishes.

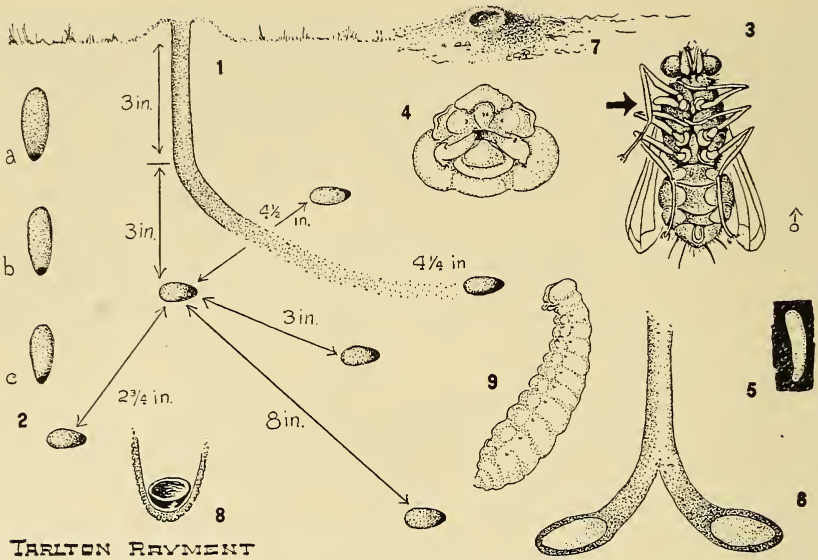


Fig. 2: Details of *Sericophorus.*

1. Nest of the wasp *Sericophorus chalybaeus* Sm. with six cells radiating from the main shaft. The small figures indicate the length in inches of the galleries, filled so perfectly by the female that they could not be identified. (Drawn from a sketch by Clifford Beauglehole.)
2. a. Cocoon of *S. chalybaeus* Sm.; b. *S. victoriensis* Raym.; c. *S. cliffordi* Raym.
3. Ventral view of fly, *Musca scorbens* showing the anterior leg raised by the wasp, *S. cliffordi* Raym., to place her egg (see arrow) at the articulation of the coxa.
4. Anterio-ventral view of head of larva.
5. Egg of *Sericophorus.*
6. Typical dichotomous shaft of *S. teliferopodus* Raym. with its two cells at the end of short galleries.
7. Tumulus of sand at the entrance to the shaft.
8. Black wad of excremental debris at base of cocoon.
9. Young larva of *S. chalybaeus.*

Beauglehole was fortunate in collecting several mutilids that haunted the vicinity of the shafts, and there is little doubt some of these at least are parasitic on the larvae of the wasps. His most interesting discovery was two wasps of another genus, and which he thought might deposit its egg on the young larva.

This observer posed the following question. "Do you know of any parasitic wasp which lays its eggs in the sericophorine nests? There is one here which appears to be parasitic. I watched her actions for an hour or so, and it immediately followed down a sericophorine that had just descended with her fly.

"A few minutes later, the parasite ? emerged from the shaft, and waited at the top, facing the entrance, and every now and then she looked down the shaft, as though expecting something to happen.

"The sericophorine came up out of the shaft after a few minutes, drawing the front legs over the jaws and face and while she was engaged in cleaning her eyes, the parasite moved back out of sight behind the mound at the entrance.

"After the sericophorine wasp had flown away, the parasite went to the entrance again, and was about to descend, when it was disturbed by a passing automobile. However, I was successful in obtaining two specimens for you." These proved to be new, and were described as *Nysson hentyi* Raym., and *N. portlandensis* Raym. The morphology and biology were published in Victorian Naturalist, pp. 123-127, Nov., 1953.

During January, 1953, Beauglehole found that for some obscure reason, the supply of golden-haired blowflies failed, and *S. victoriensis* then directed her attacks to another species not so large as the usual chubby blowfly. The "new" prey is not related to the common golden-haired blowfly, and the specific description is included here. Other "strangers" were present in cells 1 and 4, *Calliphora hilli* Patt. and *Heliora caerulescens* Stein.

There was no means of determining whether or not the scarcity was due to the activity of the wasps. The observer concluded that it was, but it may have been due to adverse weather conditions, or even a normal cycle in the biology of the blowfly. However, the observer wrote—"It would seem that these valuable wasps have so reduced the brown blowfly that they are forced to take another species. Each cell that I excavated now contained 8 smaller black flies, and out of 38 flies recovered from the cells, only one was a brown blowfly."

The smallest black flies averaged 8 mm. in length. The head is small, and the face silvery; the black arista plumose; mesothorax finely mottled with grey; each abdominal segment bears an ivory patch; the long slender legs are black; the wings subhyaline. They were identified as *Musca vetustissima* Walck (now regarded as *Musca sorbens* Wied).

The larger grey fly is not so numerous, and is taken only occasionally, and has been determined as a new one (see specific description). Both species are extremely hairy, with numerous strong black bristles.

A black spider-hunting wasp, *Pseudagenia* sp., is often found making use of the sericophorine shafts, and these will be described in a separate paper.

A CHANGE IN HABIT.

Biology of *Sericophorus chalybaeus* Smith.

Clifford Beauglehole, while collecting for the author, reported that he had observed two females of *S. victoriensis* using the same shaft. When he excavated the "nest" he then found that several cells were present. As this was a matter of some importance, since such a habit was contrary to what had been observed at Sandringham of *S. teliferopodus*, the author stressed the possibility of his having been confused by the close proximity of the cells.

Where several shafts are excavated close together, the wider dichotomous branches at the bases are thus necessarily practically contiguous, since they are approximately at the same level. The naturalists uncovering such a group would very naturally conclude that the cells had been built as one cluster. This state is frequently experienced when investigating fossorial bees such as *Nomia* and *Halictus*.

In February, 1953, the collector had the good fortune to discover half a dozen shafts of *S. chalybaeus* on the roadside close to his homestead. These could be kept under observation more conveniently, and for longer periods, since it was no longer necessary to travel to the Cape Nelson Road.

However, there was a possibility that the collector may have discovered an interesting departure from the typical architecture of two cells, therefore, on the author's advice, Beauglehole sought out one shaft far distant from any others, and excavated it. His report is included here.

"No traces of other moundlets of soil were to be seen, and the shaft was definitely isolated from all the others. Only one wasp occupied the shaft, and during the two hours that I was digging out the "nest," no other wasp arrived to search over the site."

The cells must originally have been excavated at a greater depth than that indicated here, because a mechanical bulldozer had already stripped several inches of topsoil from the roadside when clearing the way for a telegraph line. Just how many inches had been taken off could not be ascertained with any degree of accuracy; probably not less than 14 inches were scooped away.

There was the usual tumulus of loose sand, about ½ inch high, round the shaft, which did not descend vertically, but rather on a low curve. The entrance was still open, and the collector had little difficulty in following it down to the cells. He found six cells in all at the following levels:—

Nos. 1 and 2 were at 3½ inches.

Nos. 3 and 4 were at 4 inches.

Nos. 5 and 6 were at 4¼ inches.

"The cells were at various distances from the main shaft, but it was impossible to identify the several tunnels leading to Nos. 1-5 because the wasp had filled them to seal the cells, and she did it so perfectly that all traces of the original tunnels had vanished."

"The six cells now appeared to be clearly separated.

No. 1 was 1¼ inches distant, with 6 flies. (5) *Pollenia tragica* Raym.

No. 2 was 2¾ inches distant, with 5 flies. (5) *Calliphora stygia* Fab.

No. 3 was 3 inches distant, with 8 flies. (5) *Musca sorbens* Wied.

No. 4 was 2¾ inches distant, with 8 flies. (1) *Musca sorbens* Wied.

No. 5 was 4½ inches distant, lustrous, 7 flies. (—) *Heliora caerulescens* Stein.

No. 6 was 4¼ inches distant, bluish green, 1 fly with egg.

"It was evident that the wasp was engaged in storing the sixth cell. which was at the bottom of the open shaft, and I caught her when she returned with another fly. Cells 1, 2, 5 and 6 were parallel with the main shaft, but 3 and 4 were built at a right-angle. Of the 35 flies removed from the completed cells, only 16 were golden-haired blow-flies, and the number in each are included in brackets in the above table; two blow-flies in cells 3 and 4 had an egg on each.

"No. 5 cell contained seven small bluish-green flies, but the rest were like small house flies. Each of the 5 flies had the eggs attached to the right side, but in the Nelson Road cells of *S. victoriensis* the majority of the victims had it on the left side."

This is strong evidence that one species, *S. chalybaeus* at least, departs from the family habit, and constructs more than two cells, radiating from the main shaft. It is amply demonstrated that while *S. teliferopodus* takes only the golden-haired blow-fly, *S. chalybaeus* will attack and capture at least four species of flies. It will also be observed that *S. chalybaeus* prefers the right side of the ventral surface for the egg, while *S. victoriensis* prefers the left.

The egg does not differ from that of the other species investigated, neither does the larva, and the cocoons are identical with those of *S. teliferopodus* Raym. There are no valuable specific characters in the larvae to separate one species from another, such as one finds in the reed-bees *Exoneura*. The behaviour pattern is, however, very different indeed from that of *S. victoriensis* and *S. teliferopodus*. The wasp will attack several different species of flies, an appetite which she shares with *S. victoriensis*.

A long series of cocoons are under daily observation, but so far there is no material difference from those of *S. teliferopodus*, and the larvae, too, are indistinguishable from those of the other species.

EXPLANATION OF PLATE XIX.

Nos. 1-12. *Sericophorus sculpturatus*. sp. nov.

No.
1. Adult male (type) wasp.
2. Front view of head-capsule.
3. Dorsum of metathorax, scutella, etc.; inset "a," sculpture of the dorsum more highly magnified.
4. Fifth abdominal sternum: note gradulus, and compare with No. 16.

5-6. Apical sternum and tergum of male abdomen.

7. Dorsal view of male genitalia.
8. Serrated margin more highly magnified.
9. Hamuli of posterior wing.
10. Basitarsus of anterior leg.
11. Glossa and palpi of male.
12. The calcariae of the posterior legs.

Nos. 13-25. *S. victoriensis* Raym.

13. Clypeal teeth of male (allotype); outer one is larger.
14. Serrated margin more highly magnified.

15-16-18-19. Apical sterna of male abdomen.

17. Apical tergum of male abdomen.
20. Dorsum of metathorax, scutella, etc.; inset "a," sculpture of the dorsum more highly magnified. (The amount of mesothorax included is a criterion of the size of the wasps).
21. Basitarsus of the anterior leg.
22. A myrtaceous pollen-grain from the "face."
23. Clypeal teeth of male *S. victoriensis* Raym.; the inner one is larger.
24. Lateral view of genitalia of male.
25. Strigilis of anterior leg; even the small velum is serrated.
26. One of the pollen-grains of the "potato-hedge" plant.

(Figures are at various magnifications, but all corresponding parts are drawn at the same magnification. Allowance must be made for distortion due to pressure of the cover-glass.)

Dimorphism and Parthenogenesis in Halictine Bees

By TARLTON RAYMENT, F.R.Z.S.

(Plates xx-xxii, figs. 1-6.)

The phenomenon of virgin birth, parthenogenesis, has always held a peculiar attraction, not only for the biologist, but even more so for the layman, but owing to the difficulties surrounding the study, the latter seldom has an opportunity to observe it in living material. He is, therefore, compelled to accept, though it must be admitted not without certain mental reservations, the carefully acquired evidence presented by the zoologists.

Perhaps in no other natural group can the investigator find more intresting material for study than the fossorial gregarious bees in the genus *Halictus*. But again the technical difficulties are so formidable that the research is confined to a few workers with a highly specialised knowledge of the HYMENOPTERA. The late Professor W. M. Wheeler (1933) regarded halictine bees as an extremely difficult Family to investigate.

The author has had several hundreds of halictine colonies under observation during many years of research, and the "nests" of one species, *Halictus dimorphus* Raym., was under daily observation for two years by one of his assistants, Lynette Young; a sustained watch that must surely constitute a record in the literature of the apoidea.

Since much of the evidence accumulated during that long period is often in direct conflict with the findings published by European Hymenopterists—there have been no other investigators in Australia—the author deems it advisable to present the established facts for the consideration of zoologists throughout the world.

It was the practice of the early systematists to divide the APOIDEA into two great classes, OBTUSILINGUES, with a short wide glossa, and ACUTILINGUES with a longer pointed glossa. That classification had, however, to be abandoned when it was demonstrated that the two forms of glossa co-exist in the Australian genus *Meroglossa*, the female organ being obtuse, that of the male acute.

It would have given a clearer picture of the phylogeny by dividing the Families according to the period required for larval development; those which take a year, such as *Paracolletes*, *Hylaeus* and *Megachile*, and those whose larvae develop in three or four months, i.e. *Halictus*, *Exoneura*, *Trigona*.

It is a strange law of the APOIDEA that the higher the evolutionary status, the shorter the larval period. For example, the highest group of all, the hive-bee *Apis*, requires only three weeks, while the sole perfect female, the "queen," matures in about sixteen days.

All halictine bees have an acute glossa; in some it is long; in others short, but a constant generic character is seen in the caudal rima or furrow, a groove on the apical segment of the female abdomen. The dorsum of the metanotum or metathorax, is invariably sculptured with rugae, more or less resembling ranges of microscopic mountains, and the structure of this part is a stable specific character. The hind calcar of the female, with few exceptions, bears a number of coarse teeth, and these, too, provide a specific character. The wings are hyaline, richly iridescent, with three cubital cells, which may be identified from the drawings. The nervures are somewhat subject to mutation.

All bees have at least some forked hairs, but *Halictus* is not specially endowed, and most of the hairs are present on the posterior legs. In the group of metallic-coloured *Halicti*, in the subgenus *Chloralictus*, the gaster often bears a light scopa of curled hairs, but the bulk of the pollen is carried on the femora and tibiae.

Chloralictine bees are smaller, 7 mm. or so, but *Halictus*, sensu stricto, are generally larger, up to 14 mm., black, and not at all metallic, with much more white or golden hair, often in bands across the abdomen. There are in both groups surprising departures from the 3-brood sequence.

Halictus leucorhinus Ckll., the largest of the Australian species, has only one generation for the season; a bisexual one, emerging in midsummer. The bees are a-wing for a mere month, and then disappear. *H. goraeensis* Raym., another large species, has three discrete broods, yet *H. lanarius* Sm., although closely related in structure, has a very different sequence; females and males hibernating over the winter in their natal cells.

The nesting site may be in volcanic loam, but clay, and even pure sand, are favoured by others, and the bees experience no difficulty in excavating in any type of soil. The chief digging implements are primarily the dentate hind calcar, or digging-spur, and secondarily the bidentate mandibulae. The teeth of the calcar are thrust downwards, paring off the soil. Small pebbles are often wedged between the teeth, and rarely one is broken off.

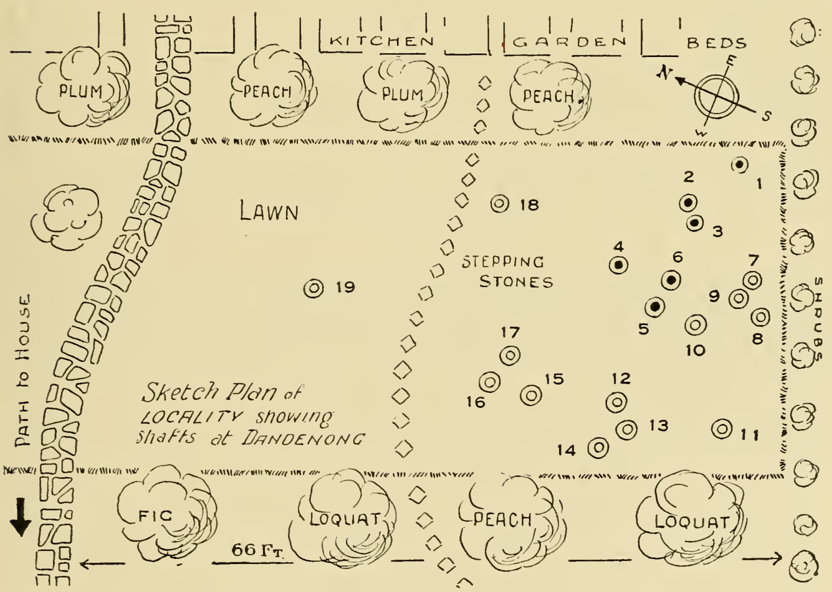


Fig. 1: Plan of site at Dandenong, Victoria, occupied by *Halictus dimorphus* Raym. The six "nests" of the season 1948 are indicated by black centres; those of 1949 white, and represent the increase of 13 colonies.

The loose periphery of the "pit-mouth" would soon collapse under the busy traffic if it were not reinforced with a rim of cement. This material is plastered down quite smooth with the caudal plate of the abdomen, and dries extremely hard.

The biology of *Halictus* (*Chloralictus*) *dimorphus* Raym., will be described in detail, and the habits of several other Australian species will be compared with it. If the season be followed, rather than the calendar, then the cycle begins at the end of August, early spring, when the first signs of halictine life will be a blackish-green head suddenly popping out of the earthen debris blocking the mouth of the shaft.

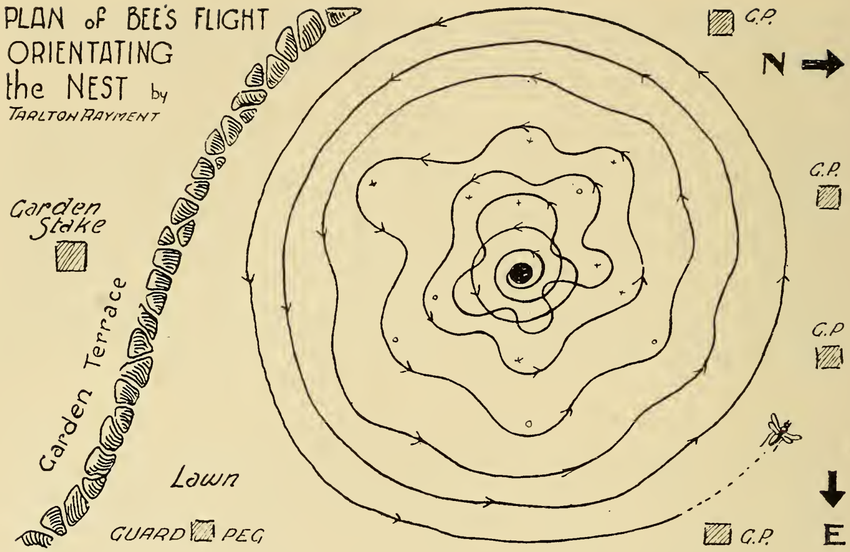


Fig. 2: Flight of red Primarius female, *Halictus dimorphus* when orientating the "nest."

Thereafter the shaft is seldom left unattended. A female's head usually closes the "doorway," and when one sister leaves for the harvest-field, another female comes up from below to close the aperture, and there awaits her turn to depart. The "watch" is assuredly maintained as a co-operative operation.

Should the investigator move ever so cautiously, the bee will instantly drop out of sight. She can do this simply by holding the legs "akimbo," and bringing the patellae or knee-plates to bear against the walls of the shaft; on the principle used in man's safety-chocks on city elevators.

During cold and windy "weather," which may contlnue over several days, the mouth of the shaft is sealed with a plug of cement; three or four arcs are first attached to the periphery, and then the central aperture is finally closed with a single pellet. The cement is composed of saliva and the finest particles of soil removed during the construction of the cells. Only once, during many years, was a pebble observed to close the shaft.

When the sun is bright enough, a female will emerge, bask in the warmth for a minute or two, and then take wing on a circular flight of orientation; always with her head towards the shaft, which is approximately 3 millimetres in diameter, and level with the ground.

During this initial flight she will plot the land-marks of the locality. If any one of these be moved during her absence, she will experience some difficulty on her return in locating her own particular shaft.

In *H. emeraldensis* Raym., the shafts are often only a few millimetres apart, and a dozen or more lie within a square foot, yet the bees will not be confused until some change in the "landscape" is effected by man or other agent.

A number of females, eight or so, emerge from each natal shaft, and continue to use it as the main "gang-way" to the numerous brood-cells situated some 13 centimetres below. Microscopical examination of several hundreds of bees in the vernal brood demonstrated that all were virgin females. Not one male was present.

This virgin brood of spring is also present in *H. emeraldensis* Raym.; *H. raymenti* Ckll.; *H. demissus* Ckll., and *H. cyclurus* Ckll. It is probably true of *H. leai* Ckll.; *H. peraustralis* Ckll. and *H. goraeensis* Raym. It does not exist in *H. lanarius* Sm., where both males and females hibernate in their natal cells over winter, and both sexes emerge in early spring. *H. seductus* Ckll. has the same sequence.

Nevertheless, in spite of this divergence from the typical pattern, there are yet two forms of females in *H. lanarius* Sm. Armbruster (1916) and Legewie (1922) agree on the three discrete generations for the European *H. malarchurus*, but maintain that the over-wintering generation is bisexual. This is true of the Australian *H. lanarius*, but it is certainly not the case in *H. dimorphus*.

The vernal virgins have a blackish-green head; a lighter metallic-green thorax, and the abdomen is of a clear apricot-colour. Excavation of over 100 shafts demonstrated that each vernal virgin had merely extended a tunnel from her natal cell, and had constructed for herself a group of eight or so cells.

The cluster of cells built by *H. cyclurus* Ckll. is much more compact, and may be lifted out in one lump, with the cells more or less contiguous and cemented together. The cluster of mud cells is even tighter, and arranged in the more orderly design of the Nomiine bee, *Nomia australica* Sm.

The subearthen colony may now contain over 60 cells in various stages of construction, but all the females will continue to use the main shaft. There is not any "mother" bee present as Fabre maintained, for not one individual field-bee of the autumnal brood survives the winter. This state

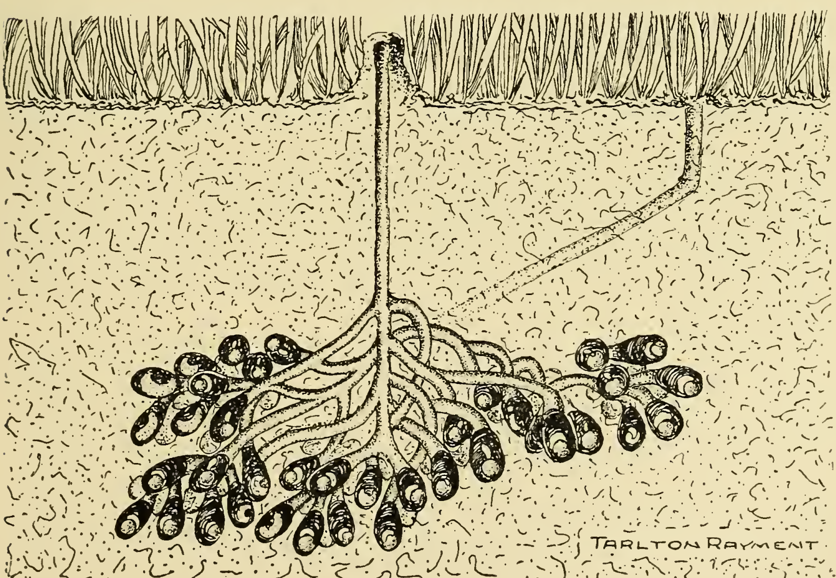


Fig. 3: Graphic section of "nest" of colony of *Halictus dimorphus* with brood at all stages.

also persists in the seven species mentioned above. In *H. leucorhinus* Ckll., and *H. eboracensis* Ckll. there is only one generation, of both sexes, which emerge in midsummer; the smaller males a few days before the females, as in all bees.

Each oval cell measures 7 mm. approx. at the long axis, and 3.5 mm. at the short, and there is an impalpable thin lining of a colloidal silvery skin, a secretion of the salivary glands of the mother. When provisioned and supplied with an egg, each cell is sealed off from the tunnel with a wad or plug of masticated "mud." The cell-walls are made of the finest pebbles cemented together with the salivary secretion. At a casual examination, they would be said to consist of refined mud. There is not a trace of the thick white porcelain described by Fabre.

The subearthen cells and galleries are maintained in a perfect sanitary condition, for every scrap of biological debris is quickly disposed of by a horde of milk-white acarine mites in the genus *Caloglyphus*. The mites literally cover the walls, and when a bee dies the symbiotes soon attack the body. They eject a drop of clear liquid onto the material, which is dissolved and then ingested.

The mites have not been observed on the field-bees, which could not, of course, be a factor in dispersal, since the female bee returns to the one colony. The mites have, however, been observed to cluster about the apical, segments of female mutillid wasps, which are parasitic on the bees, and consequently haunt many shafts when seeking a suitable host to receive an egg. The parasitic mutillids, and *not* the bees, are the chief agents in the dispersal of the mites.

The store of food for the larval bee is a perfectly smooth sphere of pollen, 3 mm. in diameter, and the colour varies according to the botanical source of the grains, and ranges from ivory-colour to olive; from russet to brightest orange, for halictine bees are polylectic, visiting many botanical species. The exterior of the pudding contains the largest proportion of nectar, but the interior is much drier, almost powdery. There is, too, a small proportion of a biological substance secreted by the pharyngeal glands of the head.

When first gathered by bees, the nectar of flowers is, of course, very thin, and liable to subsequent fermentation unless ripened in some way. The halictine female evaporates the excess water in an interesting manner. Sitting on the petals of a flower, exposed to the warm sun, she extrudes the nectar, which is supported by the upcurved glossa, and is held on either side by the galeae and maxillary palpi. The mouth-parts then maintain a rapid up and down "beating" movement. They are able to effect this owing to the hinge-like attachment of the submentum to the lorae and the cardines. The globule of nectar is thus alternately drawn out into a thread, and then contracted again into a globule. The nectar can be seen to thicken rapidly during the operation.

The elongate-oval centrolecithal egg is typical of all bees, and the chorion is sculptured with a more or less pentagonal pattern, the imprint of the follicle cells lining the ovariole. It measured 250 microns at the short axis and 450 microns at the long, and is attached to the pollen-pudding by a clear agglutinative secreted by the mucous glands in the female abdomen.

Stockhert (1923) maintains that in the European species the brood-cells are invariably sealed with a plug of mud immediately after oviposition. That is established for all the Australian species studied by the author. There is, however, certainly no progressive feeding of the larvae. There is a copious feeding of secretion for up to as long as 20 days in *Exoneura*, an Australian genus of a simple social habit.

On about the fourth day the chorion of the egg splits at the cephalic pole, and the young larva soon begins to feed on the pudding, which it does by sweeping its head to and fro as the mandibles pare off thin slices clear across the store. The larval mandibles have a molar area for the grinding

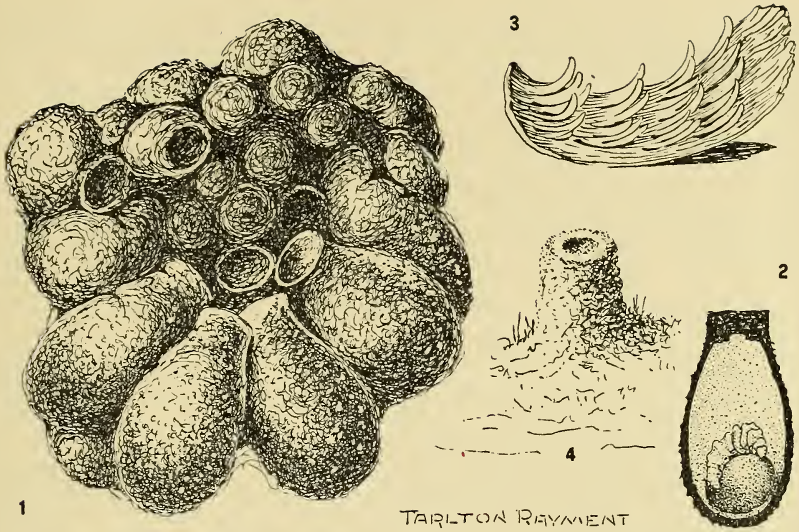


Fig. 4: Details of *Halictus cyclurus* and *leai* Cockerell.

1. A group of the small earthen cells of *Halictus cyclurus* Ckll.
2. A section of the cell showing a larva feeding on the pollen-store.
3. The old pollen-mat of *H. leai* Ckll. breaks down into a number of salivary flakes, and reveals the method of construction.
4. The tiny chimney-stack over the entrance to the shaft.

of the pollen-grains, and some eight to ten days are spent in consuming the "pudding." The soft exterior containing more nectar is not consumed first as described by Fabre for his French species.

Hymenopterists are almost unanimous in agreeing that the larval food of wild-bees consists solely of pollen and honey, but that is mere opinion, unsupported by either experiment or analytical chemistry. Indeed, Snodgrass (1925) goes so far as to assert that only the hive-bee *Apis* secretes the predigested "pap" that is fed to the larvae. The author (1951) was able to demonstrate that *Exoneura* continues the progressive feeding of pap for weeks longer than the hive-bee.

In all the genera investigated by the author, the six rectal glands are excessively large in species, such as *Halictus*, that supply only a pollen-ball for the larvae, but they are exceedingly small in other species, such as *Trigona* and *Apis*, which continues with progressive feeding of the larvae with the pharyngeal secretion over a lengthy period. Pavlovsky and Zarin (1922) concluded that the function of the glands is production of a catalase with oxidising action. In any case, the halictine glands are covered with a close network of tracheal tubules to supply oxygen.

The fully grown halictine larva measures 5 mm. in length, but when the compound eyes begin to colour, about 11 weeks later, the length is reduced to 4.5 mm. The white crystaline pupa has a very large head and thorax, and a somewhat "prickly" appearance, due to numbers of nodes on various parts of the body, but chiefly in rows round the abdominal segments.

The pollen residues are retained in the mesenteron until its junction with the proctodaeum is effected. The faeces are then voided, just prior to the onset of metamorphosis as a series of moniliform "threads."

The fifth and final ecdysis occurs about 36 hours before the adult is completely coloured, and ready to emerge from its natal cell. The larva makes no attempt to spin a cocoon of any kind, and remains naked in the cell. Fabre concluded that the thick white porcelain lining of the cell rendered the cocoon superfluous, but this cannot be true of the Australian *Halicti.*

The progeny of the vernal virgins emerges in midsummer, about the end of December, and both males and females are present, but both sexes are jet-black; the males being considerably smaller than the females.

The longest period taken by the larvae to reach full development was three months, but in summer, when the temperatures are higher, the period is shortened.

There is, consequently, three months, covering the winter, when no bees are a-wing, but a generation of coloured virgins is hibernating below.

The mating may take place on the flowers, or even in the air over the shafts, and copulation is only momentary. Vision must supersede scent on occasions, for a black male, *H. raymenti* Ckll., was observed to attempt copulation with an ant that was carrying a piece of yellow leaf, and so had the semblance of a yellow-bodied female. None of the species studied was observed to copulate in the burrows as described by Fabre.

After mating, the black females of the midsummer brood do not return to the natal shaft, but depart for another site to form a new colony. The damp "spoil" is pushed up backwards in pellets by the posterior legs, and at first forms a tiny tumulus, or mound, at the entrance; later, some of it will be built into a short rough-cast turret a few millimetres tall. It is, however, soon dispersed by rain and wind, and only a discoloured patch of subsoil remains to indicate the position.

This foundation of a new colony by a lone mated female has been observed over many years, and was confirmed in 1952 by Clifford Beauglehole, of Portland, Victoria, who was co-operating with the author in the study of *H. cyclurus* Ckll. and *H. demissus* Ckll.

It can be assumed, then, that the sexual urge is the determining factor in driving forth the mated female from the parental home to found a new colony. The virgin *Halicti,* lacking such an urge, merely extend the natal

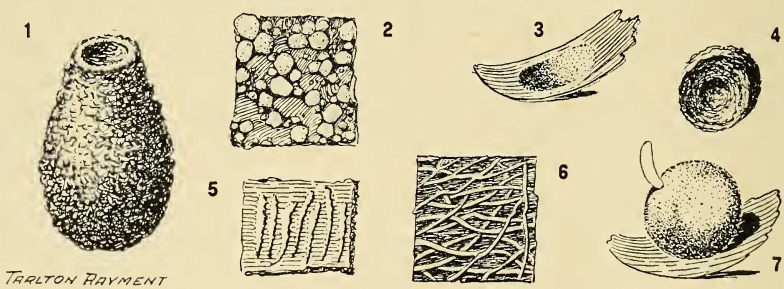


Fig. 5: Details of *Halictus emeraldensis* Rayment and *H. leai* Cockerell.

1. Earthen cells of *Halictus emeraldensis* Raym.
2. Exterior wall highly magnified to show the grains of sand.
3. Scale or mat of *H. leai* to receive the pollen-pudding.
4. The earthen plug for closing the cell.
5. Streaks of pollen regurgitated by the larva.
6. Interior wall of cell showing the strands of silk.
7. Pollen-mat, with pudding and egg of *H. leai* Ckll.

cells and remain at home. This concept is supported by the behaviour of worker-bees of the hive for, as undeveloped females, they remain inside the hive for 14 or more days before they venture to issue from the hive, whereas the true female, the "queen," flies forth in four or five days and will produce only drones, or males, if prevented from doing so. Fully sexed females in many other genera of bees and wasps die quickly when restrained from emerging to the nuptial flight. Virgins have, however, survived long confinement, up to 8 weeks, by the author.

Numerous "nests" of the mated midsummer females have been excavated in January, and without exception, only one black mother has been present, together with six or eight cells in various stages of construction. This observation was confirmed by Beauglehole in 1952 in the case of *H. cyclurus* Ckll. and *H. demissus* Ckll.

The author succeeded in establishing new colonies of *H. dimorphus* Raym. at a distance of 22 miles from the parent shafts. Hibernating virgin females were dug out of the cells in late winter; at the end of July. Knitting-needles 3 mm. in diameter were thrust down for 12 centimetres into similar soil. Two females were held over each shaft and they hastily descended, for at that stage the bees are positively geotropic. The shaft was then closed with a pellet of clay. However, after the bees have once flown, there is a change of tropism, for then the bees are heliotropic, and will refuse to descend, but simply fly off and are lost. These introduced virgin females did not depart in any way from the typical behaviour pattern.

The progeny of the black bisexual generation of midsummer emerges in autumn, and is comprised exclusively of jet-black virgins. Several hundreds of shafts have been investigated, and five others were under daily observation from 2nd Aug. 1948 to 25th Mar. 1950, and not one male was taken in spring throughout that long period.

Stockhert (1923) concluded that the old females of the autumnal generation of *H. malachurus* survive through the following spring and summer. That is most certainly not the case in any Australian *Halictus* studied by the author. Not one female lived to see her daughters emerge.

The progeny of the black autumnal virgins are fully developed before the winter, but the individuals will all be green, with the abdomen of a lively apricot-colour. They do not come out to fly, but semi-hibernate in their natal cells throughout the winter entirely without food; they are nevertheless strong enough on the wing when they emerge in spring.

There are critical differences in the gross morphology and anatomy of the vernal, summer and autumnal halictines, but they are all microscopic in character. The results of a long series of micrometer measurements are equally interesting, but are beyond the ambit of this nota previa. The triangular appendage of the labrum differs in the three females, not only in *H. dimorphus*, but in several other species having three discrete broods.

In the author's collection the specimens are distinguished by green labels for the vernal (primarius) virgins; yellow for the bisexual or summer (secondarius) brood, and blue for the autumnal (tertianus) virgins.

It has been demonstrated, then, that the new colony is undoubtedly founded by the mated female of midsummer and the population is then at its lowest ebb, but her six or eight virgin daughters of the autumn may rear 36 or more red virgins, consequently the colonies are most populous during spring and autumn.

An investigation of the chromosomes is in progress, in the hope that some light will be shed on the genetical mechanism controlling the phenomenon, but it teems with difficulties—the small size; the mere finding of such minute cells; the problem of determining to which brood the larvae belong, since the latest of any one brood may overlap the earliest of the succeeding one—the difficulties encountered in tracing any individual of a populous colony in a subearthen "nest" are almost insuperable.

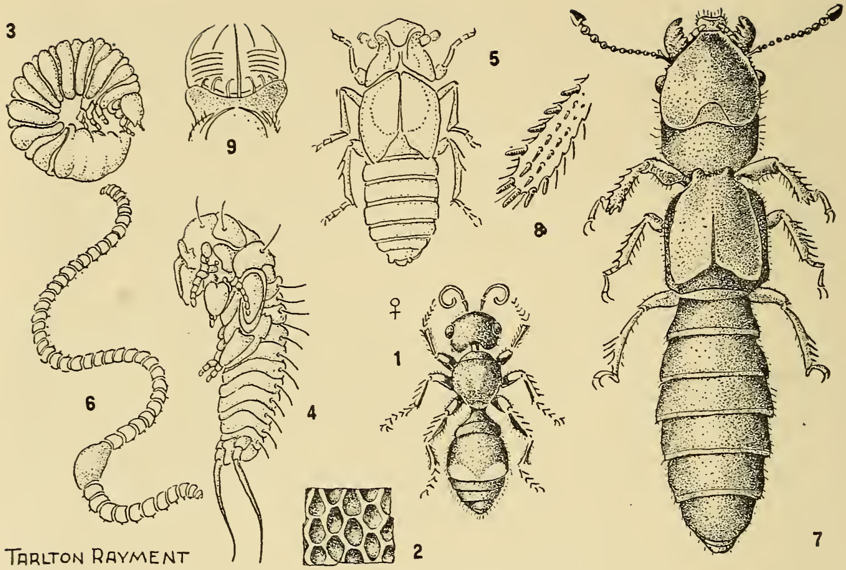


Fig. 6: The biological associates of *Halictus dimorphus* Rayment.

1. A small mutillid parasite, *Ephutomorpha gondennda*, Raym.
2. The pyriform sculpture of the mesothorax.
3. Minute larva of a beetle.
4. The white pupa of a beetle, sp. unknown, measures only 2 mm. in length.
5. A small immature beetle.
6. A small white segmented worm has a number of chaetae, and many had a "cocoon" or egg-case (Oligochaeta).
7. The largest beetle, *Oephronistus australicus* Bl., measured 5.5 mm. approx. in length.
8. Tibia of anterior leg more highly magnified.
9. Setae of mouth-parts more highly magnified.

The author's researches confirm the claim of Armbruster (1916) and Legewie (1922) that there are in certain *Halicti* three discrete broods and that the virgins produce both males and *females;* the males appearing in only one of the three broods. Prof. W. M. Wheeler (1933) concluded: "If Armbruster's and Legewie's interpretation is correct, then the Dzierzon rule has been 'shot to pieces'."

Translocation of Genes ?

The discovery in 1954 by Clifford Beauglehole of a large colony of the bee, *Halictus* (*Chloralictus*) *erythrurus* Ckll. at Gorae West, via Portland, Victoria, enabled the author to shed additional light on the genetical inheritance of these remarkable bees. The collector estimated that the colony contained over 1,000 shafts.

Excavating portion of the sub-earthen colony at crucial intervals revealed three discrete generations similar to those of *H. dimorphus* Raym., but with one fundamental departure. There is a like vernal (September) brood of virgin females (Primarius), with green head and thorax, and apricot-coloured abdomen.

Then there is a bisexual mid-summer (December) brood, the Secondarius females of which are coloured exactly like the vernal virgins, although the males with which they mate are again jet-black.

The progeny of these mated pairs are all virgin (Tertianus) females of green and apricot colour, emerging about the end of March. It is the over-wintered progeny of these Tertianus females that emerges in September.

Since the males are invariably jet-black throughout the chloralictine cluster studied in this research, the author postulates that the metallic colours are sex-linked with femaleness, so that the unique black Secondarius females of *H. dimorphus* Raym. present a tantalizing problem to the investigator. The males of ten or so species are all small, jet-black, and exceedingly difficult for the taxonomist to determine.

The mid-summer or bisexual brood contained a number of extraordinary mutations of black males with monstrous heads, and often with only the stubs of wings, suggesting those of certain mutations obtained by Morgan in his experiments with *Drosophila melanogaster*. The huge heads at once suggest parallels with Wheeler's dinergates in ants.

The author has already described (Victorian Naturalist, Ap. 1950, pp. 233-238), a number of mutations in bees, and which appear to be parallels with many of those recorded by Morgan for fruit-flies; there were white-eyed, and even totally blind drones. It would appear, then, that if the difficulties of obtaining authentic larvae from specific females were not insuperable, the genetical investigation of the chromosomes of halictine bees would produce results even more startling than those presented by the flies. Notwithstanding the difficulties involved, investigation of the larvae is being continued at every available opportunity.

The author postulates that the widest distribution connotes the oldest species, and since *H. erythrurus* Ckll. ranges down the coastal areas from Queensland to Western Australia, and even to Tasmania, he suggests that it is probably the original root from which so many of the chloralictine bees have branched.

A graphic comparison of the extraordinary and the normal head is presented by the drawings, but the insects were carefully measured, and comparisons are given below in microns.

HEAD.

	Length of	Width of	Thickness of
Normal male	1,300	1,500	700
Mutation male ..	2,000	1,900	1,500

COMPOUND EYES.

	900	400
	800	200

MANDIBULAE.

	1,000	450 at base
	1,500	700

Mutation Male:—Length 5.5 mm. Polished black, some amber colour on legs.

Head almost hairless; supraclypeal area fused with amber clypeus, which has two lateral teeth on anterior margin; mandibles large, with a conspicuous tooth on the lower margin near base; antenna filiform, black above, ferruginous beneath; labrum ferruginous; two large red maculae laterad of insertion of scapes; articles of the flagellum bear an amber flange. The basal segment of the labial palpus is expanded and dark; genae largely red, and excessively developed, thus creating a huge fossa.

Prothorax laterally reddish; scutellum smooth, dull, impunctate; abdomen broad and robust; the sterna with only dark lateral patches suffused with black (they are almost wholly suffused in the allotype, and partly so in male of *H. paradimorphus* Raym.).

Legs, especially anterior coxae, trochanters, femora and tibiae are yellow, and very large and robust (see No. 7 in Plate XXII). Wings exceedingly short, and in some specimens, reduced to mere stubs.

It is impossible to include in this nota previa the complete account of the anatomy and biology of these remarkable bees, but they are dealt with exhaustively in the author's large monograph of the subgenus which is awaiting publication.

REFERENCES.

Armbruster, L.—Zur Phylogenie der Geochlechts-bestimmungsweise bei Bienen. Zool Jahrb. Abt. Syst., 40: pp. 323-386. 1916.

Legewie, H.—Beitrage zur Biologie der Bienengattung Halictus. Mitteil, Badisch. Landesver, F. Naturk. U. Natur-schutz in Freiburg, i, B. I, pp. 235-257. 1922.

Pavlovsky, E. N. and Zarin, E. J. Quart. Journ. Micro. Sc. new ser. p. 15-17, 1922.

Rayment, Tarlton:—A Cluster of Bees, pp. 236-333, 1935.

Rayment, Tarlton.—Australian Zoologist, xi, 4, pp. 285-313, 1951.

Rayment, Tarlton.—Bees of the Portland District, p. 13-26, 1953 .

Snodgrass, R. E.—Anatomy and Physiology of the Honeybee, pp. 171-173, 1925.

Stockhert, E.—Ueber Entwicklung und Lebensweise der Bienengattung Halictus und ihrer Schmarotzer zugleich ein Beitrag zur Stammesgeschichte des Bienenstaates, Konowia, 2, 1923.

Wheeler, W. M.—Colony-Founding Among Ants, pp. 121-145, 1933.

EXPLANATION OF PLATE XX.

The colourful females of the spring brood are all virgins; the males and mated females of the summer brood are entirely black (see plate for details).

[The grateful thanks of the President and members of the Society are tendered to the "Argus" newspaper, Melbourne, for generously supplying, free of cost, the coloured plate which illustrates this paper.—Ed.]

EXPLANATION OF PLATE XXI.

1. Tumulus and crater of "spoil" from shaft is soon dispersed by the wind.
2. The mound "heaves" and tumbles as fresh material is thrust up from below.
3. A pebble is sometimes used to close the aperture.
4. A fillet of "cement" is first attached to one side of the pit-mouth.
5. A second fillet is added.
6. A third is joined to the periphery.
7. The fourth leaves only an opening in the centre.
8. A final pellet closes the aperture.
9. Pellets of "cement" are brought up in the bee's mandibles, and built round the aperture to make the friable rim hard enough to resist the wear of traffic.
10. A pebble wedged in the calcar of a Primarius female.
11. The cement rim of the periphery is finally smoothed with the tip of the abdomen.
12. The dentate hind calcar is used to pare off the "spoil" by a thrust downwards.
13. Patella or knee-plate (basitibial plate) of female.
14. The position of the bee descending the shaft, with the patellae pressed against the wall.
15. The finely serrated calcar is used to open the pollen-sacs of the flowers, and pollen-grains often fill the serrations.
16. Some of the black Secondarius females have tridentate mandibles.
17. When a "chimney" impinged on a leaf of *Hypochaeris*, the bees cut a neat round entrance through the leaf.
18. The abdomen of the female often has a few pebbles attached to the tip after she has completed the cementing of the rim about the "door."

EXPLANATION OF PLATE XXII.

Nos. 1-10.—Mutation male, *Halictus erythrurus* Ckll.

Nos. 11-18.—Allotype male.

Nos. 19-26.—Secondarius female *H. erythrurus* Ckll.

1. Front view of the large quadrate head of mutation. (Hairs not included in any diagram.)
2. Lateral view showing excessive development of the genae to a tooth.
3. Clypeus with its dentate margin viewed by transmitted light.
4. Genitalia at same magnification as No. 16.
5. Mandible, with tooth, at same magnification as No. 13.
6. Labrum.
7. Anterior leg at same magnification as No. 18.
8. Strigilis of anterior leg is alike in both males.

9-10. Two abdominal sterna at same magnification as Nos. 11 and 12.

11-12. Corresponding abdominal sterna of allotype.

13. Acute mandible.
14. Front view of head-capsule of allotype.
15. Lateral view.
16. Genitalia of allotype male.
17. Labrum.
18. Anterior leg; compare with No. 7.
19. Anterior coxae of female with prioperceptive pore-organs—Marked with an arrow.
20. Bidentate mandible of female.
21. Ventral view of prosternum of female at articulation of anterior coxae.
22. Hind calcar has one large tooth.
23. Anterior wing of Secondarius female.
24. Punctation of mesothorax is alike in both males.
25. Labial palpus of mutation with its enlarged dark basal segment.
26. Appendage of labrum of female.
27. Four apical segments of flagellum of mutation.

Opus CCC

By Gilbert Whitley, F.R.Z.S.
(Contribution from the Australian Museum, Sydney)

(Figures 1-7.)

Family GALAXIIDAE.

Genus GALAXIAS Cuvier, 1816.

GALAXIAS ORNATUS Castelnau.

(Figure 1.)

Galaxias ornatus Castelnau, Proc. Zool. Acclim. Soc. Vict. ii, May 10, 1873, p. 153. Cardinia Creek, Victoria. Holotype in Paris Museum. *Id.* Macleay, Proc. Linn. Soc. N. S. Wales vi, 1881, p. 237; Descr. Cat. Austr. Fish. ii-1882, p. 173. *Id.* Lucas, Proc. Roy. Soc. Vict. (2) ii, 1890, p. 36 (listed). *Id.* Regan, Proc. Zool. Soc. (Lond.) 1905, ii (1906), p. 381. Type redescribed. *Id.* Whitley, Rec. Austr. Mus. xx, 1939, p. 268 (wrongly regards *G. pusillus* as a synonym). *Id.* Butcher, Freshwater Fish. Vict., 1946, p. 9 (listed).

I am grateful to Mademoiselle Gisele Mauger for the accompanying illustration of the unique holotype of Castelnau's species, which is No. A.5225 in the Museum national d'Histoire naturelle, Paris. The specimen is said to be "en aussi mauvais etat," is 95 mm. in standard length and has D. 9; A. 10; P. 15; V. 7 and 16 principal caudal rays. This formula differs slightly from those given by Castelnau and Regan.

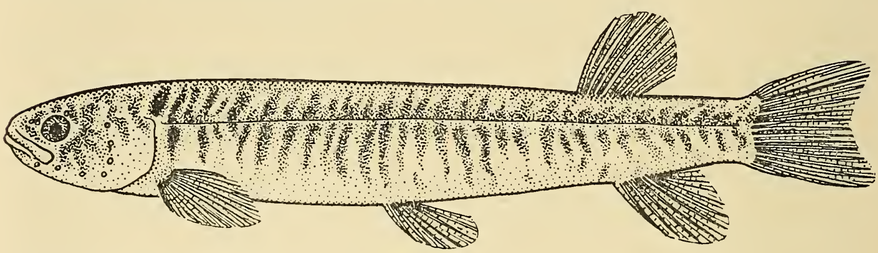


Figure 1.—Mountain Trout, *Galaxias ornatus.* Holotype from Victoria.
Mlle. Gisele Mauger del.

GALAXIAS OCONNORI Ogilby.

(Figure 2.)

Galaxias oconnori Ogilby, Mem. Qld. Mus. i, 1912, p. 33. Lyra, south Queensland. *Id.* McCulloch & Whitley, Mem. Qld. Mus. viii, 1925, p. 133 (listed). *Id.* Duhig, Proc. Roy. Soc. Qld. xlii, 1931, p. xvi (melanosis & trematode). *Id.* Whitley, Rec. Austr. Mus. xix, 1933, p. 61, pl. xii, fig. 3 (holotype figured.)

Lyragalaxias oconnori Whitley, Vict. Nat. lii, 1935, pl. iii, fig. 5.

Seven specimens (Austr. Mus. regd. Nos. I.13459, IB.756 and IB.3278) from Rawdon, Rylstone, Cudgegong River, 18 Dec. 1911, and two (IB.755) from the junction of the Namoi and Barwon Rivers were received many years ago from Mr. D. G. Stead. The largest (65 mm. in standard length, No. IB.3278 from Rylstone), figured here, has the ventral origin nearer tip of snout than base of caudal, which is the case in three other specimens, but another example has the ventral origin equidistant from those two points, and the majority have the ventrals nearer base of caudal than tip of snout as in typical *oconnori*.

New record for New South Wales.

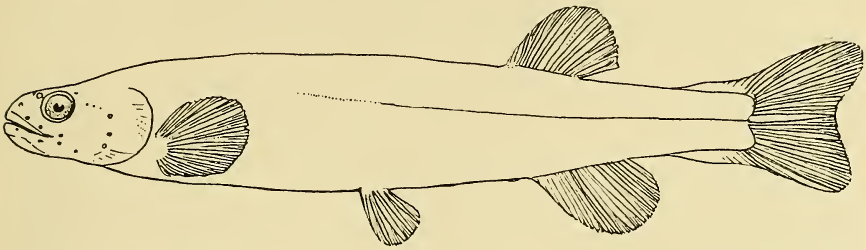


Figure 2.—Native Trout, *Galaxias oconnori*, from New South Wales.
G. P. Whitley del.

Family SYNGNATHIDAE.

Genus HISTIOGAMPHELUS McCulloch, 1914.

HISTIOGAMPHELUS MERACULUS Whitley.

(Figure 3.)

Histiogamphelus meraculus Whitley, Austr. Zool. xi, 3, Feb. 11, 1948 p. 271. City Beach, near Perth, Western Australia.

Here figured for the first time from the holotype, kindly lent for the purpose of illustration by Mr. L. Glauert, Director of the Western Australian Museum, Perth.

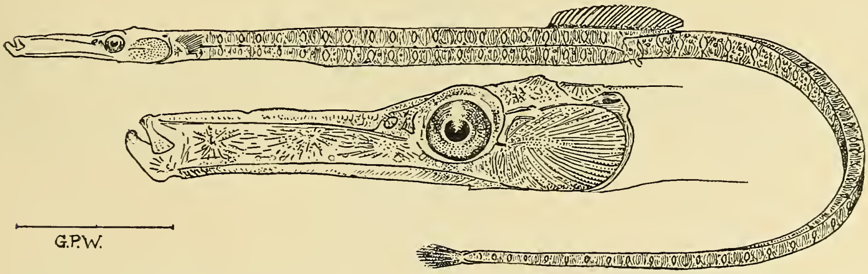


Figure 3.—Pipefish, *Histiogamphelus meraculus*. Holotype from Western Australia.
G. P. Whitley del.

Family SOLENICHTHYIDAE.

Genus SOLENICHTHYS Bleeker, 1865.

Solenichthys Bleeker, Ned. Tijdschr. Dierk. ii, 1865, p. 183. Logotype, *Solenostoma paradoxus* Lacepede = *Fistularia paradoxa* Pallas. *Id.* Whitley, Proc. Roy. Zool. Soc. N. S. Wales 1951-2 (1953), p. 30 (refs., synonymy and list of species).

SOLENICHTHYS RACEKI, sp. nov.

(Figure 4.)

Head (38 mm.) 2.4, depth of body (18) 5.2, of caudal peduncle (6) 15.6 in standard length (94), or 3, 6, and 20 in total length respectively. Eye (4) 9.5, interorbital (4) 9.5, snout (27) 1.4 in head. Depth of snout (9) 3 in its length. Length of caudal peduncle less than one-third of base of soft dorsal. Predorsal length 54 mm.; length of pectoral, 3.5; of ventral, 26; longest anal ray, 4; anal base, 9.

Head and body strongly compressed, widest at interorbital. Belly cultrate behind anal fin. Jaws toothless, premaxillaries ending in two spines superiorly. Maxillary (5 mm.) greater than interorbital, with concave posterior margin. Upper part of snout (especially mesethmoid) and lower sides of head elevated into papery crests; most of head-bones sculptured and with serrated ridges. Nostrils large, with about 15 exposed radiating laminae. Three main opercular keels radiate from behind eye. Gill-openings wide; isthmus very narrow. A median scute behind isthmus and two keeled rings just before ventral fins; a bony pre-dorsal ridge. Rings on body 29 between head and tail fin; of these, 5 are before first dorsal, 5 in a mediolateral row between first dorsal and level of vent (with 11 or 12 scutes above and below them), and about 14 from vent to beginning of caudal fin. First dorsal over 1½ scutes, second dorsal over about 8; anal under 5 plates.

D. v/?; A. 20; P. 27; V. 10; C. 16.

Dorsal base elevated. Fifth dorsal spine longest: however, the dorsal fins appear to be abnormal (probably injured and healed), the ends of the spines being curled and much of the second dorsal missing. Second dorsal and anal about as high as eye-diameter. Ventrals not united to one another or to abdomen, only their upper and lower rays simple. Ventrals, caudal and snout subequal in length.

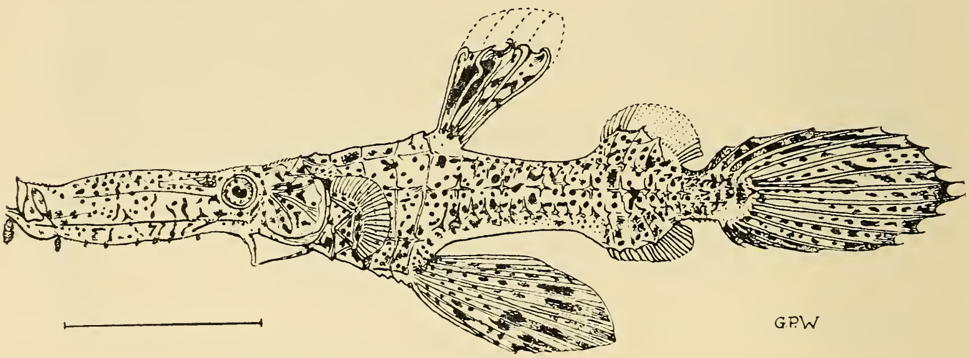


Figure 4.—Ghost Pipefish, *Solenichthys raceki*. Holotype from New South Wales. Dorsal fins restored where lines are dotted.

G. P. Whitley del.

Colour green in life with dark blotches on head, body and fins (except pectorals, second dorsal and anal which are plain). After death and preservation, brownish yellow with brown to blackish markings as figured, the dark blotches being largest and most conspicuous on first dorsal and caudal fins. Eye reddish. Pink edges to first dorsal fin, upper and lower surfaces of caudal peduncle, ventral and caudal fins. Pink barbel-like tags below snout and caudal peduncle.

Described and figured from the holotype, a specimen 120 mm. or 4¾ inches in total length. Australian Museum regd. No. IB.3300.

Loc.—Off Broken Bay, New South Wales; hiding amongst weed from daytime prawn-trawl, 5 to 7 fathoms, 27 January 1955. Collected by Dr. A. A. Racek of the State Fisheries Branch, Chief Secretary's Dept., Sydney.

The new species is distinguished from its congeners by its coloration, very deep snout, the W-shaped ridges down pectoral base, the deep caudal peduncle, ventrals equalling snout in length, the ten ventral rays, and in the disposition of the scutes on the body.

It is evidently closest to *S. paegnius* Jordan & Thompson (Mem. Carneg. Mus. vi, 4, Sept. 1914, p. 235, as *Solenostomus*) from Japan, differing in proportions and fin-counts, thus:

A. Length of caudal peduncle, measured from last anal ray to middle caudal rays, 4.75 in head. Ventral rays eight .... *paegnius*

AA. Caudal peduncle 3.5 in head. Ventral rays ten .... *raceki*, sp. nov.

From all other species (*paradoxus*, *cyanopterus*, *brachyurus*, *armatus*, *bleekeri*, *laciniatus*, *phantasticus* and *leptosomus*) the deep snout separates *raceki*.

The male "*Solenostomus cyanopterus*" beautifully figured by Jungersen (D. Kgl. Danske Vidensk. Selsk. Skr., 7 Raekke, viii, 5, p. 310, pl. III, figs. 10-11; pl. vi, figs. 2-3 and 6-9; and pl. vii, figs. 3-6) from Japan is evidently *Solenichthys paegnius*. It has caudal peduncle 5 in head, ventral rays seven and a deep snout. My specimen most resembles his female E in numerical characters. I am grateful to the Royal Society of South Australia for a loan of the volume in which Jungersen's paper was published.

Family GERRIDAE.

Genus PAROCHUSUS Whitley, 1930.

PAROCHUSUS CHEVERTI (Alleyne & Macleay).

Gerres cheverti Alleyne & Macleay, Proc. Linn. Soc. N. S. Wales i, Feb. 1877, p. 272, pl. vii, fig. 1. Cape Grenville, Queensland.

One specimen, 6¼ inches long, from Darwin (Austr. Mus. regd. No. IB.3366). New record for the Northern Territory.

Family ACANTHURIDAE.

Genus CYPHOMYCTER Fowler & Bean, 1929.

CYPHOMYCTER TUBEROSUS (Lacepede).

Naso tuberosus Lacepede, Hist. Nat. Poiss. iii, 1802, pp. 105 & 111, pl. vii, fig. 3. Mauritius.

Naseus johnstonei Ramsay, Austr. Mus. Rept. 1875 (1876), p. 4. *N.n.*

Naso (*Cyphomycter*) *tuberosus* Fowler & Bean, Bull. U.S. Nat. Mus. 100, viii, 1929, p. 273, fig. 19 (refs. & synon.). *Id.* Whitley, Mem. Qld. Mus. x, 1930, p. 18.

Dr. R. Catala sent me a kodachrome photograph of a specimen from the reef off Noumea, Feb. 1955; new record for New Caledonia. Apart from specimens from Mauritius and New Guinea in the Australian Museum, there is a photograph of the chirotype (an adult female) of *Naseus johnstonei* Ramsay, a hitherto unrecorded synonym of this species; it was 21½ inches long, has a humped back, and came from Port Moresby, Papua.

Family SEMIONOTIDAE.

LEI, gen. nov.

Orthotype, *Leiolepis kohlmanni* Heller (Geol. Bl. NO.—Bayern ii, 1, 1952, p. 25, pl. ii) = *Lei kohlmanni*.

A new name, of masculine gender, to replace *Leiolepis* Heller, *loc. cit.*, which is preoccupied by *Leiolepis* Cuvier (Regne Anim. ed. 2, ii, 1829, p. 37) and of several later authors in Reptiles and Fishes.

Family CHAETODONTIDAE.

Genus CHELMON Cloquet, 1817.

CHELMON ROSTRATUS (Linne).

(Figure 5.)

The Beaked Coral Fish, *Chelmon rostratus* (or, less likely its relative, *Forcipiger longirostris*) appears to be the species of fish represented on an interesting aboriginal shield in Mr. Melbourne Ward's Gallery of Natural History and Native Art, Medlow Bath, where he kindly allowed me to prepare the accompanying figure when I was his guest on a brief visit to the Blue Mountains. It is registered No. H.1414 and came from Raffles Bay, Northern Territory. The shield is 2 feet long, 5½ inches wide, nearly 2 inches in depth, slightly curved from end to end (the inner side, with sunken hand-grip, here shown being concave) and the outer sides are

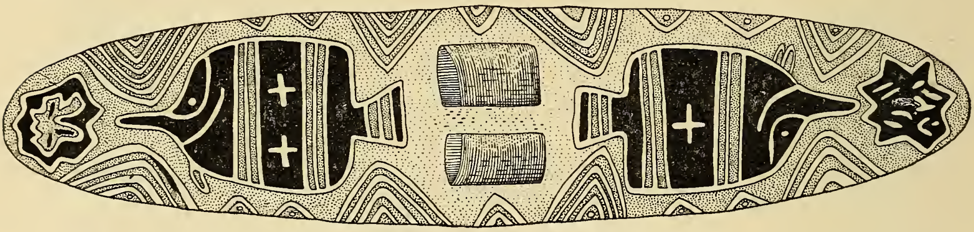


Figure 5.—Aboriginal shield from the Northern Territory with Beaked Coral Fish, Starfish, etc. in design.
G. P. Whitley del.

strongly convex. Mr. Frederick McCarthy, anthropologist at the Australian Museum, says the shield is of a type not native to the Northern Territory but more like certain Kimberley (W.A.) forms, but the decoration is unlike any in the Australian Museum and might be due to non-aboriginal influence. The outlines are incised and white as shown in the diagram, stippled areas are red and black ones black, the design and execution showing a fine degree of craftsmanship. The reversal of one fish might indicate its habit of swimming upside-down, as *Forcipiger* sometimes does. Besides the fish and boomerang-shaped waves (?) there are two starfish (*Oreaster nodosus*). These are not greatly conventionalized, but on the other side of the shield there are two hammerhead sharks (*Sphyrna*) which are ornamented with scrolls and not naturally drawn. Altogether a unique piece of native art.

The same species of beaked coral fish is represented in a wood carving made at Goulburn Island, Arnhem Land, and illustrated by Axel Poignant (Sydney Morning Herald newspaper, May 28, 1955, p. 10, fig.).

Family ATHERINIDAE

Genus ATHERINOSOMA Castelnau, 1872.

ATHERINOSOMA LINCOLNENSIS Whitley.

(Figure 6.)

Atherinosoma microstoma lincolnensis Whitley, Austr. Zool. x, 1941, p. 17. Port Lincoln, South Australia.

The holotype (Austr. Mus. regd. No. IB. 662) is here figured for the first time; it was collected before May 1941, but whether in fresh or salt water I have been unable to ascertain. The large eye is characteristic, also the shallow caudal peduncle and slender form, apart from the fin and scale-counts.

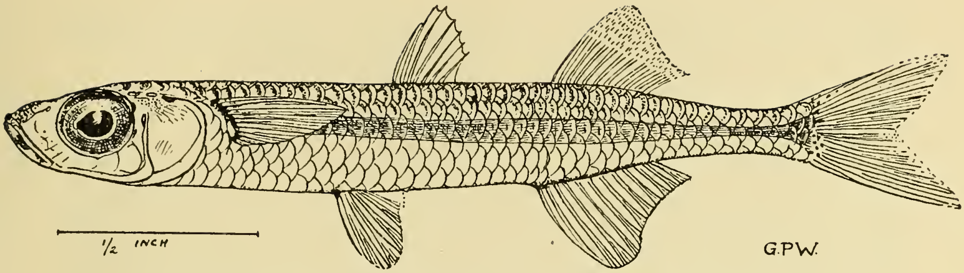


Fig. 6: Hardyhead, *Atherinosoma lincolnensis.* Holotype from South Australia.

ATHERINOSOMA TROPICALIS Whitley.

(Figure 7.)

Atherinosoma (*Taeniomembras*) *tropicalis* Whitley, Rec. Austr. Mus. xxii, 1948, p. 87. Whitsunday Passage, Queensland.

For comparative purposes, I offer here an original figure of the holotype (Austr. Mus. regd. No. IA. 1553) of this north Queensland species. This has a robust body, with more than 40 lateral scales; pectoral rays 17 and 20 predorsal scales.

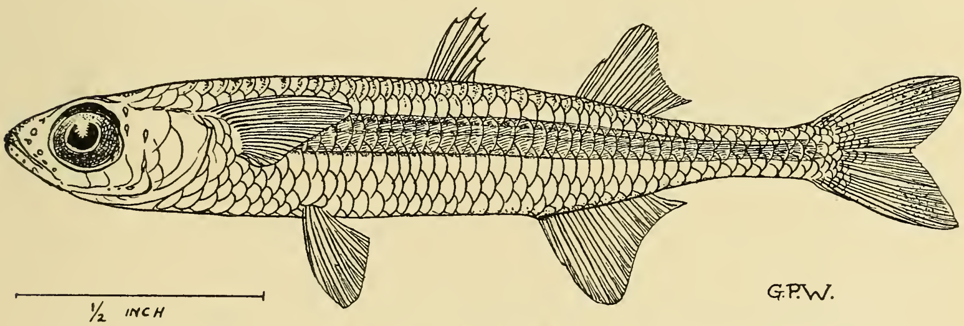


Fig. 7: Hardyhead, *Atherinosoma tropicalis.* Holotype from Queensland.

Genus CRATEROCEPHALUS McCulloch, 1912.

CRATEROCEPHALUS ANTICANUS, sp. nov.

New name for *Craterocephalus edelensis* Whitley (Proc. Linn. Soc. N. S. Wales lxviii, 1943, p. 135, description only not synonymy or figure), not *Atherinichthys edelensis* Castelnau, 1873, which is as now restricted a freshwater species from the Swan River system.

A Western Australian marine atherine from the North-west Cape to Abrolhos area in which the vent is situated almost as far forward as the bases of the ventral fins. A useful diagnostic feature is a dark streak along each side of chin. The premaxillary processes are slender and longer than pupil; there are large scales below pectoral base, 3½ scales from there to chest; the body-cavity ends bluntly just in front of anal origin, not entering first haemal arch; none of haemal spines or hypophyses broadened.

Holotype (Austr. Mus. regd. No. IB.282) from Shark's Bay and a number of paratypes in the Australian and West Australian Museums.

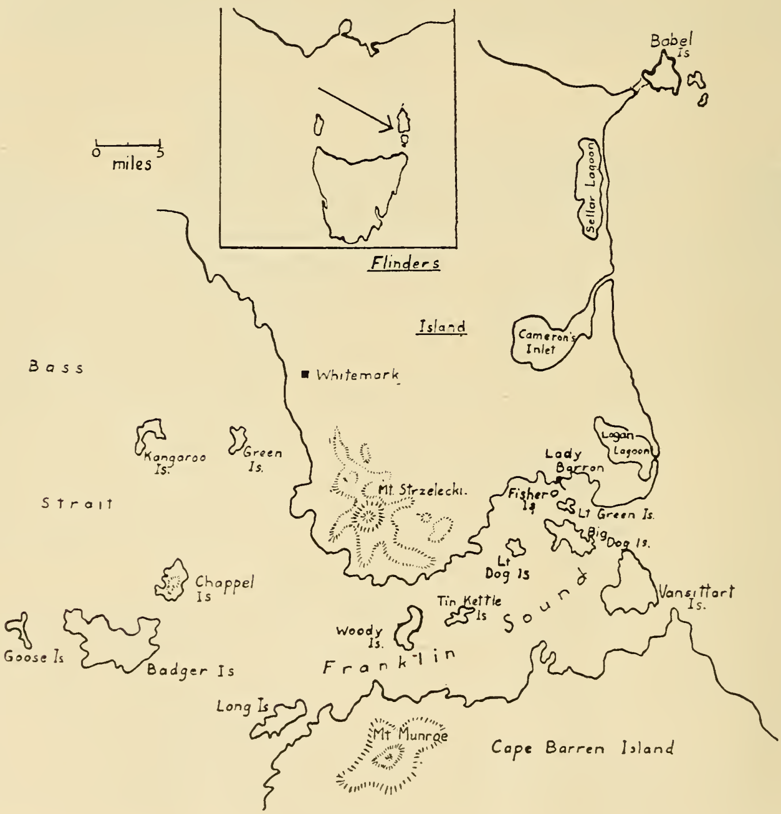
Nearest *C. capreoli* Rendahl but with vent farther forward and slightly different proportions.

anticanus, from Latin *anticus*, forward, and *anus*, vent.

Notes on a Collection of Reptiles and Amphibians from the Furneaux Islands, Bass Strait

By ROY D. MACKAY.

Very few lists of reptiles from restricted geographical areas have been published in Australia. Papers of this type by Kinghorn(1) and Loveridge(2) have proved of immense value to herpetologists in plotting the distribution of various species and in the study of ecological preferences. The present paper is a contribution to the knowledge of the reptiles found on the Furneaux Islands. These islands are of volcanic origin and attained their present position after a series of submergences and upheavals of a land bridge connecting Tasmania and Victoria in the Tertiary Period some twenty to fifty million years ago. Many granite surfaces have been exfoliated by fluctuations in diurnal and seasonal temperatures. These exfoliations provide cover for many reptiles and their insect prey. The smaller islands are for the most part covered with tussock grass beneath which Mutton-birds (*Puffinus tenuirostris*) dig their nesting burrows. These burrows average three feet in length and form the main shelter for most of the reptiles found on the smaller islands. Steep and rugged mountains occur



Locality map.

on the largest islands, Flinders Island and Cape Barron Island, the highest being Mt. Strzelecki, 2550 ft. on the southwestern end of Flinders island. Several small islands are frequented by either the Black Tiger Snake (*Notechis scutatus*) or the Copperhead (*Denisonia superba*) but apparently both species are not found together except on the largest islands where there is a greater diversity of habitat. Black Tiger Snakes are very common on Chappell, Cat, Babel and Forsyth Islands; Copperheads are found on Big Dog and Little Green Islands. Both species occur on Flinders Island.

Melanism is prevalent to a greater or less degree in almost all the reptiles seen on these islands. Its greatest effect is seen in the Tiger snakes most of which are jet black above and yellow or blue-black below. Copperheads are affected almost to the same extent. The young of the Tiger snakes are also very dark but show the typical pattern of the species. This pattern usually disappears as the snake matures though a few adults still show faint banding.

A complete list of the reptiles and amphibians collected is given below with notes on significant variations.

AMPHIBIA.

Family Ceratophriidae.

Crinia tasmaniensis (Gunther).

Pterophrynus tasmaniensis, Gunther, 1864, Proc. Zool. Soc. London, p. 48, pl. vii, fig. 3, Tasmania.

One specimen, a female, was found on 19-3-55 under a log in a fallow paddock on Mr. F. Langley's property, eight miles north-west of Lady Barron, Flinders Island. This property is situated at the base of the Strzelecki Peaks. The nearest water was about eighty yards away, a tributary of the Samphire River. This specimen was brightly marbled with black and white on the ventral surface and measured 30 mm. in length.

Family Hylidae.

Hyla jervisiensis Dumeril & Bibron.

Hyla jervisiensis Dumeril & Bibron, 1841, Erpet. Gen. 8, p. 580. Jervis Bay, N.S.W.

Three specimens, all females, were found in the same paddock as the preceding species and under similar conditions. The hinder thigh colour was bright yellow. The specimens measured 31, 35 and 35 mm. respectively.

Lacertilia.

Family Scincidae.

Egernia whitii (Lacepede).

Scincus whitii, Lacepede, 1804, Ann. Mus. Paris, 4, p. 209. Australia.

Only one specimen, a juvenile, was collected. It was found on a granite slope of a ridge leading up the eastern side of the Strzelecki Peaks on Flinders Island. Many family groups and individuals were seen, all of which possessed the typical pattern of dorsal stripes and ocelli, though in the adults this pattern was almost obscured by melanin pigment. No *Egernia whitii* were observed on the smaller islands though it is quite likely they do occur on them.

Diagnosis:—Scale rows 33, lamellae under fourth toe 23/24, six supraciliaries.

Total length 95 mm., tail length 55 mm. Ratio

$$\frac{\text{Total length}}{\text{Tail length}} = 1.73.$$

TILIQUA NIGROLUTEA (Quoy & Gaimard).

Scincus nigroluteus Quoy & Gaimard, Voy. Uranie Physic., Zool., 1824, p. 176, pl. xli. Blue Mountains, N. S. Wales.

Six specimens were collected on Babel Island off the east coast of Flinders Island. All specimens were heavily pigmented with melanin.

The head of each specimen was pale orange in colour and the dorsal blotches varied in size and shape in different specimens or on each side of the one specimen. These lizards were all found in the open and when approached they attempted to run into a Mutton-bird burrow. Numerous sloughs and a few dead specimens were seen on the island. One slough was found on Big Dog Island. The lizards are noticeably smaller than known New South Wales specimens.

Diagnosis:—Six specimens from Babel Island 12/16-3-55. Scale rows 27 to 33, lamellae beneath fourth toe 7 or 8, five supraciliaries. Largest scink 385 mm. Ratio of $\frac{\text{Total length}}{\text{Tail length}} = 3.00$ to 3.44.

LEIOLOPISMA TRILINEATUM (Gray).

Tiliqua trilineata Gray, 1839, Ann. Nat. Hist., 2, p. 291, Australia.

This species was found commonly on all islands visited. The lizards were collected from under slabs of granite and from the sandy ground around the Mutton-bird burrows. The young are usually very pale and may lack the central dorsal stripe. As they mature they become much darker in colour. Aged specimens are so dark that the dorsal and lateral markings are often totally obscured.

Nineteen specimens were collected.

6 from Little Dog Island, 8-3-55.
3 from Big Dog Island, 9-3-55.
5 from Babel Island, 12/16-3-55.
5 from Flinders Island, 19/20-3-55.

Diagnosis:—Scales in 24 to 27 rows, lamellae under fourth toe 18 to 23, 6 to 8 supraciliaries. The longest scink measured 149 mm. Ratio of $\frac{\text{Total length}}{\text{Tail length}} = 1.63$ to 1.89. Each of the dorsal scales has three to six acute keels.

LEIOLOPISMA ENTRECASTEAUXII Dumeril & Bibron.

Lygosoma entrecasteauxii, Dumeril & Bibron, 1839, Erpet. Gen., 5, p. 717, Australia.

Although this lizard was seen frequently on several of the islands only one specimen was collected and that on Fisher Island, on 17-3-55.

Diagnosis:—Scales in 28 rows, lamellae under fourth toe 18/19, 5 supraciliaries. Total length 118 mm.

Ratio of $\frac{\text{Total length}}{\text{Tail length}} = 1.81.$

LEIOLOPISMA OCELLATA (Gray).

Mocoa ocellata Gray, 1845. List Lizards Brit. Mus., p. 81 (June 28); Zool. Erebus & Terror, Rept. p. 8, pl. vii, fig. 3; Australia.

Several specimens were seen on the exposed rocky areas of a ridge approaching Strzelecki Peaks, eight miles north-west of Lady Barron, Flinders Island. Only two specimens were collected, an adult and a juvenile.

Diagnosis:—Scales in 52 to 53 rows, lamellae under fourth toe 22. Both specimens possessed six supraciliaries on the left side and seven on the right. The larger specimen measured 149 mm., including a regenerated tail 70 mm. long.

RHODONA BOUGAINVILLII (Gray).

Riopa bougainvillii Gray, 1839, Ann. Nat. Hist., 2, p. 332. Australia.

One specimen was collected from loose sand at the entrance of an old Mutton-bird burrow on the north-west slopes of Babel Island on 14-3-55. Babel Island is connected to Flinders Island by a sandspit. This spit was broken by the sea about one-third of the way from Babel Island during my visit.

This specimen is apparently the most southern record for the species and appears to be a new record for the Tasmanian region.

Diagnosis:—Scales in 20 rows, lamellae under fourth toe 17, six supraciliaries. Total length 82 mm. Tail length 12 mm. (regenerated).

OPHIDIA.

Family ELAPIDAE.

DENISONIA CORONOIDES (Gunther).

Hoplocephalus coronoides Gunther, 1858, Cat. Snakes Brit. Mus., p. 215, Tasmania and Swan River, W.A.

Pseudelaps minutus Fry, 1915, Proc. Roy. Soc. Qld., 27, p. 93, fig. 7. Wilde's Meadow, nr. Moss Vale, Colo Vale, Tamworth, or Guntawang, all in N.S.W.

Four specimens were collected on Babel Island on 15/16-3-55 and one juvenile from Flinders Island on 19-3-55. I also have a specimen from Fisher Island collected on 26-11-48 and passed on to me by Dr. D. L. Serventy and Mr. K. Hindwood.

These specimens are similar to Tasmanian specimens but differ greatly in colour and proportion from those occurring in N.S.W.

Diagnosis:—Scales in 15 rows, ventrals in 132 to 147, anal single, subcaudals 46 to 56. It should be noted that the two lowest ventral and subcaudal counts (132, 139—46, 47) belong to the only female specimens in the series. Nasal single, in contact with the single preocular, two postoculars, temporals 2:2, 2:3 or 3:3. Number of teeth behind fang, one. Number of functional palatine teeth, four. Number of functional pterygoid teeth, eight or nine. Longest snake measures 495 mm., tail 112 mm.

Ratio of $\frac{\text{Total length}}{\text{Tail length}}$ varies from 4.27 to 5.25.

DENISONIA SUPERBA (Gunther).

Hoplocephalus superbus Gunther (part), 1858, Cat. Sn. Brit. Mus., p. 217. Australia and Tasmania.

No specimens were collected but a preserved specimen was passed on to me for the Australian Museum collection. It was collected on Fisher Island on 6-12-52. It is believed to be found commonly on Little Green Island and Big Dog Island and is actually quite common on Flinders Island. The preserved specimen is much darker than mainland (Victorian) specimens but otherwise the scalation, as given below, falls within the known range of variation. Its colour is uniform blue-black above and blue-grey below.

Diagnosis:—Scales in 15 rows, ventrals 154, anal single, subcaudals 46. Number of teeth behind fang, seven on left side, eight on right, four palatine teeth and six pterygoid teeth. Total length 740 mm.

Ratio of $\frac{\text{Total length}}{\text{Tail length}} = 5.87$.

NOTECHIS SCUTATUS (Peters).

Naja (Hamadryas) scutata Peters, 1861, Monatsb. Akad. Wiss. Berlin, p. 690, "Java."

The Black Tiger Snake is extremely common on Chappell Island, Cat, Babel, and Forsyth Islands, and is fairly common on Flinders Island. This may be due to abundance of the food—namely rats, (*Rattus* and *Hydromys*).

An abundance of these latter animals on the smaller islands might prevent population increase among mice and frogs and so hinder the establishment of a population of the other large snake found on the islands, the Copperhead (*Denisonia superba*). Frogs and mice are known to be the principal source of food supply of the Copperhead. In such a case as the Chappell Island population of Black Tiger Snakes any major changes of food supply or habitat might quickly upset the natural balance and could cause the total extinction of the species from the area. For instance, if the rats were destroyed and livestock were allowed to trample in the Mutton-bird burrows, the snakes would lack food and have very little cover and so would soon die out.

Evidently Black Tiger Snakes are not so plentiful at present as formerly. This situation can be accounted for by "mutton-birders," while collecting young birds, having killed all the snakes they encountered. It is interesting to note that most of the Black Tiger snakes live on the higher ground where the young Muttonbirds are collected only when the flats near the shore have become exhausted of young birds.

One male and two females were collected from Chappell Island on 11-3-55. One juvenile and one adult, both unsexed, were collected from Babel Island on 14/15-3-55.

Diagnosis:—Scales in 17 rows, ventrals 161 to 175, anal single, subcaudals 34 to 52. Number of teeth behind fang, two. Five to seven palatine teeth and eight to fourteen pterygoid teeth. Longest specimen 1388 mm., a female.

Ratio of $\frac{\text{Total length}}{\text{Tail length}}$ varies from 6.76 to 6.94. A female 1320 mm. long contained eleven young in an advanced state of development.

The colour of these specimens is black above with or without faint bands showing. The ventral surface is yellow or blue-black.

The above data suggest a need for a revision of Kinghorn's description(3) of *Notechis scutatus niger*, as the colour and details of scalation of this series overlap the distinguishing characters of typical *Notechis scutatus* and *N. s. niger.*

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(1) Kinghorn, J. R., 1945, The Simpson Desert Expedition, 1939, *Trans. Roy. Soc. S. Aust.*, 69 (I); 27.

(2) Loveridge, A., 1949, On Some Reptiles and Amphibians from the Northern Territory, *Trans. Roy. Soc. S. Aust.*, 72, (2); 208.

(3) Kinghorn, J. R., 1921, Studies in Australian Reptiles, No. 2. *Rec. Austr. Mus.* 13, 4, p. 143, pl. xxvi, figs. 6-8.

Teaching Zoology

I. STUDENT ATTITUDE TO UNIVERSITY ZOOLOGY.

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(Figures 1-4.)

(i) INTRODUCTION

In 1952 the University of Sydney taught Zoology I to all first year students of Medicine and Veterinary Science, all second year students of Agriculture, and to students of Science and Arts who selected the course. Classes were divided into two groups, one medical and one non-medical, each with its own course of lectures and practical work.

Observations of student behaviour in lecture-room and laboratory during 1952 showed that different faculty groups seemed to have different attitudes towards Zoology; some groups having extremely unfavourable opinions of the course as a whole. A scale was constructed to measure the general attitude of each group and attitudes towards special aspects of the course, such as study and reading in Zoology, dissections, subject preference, the use of the course and lectures on evolution.

These measurements were made to find the students' opinion of the course and to give some direction to the design of a new Zoology syllabus.

(ii) METHOD.

An attitude scale was constructed by the method described by Thurstone and Chave (1929) and by Jordan (1941). Sixty statements about first year courses in Zoology were written on separate cards. In writing each statement, Wang's (1932) rules were followed as closely as possible. Ten people who had taught the students then independently sorted these statements into eleven groups ranging from highly favourable (Group 1) through neutral (Group 6) to highly unfavourable (Group 11). The sorters were asked to prevent personal opinions influencing their decisions.

The results of the examiners' sorting were presented in a frequency distribution table and a table of accumulative proportions was made out for each statement. The scale value of each statement was then determined graphically. (See Jordan for details of method.)

Each statement was tested for ambiguity by determining "Q" values as described by Jordan. Ten statements with "Q" values in excess of 3.0 were rejected, leaving 50 statements with an average "Q" value of 1.7.

These fifty statements were built into a questionnaire. The questionnaire was presented to all non-medical students and to 51 per cent of medical students during the last week of the academic year 1952. Students were asked to place a tick in a column headed "yes" if they *fully* agreed with a statement and in a column under "No" if they did *not fully* agree with a statement. All questionnaires were filled in anonymously. Attitude values did not appear on this questionnaire.

The attitude score of each student was determined by calculating the mean scale value of all the statements which he answered in the affirmative. The higher the score the more unfavourable the attitude. A frequency distribution of attitude scores was plotted for each faculty group, and the percentages of affirmative answers to certain statements on the questionnaire were calculated.

(iii) THE QUESTIONNAIRE

Statement	Attitude Scale Value
1. I listen regularly to broadcast talks on zoological topics ..	2.0
2. I would like to see more Zoology taught to first year students	2.0
3. The course should deal only with vertebrates—especially mammals	6.5

4.	Zoology has only interested me slightly; but I prefer it to several other university courses that I have attended ..	6.7
5.	Animals interest me very much	0.8
6.	I have read nothing in Zoology apart from my lecture notes	7.7
7.	I enjoy finding out how animals "work"	1.5
8.	I spend the bulk of my study-time on Zoology because I find it very interesting	1.5
9.	Zoology is a "dead" subject and I greatly dislike it	10.4
10.	I spend study-time in Zoology only because I want to pass an examination and not because I am very interested in the subject	9.5
11.	*Only* the fact that Zoology was "compulsory" made me enrol	10.3
12.	I think that Zoology I has been a complete waste of time and I regret having undertaken the course	10.5
13.	I have read nothing in Zoology and do not intend to read anything zoological at any time this year	10.5
14.	I hope to become a professional Zoologist after graduation	0.7
15.	Invertebrate animals are very interesting and we should study more of them	2.0
16.	I have only a slight interest in animals	8.5
17.	Zoology interests me because it lets one see the detailed structure of many types of animals	2.7
18.	I enjoy dissecting animals and think that we should do more dissections	3.3
19.	Zoology will be of no practical value to me in the future but I have enjoyed the course	4.0
20.	I can't dissect animals and don't want to anyway	10.1
21.	Zoology will probably be of some value in my postgraduate career	5.3
22.	Books and articles on Zoology will always interest me but I'll only read them very occasionally after I finish the course	5.6
23.	The course in Zoology is far too long but the subject matter is fairly interesting	4.5
24.	Theory of evolution is dull and uninteresting	8.7
25.	Zoological articles in scientific or popular magazines or books have never attracted me	9.4
26.	I feel that Zoology I will help me to understand courses which I will take in later undergraduate years	2.0
27.	I hope to major in Zoology and will use it to supplement another field (e.g. Physiology, Biochemistry, etc.)	2.3
28.	Zoology bores me so much that I can't force myself to do any study in it	10.4
29.	If I happen to tune in to a radio talk on a zoological subject I usually remain tuned in to that station	2.0
30.	I do a lot of reading in Zoology to supplement the material given in lectures and text-books	1.5
31.	Zoology I should be a compulsory course in all faculties ..	2.5
32.	Dissections interest me but I find them difficult	4.4
33.	If I happen to tune into a radio talk on any aspect of Zoology I quickly tune into another station	10.0
34.	I plan to keep in touch with Zoology through a fair amount of individual reading after I have completed the course ..	1.5
35.	I have read my lecture notes thoroughly but have made little use of a text-book	6.8
36.	I do a great deal of reading in Zoology outside the scope of the course	1.3
37.	The Theory of Evolution is very interesting and has opened up new fields of thought for me	1.3

38.	I have not read any of my lecture notes or text-books in Zoology but will have done so before the examinations ..	8.5
39.	Evolution is the most interesting concept I have studied at the University	2.0
40.	Of all the courses I've attended at the University I have enjoyed Zoology the most	1.7
41.	The Theory of Evolution is too academic and has not interested me very much	7.3
42.	I do very little study in Zoology because I find the subject matter so dull and uninteresting	10.2
43.	I greatly dislike Zoology and would place it last on a preference list of courses I have attended	10.3
44.	Animals don't interest me	10.3
45.	Zoology is dry and uninteresting	10.3
46.	While the course of lectures has been interesting I wouldn't like to take a first year course which covered any *more* ground	4.7
47.	Too much material has been covered by the course to allow full appreciation	5.0
48.	Cutting up dead animals makes me sick	8.0
49.	I hope never to have to read anything connected with a Zoological topic again	10.4
50.	Zoology I should be withdrawn from the requirements of my faculty	10.4

(iv) RELIABILITY OF THE TEST

The reliability of the test was estimated by the odd-even or split-half technique. A random sample of fifty test answer papers was used.

The reliability was 0.81.

(v) RESULTS

1. *General Attitude Towards the Course in Zoology.*

Only students of Agricultural Science (Fig. 2) and Medicine (Fig. 4) had any marked dislike for the subject. More than 50 per cent of Agriculture were indifferent to the course and only 32 per cent favourable to it. Agriculture had a mean score (5.35) well within the neutral range (4-8) of the scale. Of the other groups only Medicine, with a mean score of 3.97, tended towards a neutral attitude; all others having mean scores within the favourable region of the scale.

The spread of attitude score was greatest with Agriculture and Medicine, and least with Arts and Veterinary Science. Science had a fairly wide spread, ranging from 2.0 to 6.5, but in fact only 10 per cent of these students had scores greater than 5.0.

Faculty	Number	Mean	Median	Standard Deviation	Range
Agriculture	22	5.35	5.38	2.04	2.4—9.3
Medicine	162	3.97	3.74	1.36	2.0—8.1
Science	60	3.42	2.98	1.13	2.0—6.5
Arts	10	3.40	3.50	1.02	2.1—5.5
Veterinary Science ..	19	3.34	3.63	1.03	2.2—5.2
All Faculties	273	3.90	3.58	1.43	2.0—9.3

Arts (Fig. 2) and Science (Fig. 3) students had extremely favourable attitudes, 40 per cent of Arts and 52 per cent of Science being within the range 2 to 3. The upper limits of the distributions were well within the neutral range of the scale but did not approach the unfavourable scores. Medicine (Fig. 4) and Veterinary Science (Fig. 3) were groups with large numbers of people with indifferent attitudes, almost no one with unfavourable attitudes, and nearly 60 per cent in the favourable range.

Faculty	Percentage of Students With Favourable Attitudes Scores 1-4	With Neutral Attitudes Scores 4-8	With Unfavourable Attitudes Scores 8-11
Agriculture	32	54	14
Medicine	56	43	1
Veterinary Science ..	58	42	0
Science	70	30	0
Arts	80	20	0
All Faculties	58	40	2

These results give a measure of attitude in each faculty group. Some explanation of the measured differences can be given as a result of close observation of student attitude in lecture-room and laboratory throughout the 1952 academic year. Students were observed in the course of their practical work and all students were questioned about their work. Teachers concluded that any differences in attitude could be explained by the freedom or otherwise of students to elect their courses of study, and by a student's concept of the use of Zoology to his future career. In other words, attitude was determined not so much by whether the student enjoyed the course, as by his estimate of its immediate and future value to a previously selected vocation.

Agriculture. The Faculty of Agriculture required all students to take Zoology I as a course in the second year. Most Agriculture students were irritated by Zoology and had a "superior," antagonistic view. They resented being placed in a class of first year students from other faculties, and adopted a contemptuous "beneath our dignity" attitude.

Because of this resentment, few students made any attempt to search for value in the subject. To most it was studied under compulsion and not from any choice. Many would have liked the subject withdrawn from the requirements of the faculty. For instance, in first year, entomology appeared as nothing but a study of the anatomy of the cockroach; animal physiology as a study of such details as the digestive enzymes of the frog, and nothing more. To these students, Zoology was remote, academic and useless.

Medicine. Students of Medicine and Veterinary Science had to take first courses in Botany, Zoology, Physics and Chemistry. Medical students found Zoology the most bearable of this series of barely tolerable subjects which they were compelled to pass before proceeding to the more interesting senior years. Zoology, with studies in anatomy, physiology, parasitology, embryology and genetics, was perhaps closer to medical study than any other first year subject.

However, large numbers of medical students were indifferent to Zoology. To them the subject was a necessary evil, to be passed over as quickly as possible. These students studied Zoology only because they had to pass an examination and not because of any real interest.

Some application of Zoology to future studies was seen by most medical students, but only the most obvious values were seen. Students were aware that skill in dissection would help them in later years, they saw the application of much detailed content such as studies of human parasites, the anatomy of the mammal, and vertebrate physiology, but most failed to see the application of general principles and skills to later studies. Nearly 40 per cent of medical students believed that Zoology would be of no practical value in their future training, and post-graduate careers.

Veterinary Science. This small group of enthusiastic students saw Zoology as a preliminary training for later studies in veterinary anatomy and physiology. But the Veterinary Science student had little interest in aspects of the work that were not immediately and obviously related to his future studies. Hence few had any positive attitude towards the lectures on evolution, while all were keenly interested in dissections. Animals such as *Obelia*, sea-star, crayfish and snail, which had no immediate significance in later work, were studied indifferently with little genuine

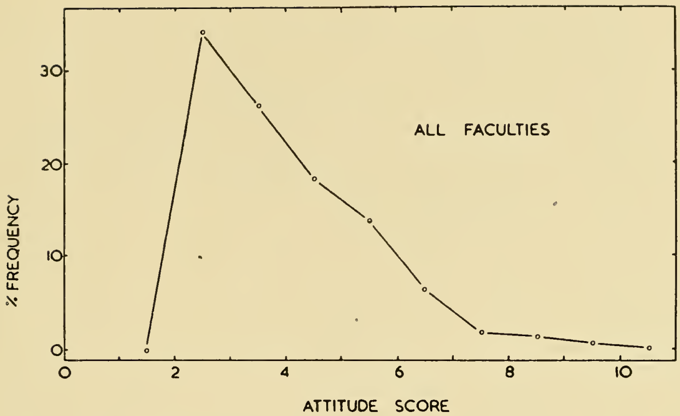


Fig. 1: The distribution of attitude scores of students in all faculties. The higher the score the more unfavourable the attitude.

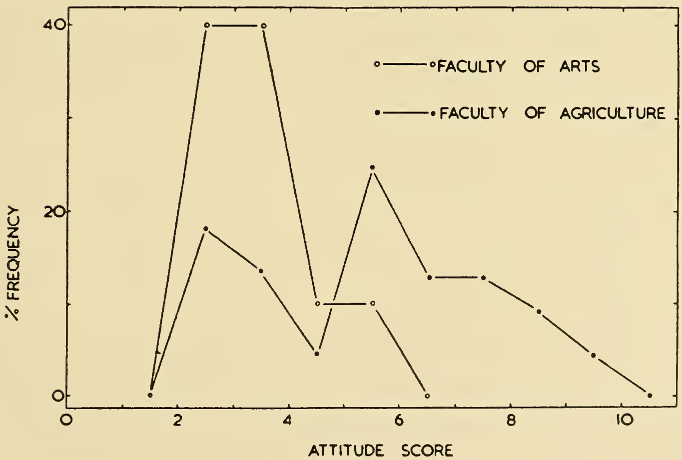


Fig. 2: The distribution of attitude scores of students in the faculties of Arts and Agriculture. The higher the score the more unfavourable the attitude.

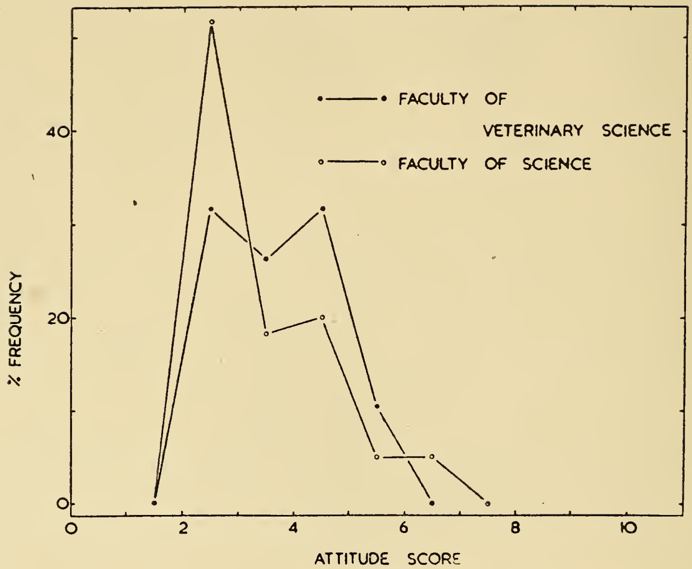


Fig. 3: The distribution of attitude scores of students in the faculties of Veterinary Science and Science. The higher the score the more unfavourable the attitude.

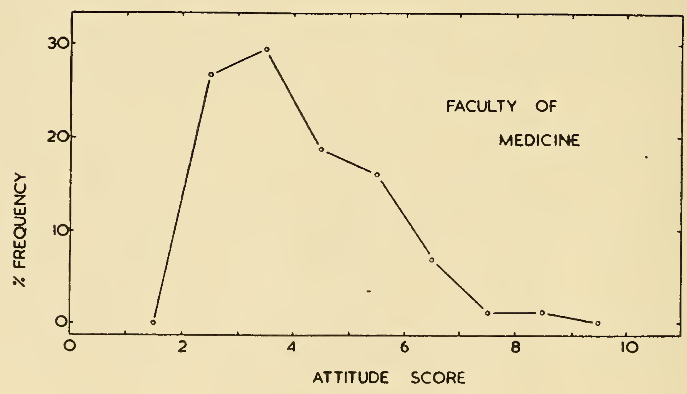


Fig. 4: The distribution of attitude scores of students in the Faculty of Medicine. The higher the score the more unfavourable the attitude.

interest. However, veterinary students were hard, steady workers, intensely interested in their future careers and prepared to work hard to gain their objectives, even where immediate interest was not necessarily high.

The Veterinary Science student, just as the Medical or Agricultural student, rarely saw beyond the similarity of content to the basic similarities of principle and method that would have been of more value to him. However, because Zoology I had so much factual material that would be useful in later years, the veterinary student was keen and interested in the course.

Arts and Science. Students of these faculties elected to take Zoology. Arts students had a very wide range of subjects from which to select and could undertake the course at any level of their undergraduate career. First year Science students selected Zoology as one of four subjects from a more limited range.

This free choice meant that students came to the course already favourably disposed towards Zoology. Even those Science students who had selected Zoology as their fourth subject and were primarily interested in Physics, Chemistry and Mathematics, at least preferred it to, say, Botany, Geology, Geography or a subject from the Faculty of Arts. Because of the even wider choice available to them, Arts students generally came to Zoology with more favourable attitudes than the Science students.

In these groups, vocational ambition had less influence on attitude than in the applied faculties. In many cases, students had no specific aims and had not planned beyond the first year examinations. They desired to graduate in Arts or Science and *then* think about employment.

These students evaluated Zoology on its own merits, and while not looking for extensions and applications of study to later courses, had some time to think about general principles. Hence they had highly favourable atittudes towards lectures on evolution, and were less interested in dissections than the Veterinary and Medical students. They approached all aspcts of the practical work with equal interest, and did not protest that they found the course too academic.

2. *Attitudes to Special Aspects of the Course.*

The statements on the attitude scale were written by selecting certain aspects of the course, such as reading, study, lectures on evolution, practical dissections etc., and constructing four or five statements about each so that they ranged from favourable through neutral to unfavourable. The questionnaire was built by random shuffling of all these statements. Thus by once more drawing together those statements about a given aspect and calculating the percentages of affirmative answers to each, some measure of attitude could be obtained towards a given aspect of the course.

ATTITUDE TO DISSECTIONS

		Percentage of Affirmative Answers in each Faculty				
Statement	Scale Value	Arts	Agriculture	Medicine	Science	Vet. Sc.
17	2.7	80.0	40.9	73.5	73.3	100.0
18	3.3	70.0	22.7	65.5	55.0	94.4
32	4.4	70.0	40.9	42.0	65.0	61.1
48	8.0	10.0	13.6	3.5	3.0	0.0
20	10.1	10.0	18.2	5.0	0.0	0.0

Science and Arts students were interested in dissection more as an instrument of investigation than as an end in itself, hence the different percentages for statements 17 and 18. They were aware that dissecting ability would help them to understand Zoology. Medical students on the other hand were interested in dissecting for its own sake. They wished to train for the dissections to come in the later years of human anatomy, and hence over 65 per cent agreed with statement 18. Only 42 per cent of medical students admitted that they liked dissections and found them difficult, whereas 65 per cent of Science students were prepared to admit that they found them hard.

Veterinary Science students had an extremely favourable attitude to dissections because of direct application to their under-graduate and post-graduate careers. They also had the more academic interest of the science student, and unlike most potential medicos, were interested in finding out details of animal structure.

Students of Agriculture were particularly unfavourably disposed towards dissections, and regarded dissecting skill as something quite irrelevant to their studies.

ATTITUDE TO LECTURES ON EVOLUTION

		Percentage of Affirmative Answers in each Faculty				
Statement	Scale Value	Arts	Agriculture	Medicine	Science	Vet. Sc.
37	1.3	100	45.5	61.0	81.7	55.6
39	2.0	30	4.5	19.5	33.3	11.1
41	7.3	0	36.4	15.0	11.7	22.2
24	8.7	0	22.7	13.5	10.0	27.8

Students in the "applied" faculties—Agriculture, Veterinary Science and Medicine—had less favourable attitudes to lectures on evolution than Arts and Science students. Lack of appreciation of the value of the principles of evolution was particularly noticeable with agricultural and veterinary students.

Statement 39 gave a fair measure of faculty differences. Over 33 per cent of Science, 30 per cent of Arts, 20 per cent of Medicine, 11 per cent of Veterinary Science and 4 per cent of Agriculture agreed that the theory of evolution was the most interesting concept they had studied at the University.

The Zoology course had failed to give the trainee agriculturalist and veterinarian any appreciation of the practical value of a knowledge of the principles of evolution.

ATTITUDE TO SUBJECT PREFERENCE

		Percentage of Affirmative Answers in each Faculty				
Statement	Scale Value	Arts	Agriculture	Medicine	Science	Vet. Sc.
40	1.7	50.0	0.0	60.0	35.0	55.6
31	2.5	30.0	9.9	11.0	11.7	5.6
4	6.7	50.0	22.7	36.0	13.3	44.4
43	10.3	0.0	18.2	4.0	3.3	0.0
50	10.4	0.0	31.8	6.5	0.0	0.0

Zoology was the least popular University subject with 18 per cent of students in Agriculture, 4 per cent in Medicine, 3 per cent in Science and no one in Arts or Veterinary Science; and the most popular with 60 per cent of students in Medicine, 56 per cent in Veterinary Science, 50 per cent in Arts, 35 per cent in Science and no one in Agriculture.

Agriculture students had studied twelve courses in two years, and many believed Zoology to be the least relevant of the twelve. Science students usually selected Zoology as their fourth subject, and were chiefly interested in other subjects such as Physics, Chemistry and Mathematics. This preference was probably related to previous school training; most were boys and had had no training in Biology. Arts students also had primary interests elsewhere—with the humanities—but the group was interested in Zoology largely because of school training in Biology. Nearly all Arts students in Zoology were girls, and secondary school Biology at this time was almost entirely confined to girls' schools. First preference was given to Zoology by 50 per cent of these Arts pupils.

A large percentage of Veterinary Science and Medical students gave Zoology first preference because it was the most immediately relevant of the four subjects they were compelled to attend.

ATTITUDE TO READING AND STUDY IN ZOOLOGY

Attitude to Reading

Statement	Scale Value	Percentage of Affirmative Answers in each Faculty				
		Arts	Agriculture	Medicine	Science	Vet. Sc.
36	1.3	10.0	0.0	20.0	8.3	16.7
35	6.8	10.0	4.5	13.5	5.0	0.0
6	7.7	20.0	27.3	9.5	8.3	5.6
38	8.5	20.0	18.2	3.5	3.3	5.6
13	10.5	0.0	9.9	6.0	1.7	0.0

Attitude to Study

Statement	Scale Value	Percentage of Affirmative Answers in each Faculty				
		Arts	Agriculture	Medicine	Science	Vet. Sc.
8	1.5	10.0	4.5	25.5	10.0	16.7
10	9.5	20.0	59.1	30.0	13.3	33.3
42	10.2	0.0	18.2	3.0	1.7	0.0
28	10.4	0.0	9.9	1.5	1.7	0.0

In general, the above tables show that a great many students did little reading and study in Zoology until just prior to the examinations. Some faculty groups were more conscientious than others, and once again it was the Agriculture group which had the least favourable attitude. Ten per cent of Agriculture admitted to having read nothing in Zoology at any time during the year, and were so bored by the subject that they couldn't force themselves to study. No one in Agriculture had read outside the scope of the course. Remembering that the questionnaire was issued in the last week of third term, it was disturbing that over 18 per cent of Agriculture had left all intended preparation until one week before the examinations, and that another 10 per cent did not intend to prepare for the examination at all.

Other faculties were indifferent, and none showed adequate interest in reading and studying the subject. Even the more favourably disposed groups were cautious in their response. Only 17 per cent of Veterinary Science, 10 per cent of Arts, and 10 per cent of Science agreed that they spent most of their study time in Zoology.

Medical students studied hard, 20 per cent claiming that they spent more study time in Zoology than other subjects and 30 per cent that they studied Zoology because they wanted to pass the examination and not because of interest in the subject as such. This interest in study was commonly due to a fear of failure in the final examination. This fear was very real to the medical student. His faculty imposed a much more severe and restrictive system of granting deferred examinations than other faculties.

ATTITUDE TO THE PRACTICAL VALUE OF THE ZOOLOGY COURSE

Statement	Scale Value	Percentage of Affirmative Answers in each Faculty				
		Arts	Agriculture	Medicine	Science	Vet. Sc.
14	0.7	10.0	0.0	0.0	5.0	5.6
27	2.3	20.0	4.5	27.5	15.0	33.3
19	4.0	50.0	18.2	39.0	45.0	33.3
21	5.3	70.0	59.1	66.0	60.0	88.9
12	10.5	0.0	27.3	2.0	0.0	0.0

Only Agriculture and Medicine had students with completely unfavourable attitudes, 27 per cent of Agriculture and 2 per cent of Medicine agreeing that the course had been a complete waste of time.

Most students believed the subject would be of some value in their post-graduate careers; even 50 per cent of Agriculture believed this. A small number of people wished to major in Zoology; those in the applied faculties probably in specialised aspects of the subject, such as parasitology or agricultural entomology.

Very few students desired to become professional Zoologists. The 6 per cent of Veterinary students probably aimed at research work in applied zoology. Only one Arts and three Science students had any ambition to make careers of Zoology. This lack of trainee zoologists was probably due to student ignorance of the economic possibilities of the subject, and a lack of employer publicity. This problem has been discussed in some detail by Murray (1954).

(vi) CONCLUSIONS

It is possible to draw up a type of "balance sheet" of attitude. The following trends were obvious:—

"Credit"

1. An appreciation of factual material that would be useful in later years. Especially in the applied faculties.
2. An interest in discovering how animals function.
3. Arts and Science students were interested to learn the elements of Biology for general interest or as background to other sciences.

"Debit"

1. A lack of appreciation of basic biological principles, particularly noticeable in attitude towards the lectures on evolution.
2. A general apathy towards study. Too many people read only to ensure examination success.
3. Resistance to classical methods of descriptive morphology. Many students found anatomy dull, uninteresting and lacking application to future needs.
4. A disastrous absence of an ambition to make a career of Zoology, either directly or indirectly.

These conclusions give some direction to the design of syllabuses for elementary tertiary Zoology. If such courses are to hold student interest and create favourable attitudes, their design and administration should be carefully prescribed.

1. Lecure and practical courses should teach only sufficient factual information for an understanding of basic zoological principles and methods. Masses of factual detail, taught as "facts for facts' sake" should *not* be introduced.

2. The course should be dynamic. The frontiers of advancing research should be made known to students and some basic research problems discussed in detail.

3. The various prevocational groups should be given a basic course. There should be no vocational specialisation at this elementary level. The varied vocational interests should be brought together in an understanding of basic principles and methods rather than separated by different emphases on factual detail.

4. Experimental work should be a major feature of an elementary course in Zoology. Dissection skill for instance has more value if acquired as the result of solving some definite problem. Dissections undertaken as a means of solving some precise problem in physiology or behaviour have more significance than dissections for "their own sake."

5. Whenever possible living or freshly killed animals should be used in the laboratory. Preserved specimens should appear only when the fresh material is absolutely unobtainable.

An obvious extension is to make a feature of field work.

6. There should be a system of term examinations to evaluate teaching efficiency. These examinations should include tests of attitude and understanding of basic principles rather than the ability to memorise factual detail.

7. The course should be administered so that reading and study are essential features of the programme. Thus most of the work should be presented in the form of projects.

8. The course should be made real by an emphasis on the role of Zoology in our society, its place in the economy of the country and its contributions to human welfare.

REFERENCES

Jordan, D.—"The Attitude of Central School Pupils to certain school subjects, and the correlation between attitude and attainment." *Brit. J. Educ. Psychol.*, 1941, Vol. II, pt. 1, pp. 28-44.

McNemar, Q.—"Opinion Attitude Methodology." *Psychol. Bull.*, 1946, Vol. 43, pp. 289-374.

Murray, P. D. F.—"The Position of Biological Science in School and University." *Forum of Education*, 1954, Vol. 12, pp. 121-124.

Thurstone, L. L., Chave, E. J.—*The Measurement of Attitude*, 1929, Chicago: University Press.

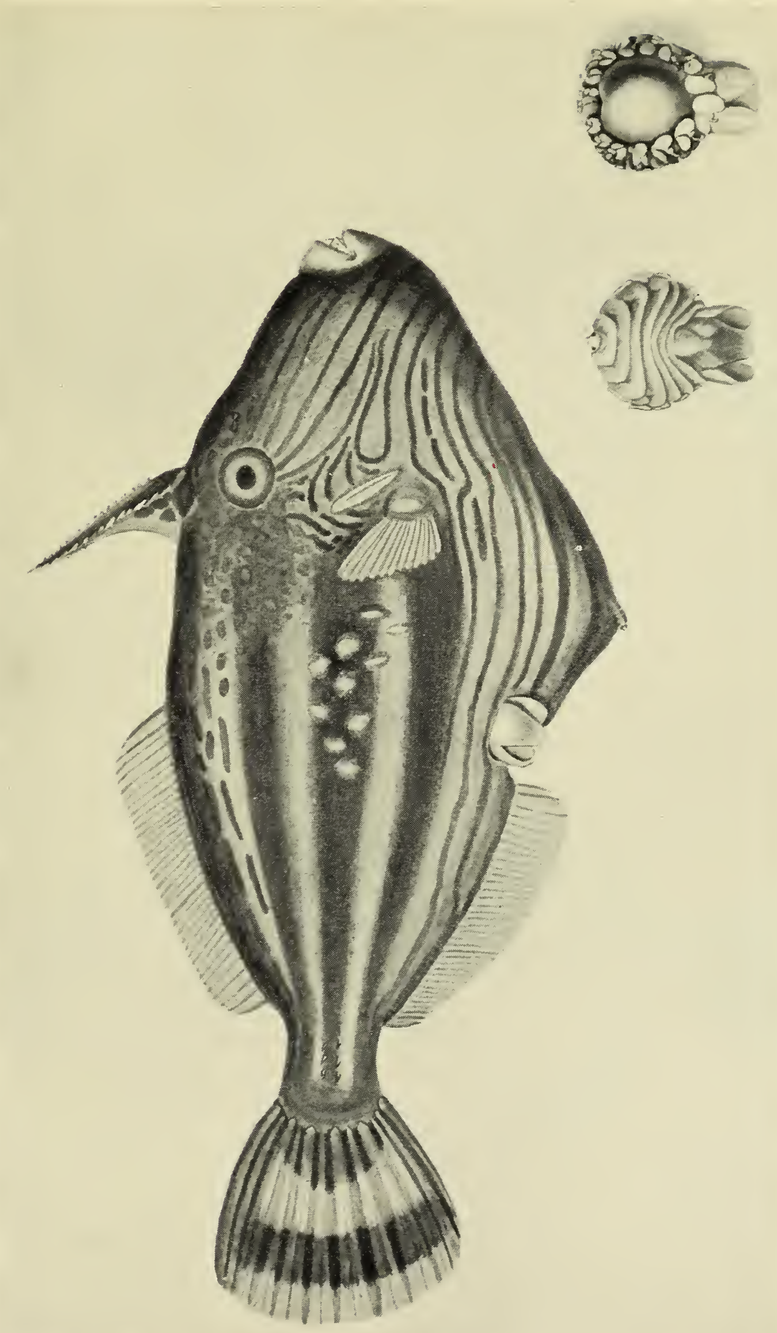
Thurstone, L. L.—"Theory of Attitude Measurement." *Psychol. Rev.*, 1929, Vol. 36, pp. 222-241.

Wang, C. K. A.—"Suggested Criteria for Writing Attitude Statements," *J. Soc. Psychol.*, Aug., 1932, pp. 367-373.

Froriep and Lamarck

By TOM IREDALE.

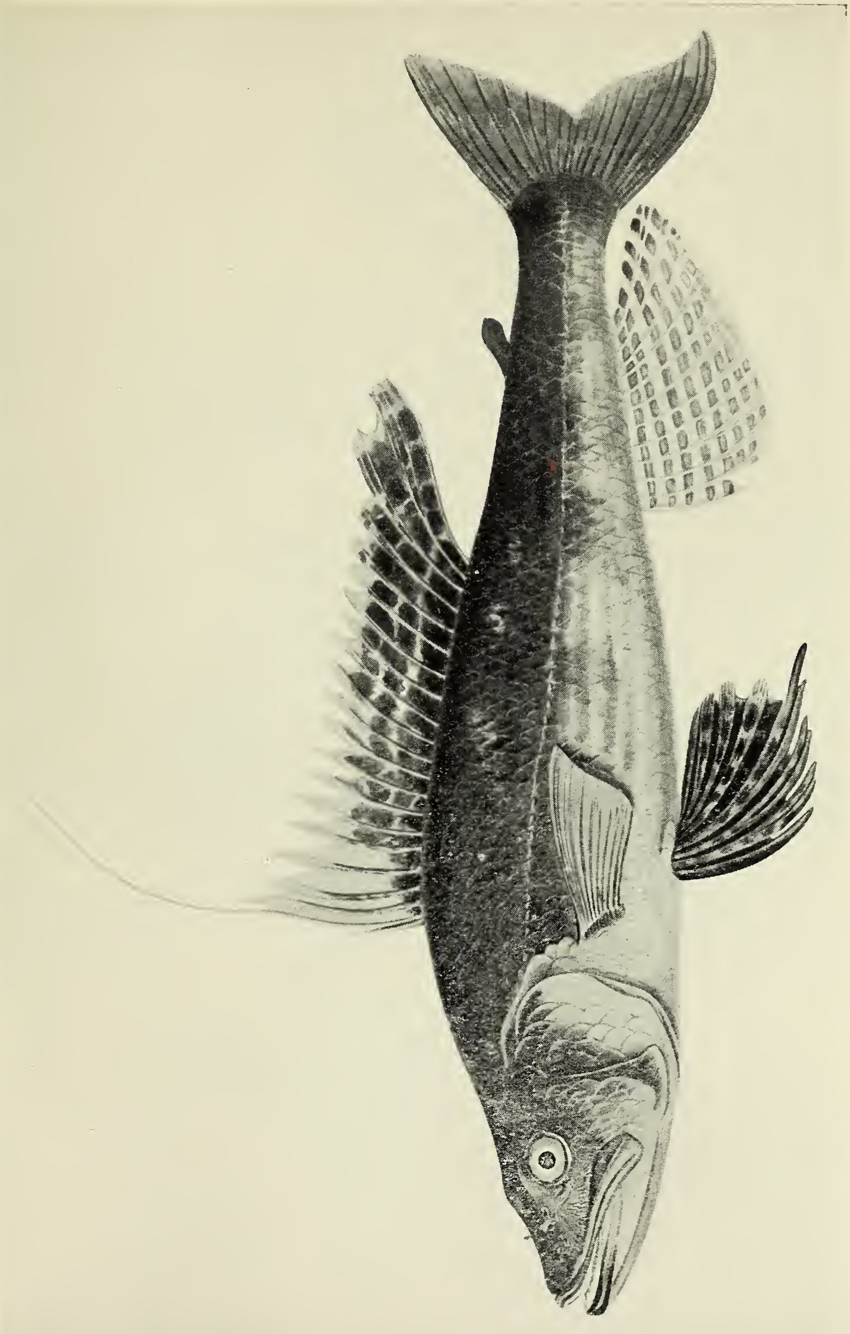
Reference to the Proceedings of the Malacological Society of London (Vol. XII, pp. 79-84, 1916) will show some notes on Dumeril's Zoologie Analytique, and a German translation by Froriep, which seemed important on account of some emendations. Long after the Proceedings were published, I noticed in an advertisement in Froriep's Notizen for 1831, an advertisement of a translation by Froriep of Lamarck's Systeme, which has apparently been overlooked by most commentators. It was not in the British Museum (Natural History) Library Catalogue, and not recorded by Sherborn. Over twenty years passed before I was able to secure a copy, and therefrom record its unimportance. Lamarck first issued a list of Molluscan genera with descriptions and examples in a paper in 1799, and later followed with a slightly enlarged edition, as a book, with the title "Systeme des Animaux sans Vertebres" in 1801, of which there are two or three prints, fide Sherborn. This book, with an opening essay, ran into 8+432 pages. Fortunately Froriep's translation is a very short account of some of the genera only. The title reads "J. B. Lamarck's . . . Neues System der Conchyliologie. Aus dem Franzosischen von Dr. L. F. Froriep, Professor zu Halle. Mit einer Kupfertafel. Weimar. 1807." It contains only 10+52 pages, and after a brief introduction, numbers the genera included by Lamarck, only of the shelled forms, including Foraminifera, Brachiopods and Barnacles. There does not appear to be anything novel in it, except the incorporation of genera proposed by Lamarck after the publication of the Systeme, such as *Delphinula, Phasianella* and *Amphibulima.*



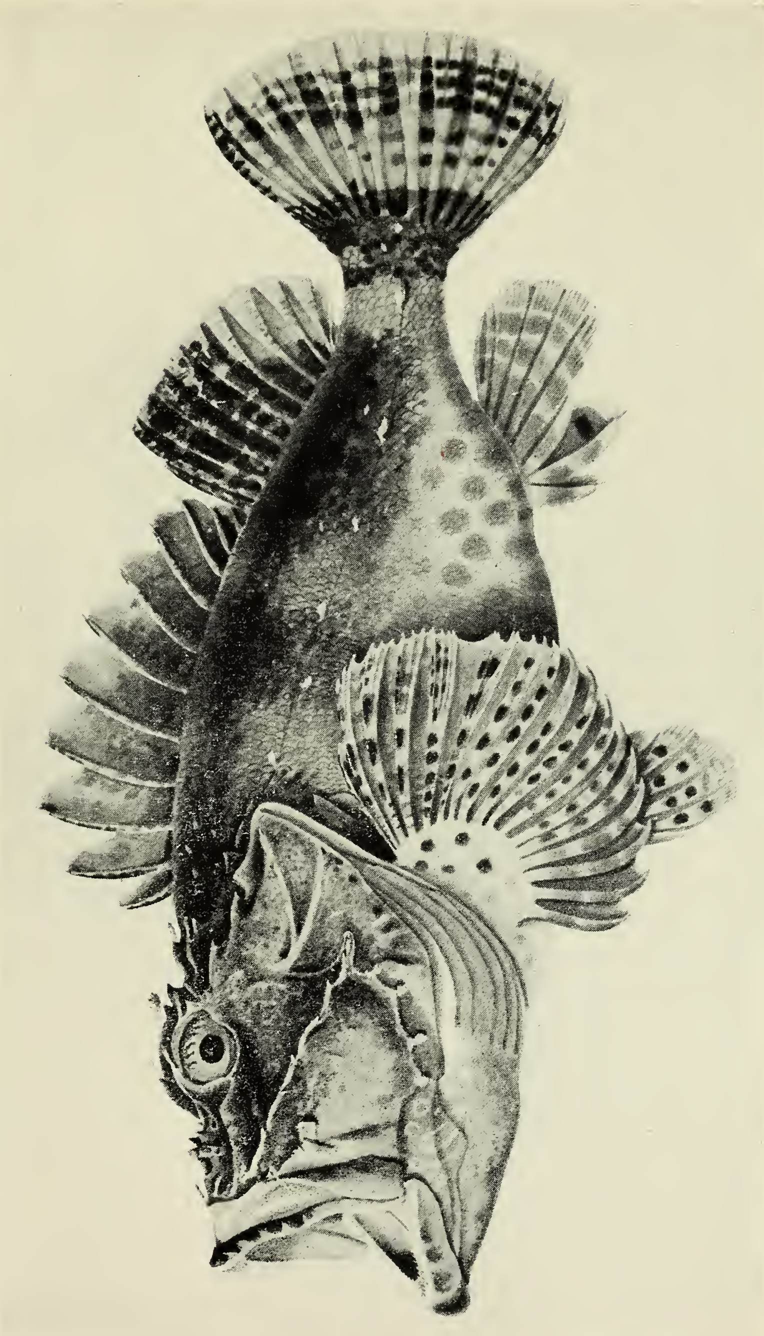
The Horseshoe Leatherjacket of Sydney, painted Nov. 3, 1841, with dorsal and ventral views of the crustacean fish-louse which can also be seen burrowing into the fish's body.

James Stuart painting No. 122.

Upper figure: A Leatherjacket from Sydney, 1841. James Stuart painting No. 121.
Lower figure: Silver Bream from New South Wales; Feb. 24, 1842. James Stuart painting No. 127.

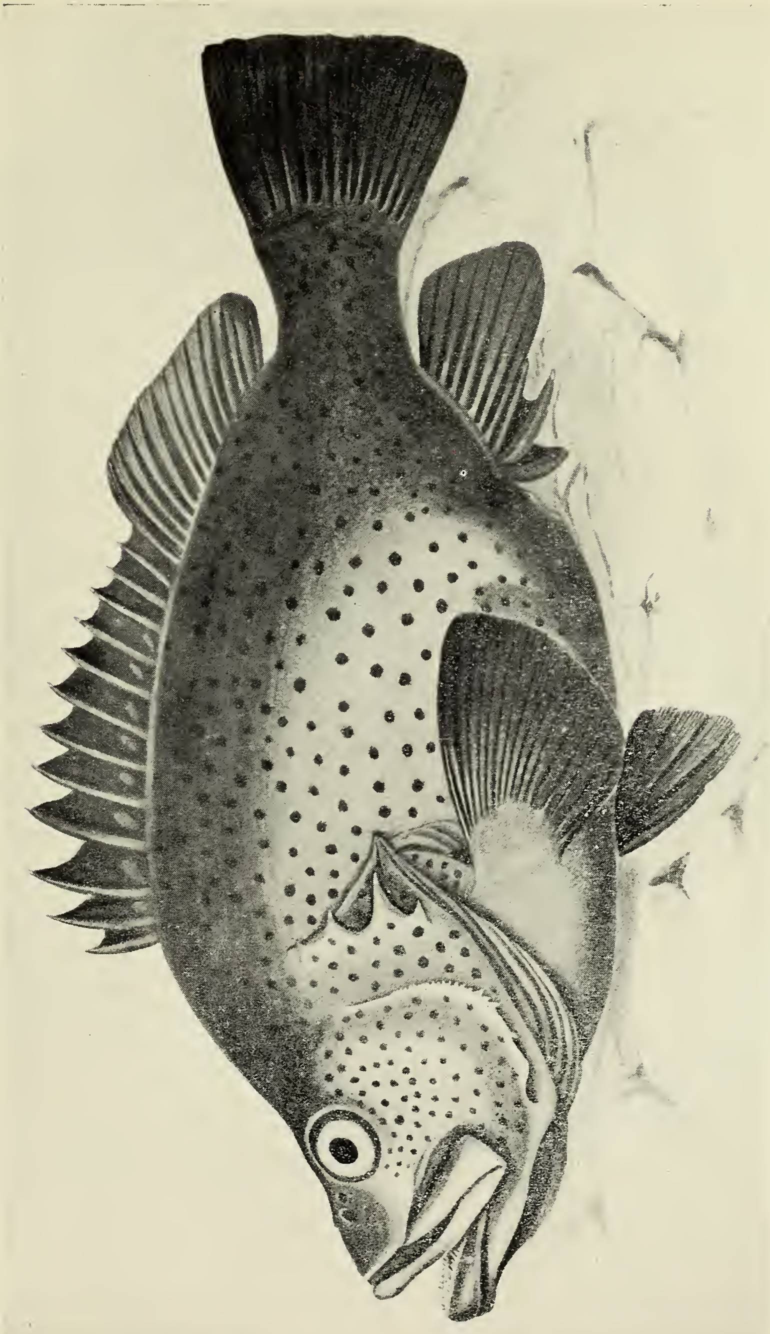


Adult male Sergeant Baker, Sydney; August 21, 1841.
James Stuart painting No. 148.



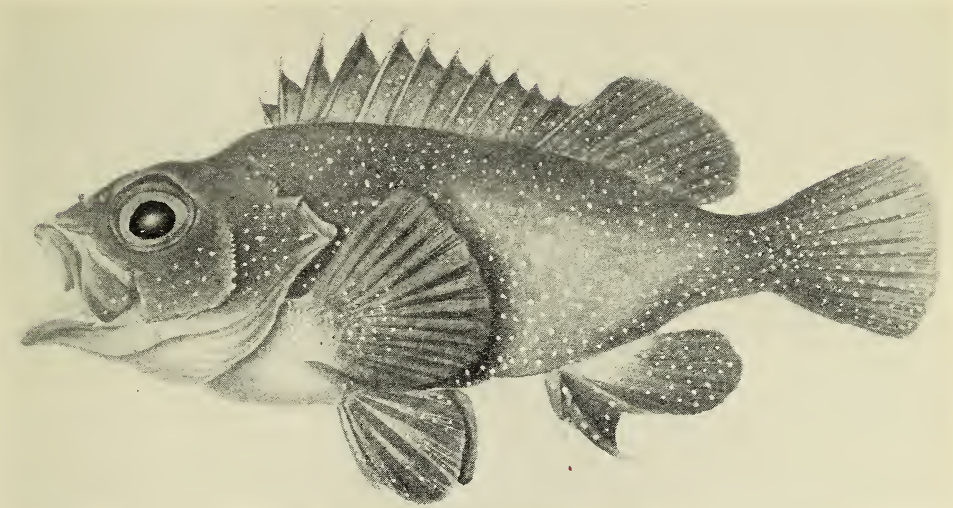
Red Rock Cod from Norfolk Island; May 26, 1839.

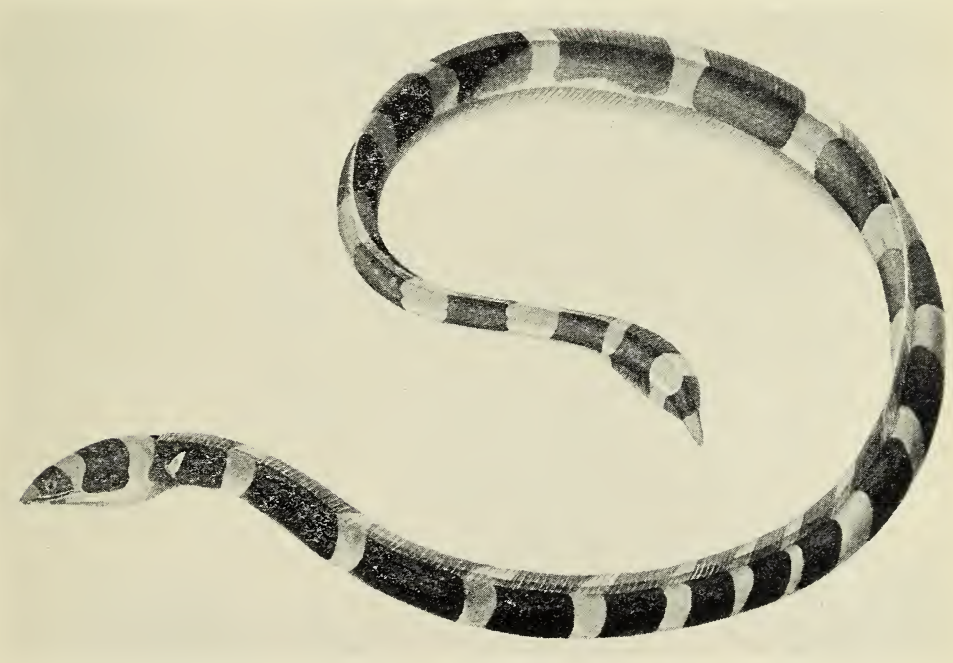
James Stuart painting No. 162.



The spotted variety of the Wirrah, probably from Sydney.

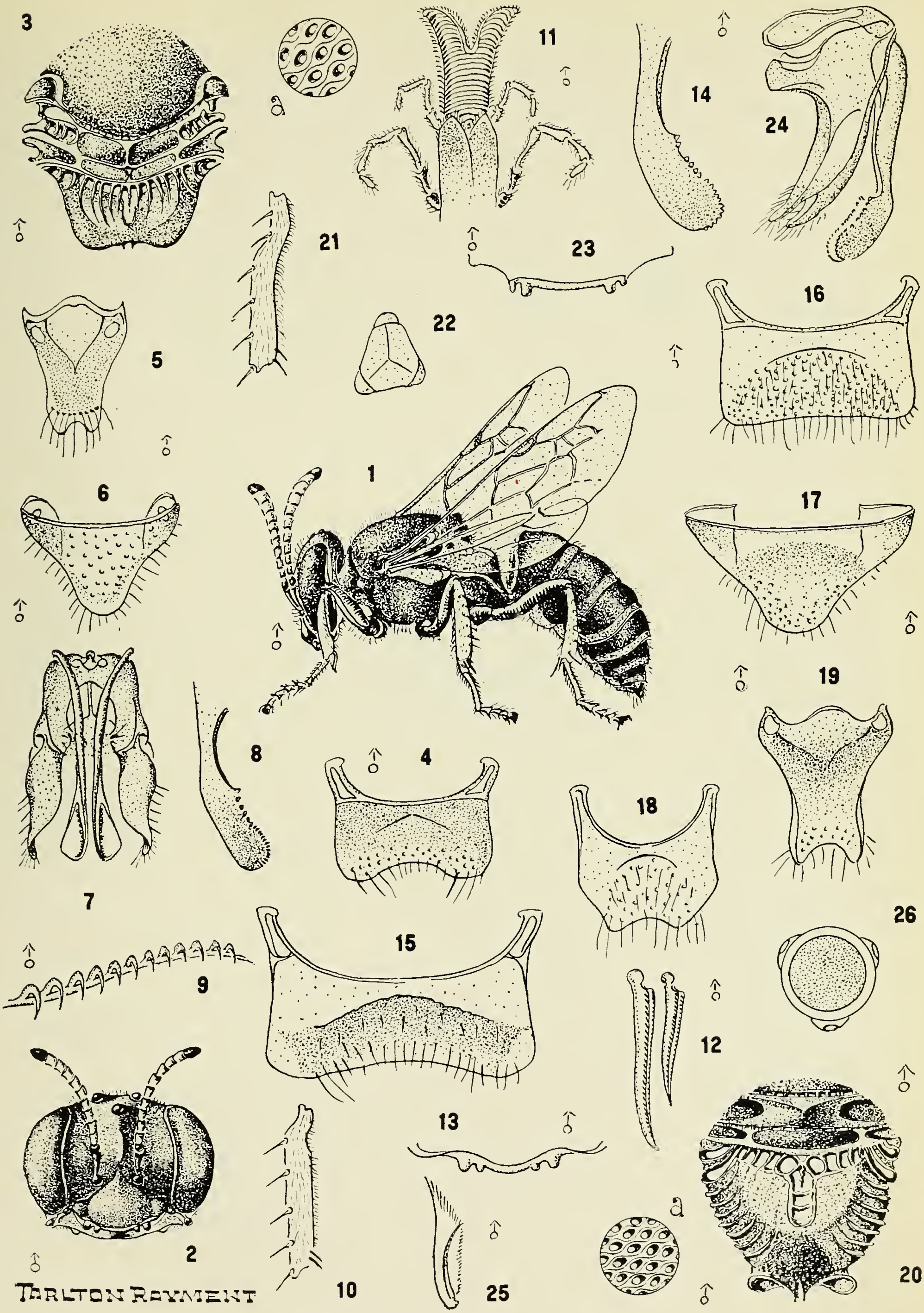
James Stuart painting No. 170.



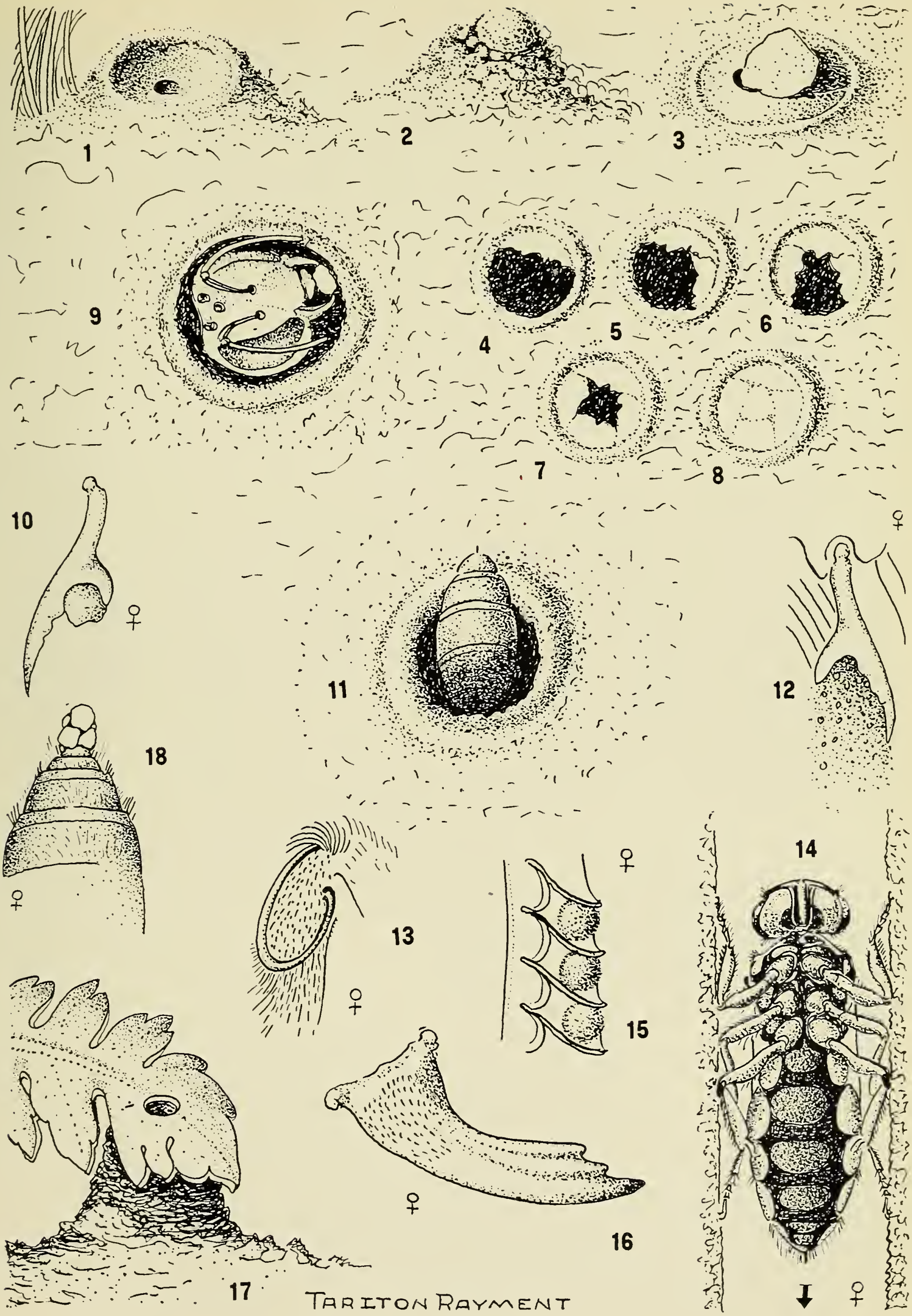


Upper figure: Pacific Perch from Norfolk Island; Feb. 17, 1839.
James Stuart painting No. 107.

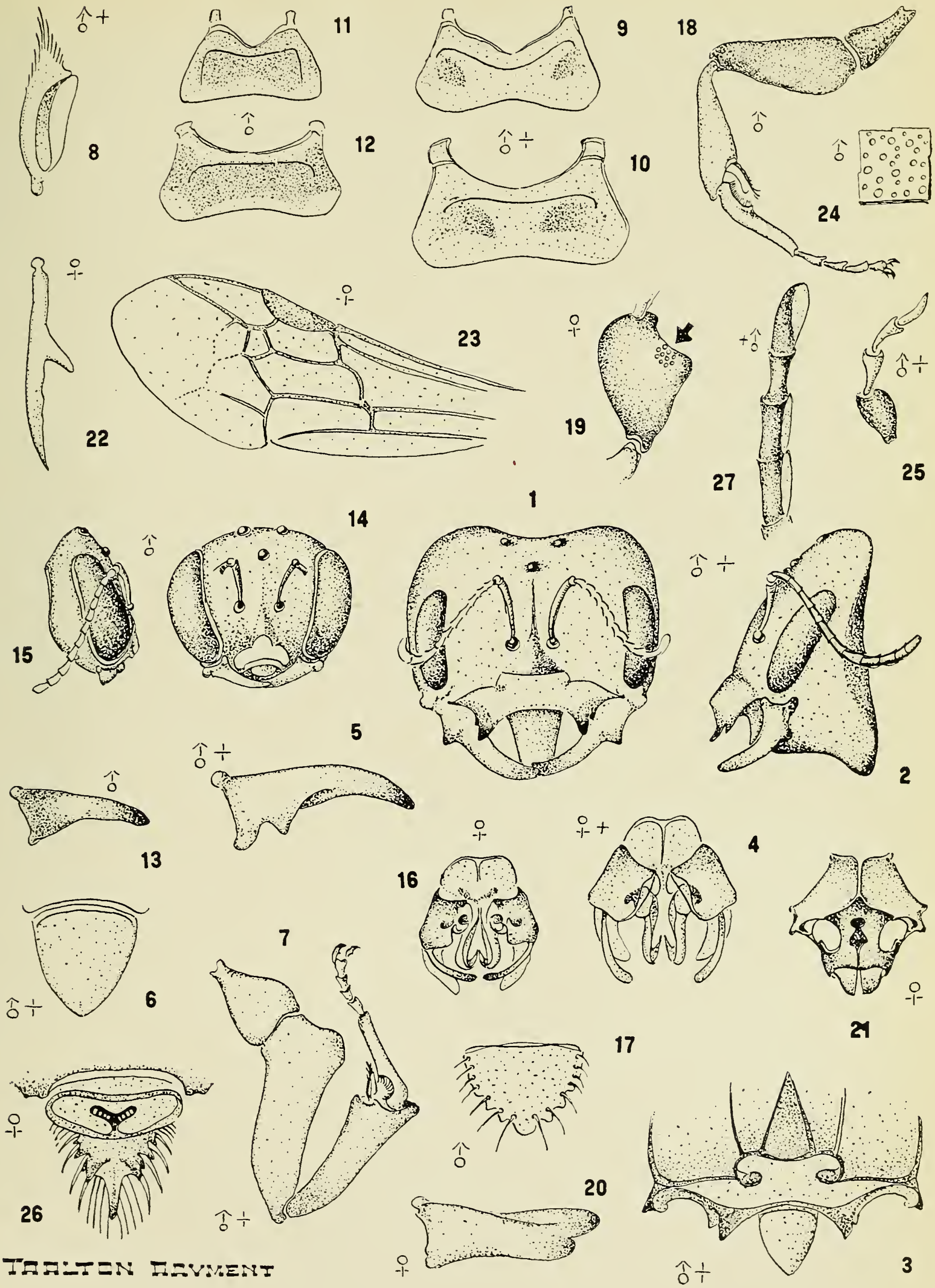
Lower figure: Snake Eel from Norfolk Island; May 3, 1839.
James Stuart painting No. 205.



Details of *Sericophorus* wasps.



Halictus dimorphus Rayment.



Details of male and mutation of *Halictus erythrurus* Cockerell.

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THE AUSTRALIAN ZOOLOGIST

Vol. XII. Part 3.

The Nomia australica Sm. Complex Its Taxonomy, Morphology and Biology With the Description of a New Mutillid Wasp

By TARLTON RAYMENT, F.R.Z.S.

Hon. Associate in Research, National Museum, Melbourne, Victoria.

(Plates xxiii-xxvi and Text-figures 1-6.)

The nomiine bees of Australia have been known to science for over 100 years, for the first species was described by Fred Smith, British Museum, in 1854, and he published 8 more descriptions in 1875, his best year of achievement. Subsequently T. D. A. Cockerell (1866-1948), Colorado University, U.S.A., added 36 species; Friese, circa 1909, described another 7, and the present author 6 more, so that the total number of species and subspecies is now 58.

Only one species, *Nomia submoerens* Ckll. has so far been recorded from Tasmania, and the genus must have reached the island before its separation from the mainland by the waters of Bass Strait, which now constitute an effective barrier to progress farther south. However, a close relative, *N. moerens ulongensis* Ckll. is found at Portland, Victoria, which looks over Bass Strait.

The genus *Nomia* Latr. is not endemic to Australia, for it is widely distributed over the Old World, but sensu stricto did not reach the New World, i.e. America. Michener(1) (1944) states that the American species resemble those of Australia, which "are as yet unplaced subgenerically in the curvature of the basal abscissa of vein M of the fore wing." In *Nomia*, sensu stricto, the basal vein is not arcuate, but in *Halictus* it is strongly arched.

It appears to have its origin in Asia, for the Malay Archipelago is rich in species, consequently, several of the nomiine bees of Northern Australia, such as *N. pulchribalteata austrovagans* Ckll. are close to *N. westwoodii* Grib., described from Bengal; also *N. formosa* Sm. from Celebes, and there is little doubt that this distribution indicates the New Guinea Passage by which the coloured species at least penetrated to Australia.

As recognised by present day systematists, the genus undoubtedly contains several diverse elements, and fourteen subgenera have been proposed for the Old World species. The present author would separate those Australian species having a fish-tailed process on the postscutellum, but defers the task until he is able to monograph the whole of the Subfamily.

A reference to Plate XXIII will show considerable differences in the form and the size of the posterior tibia and femur of the males, but as the sternal plates and genitalia in all of them do not have any distinctive characters, the author concludes that it is less confusing to regard *N. australica* as a highly variable species rather than separate an excessive number of subspecies. (See Plate XXVI, figs. 3 and 4.)

(1) Michener, C. D.; Comparative External Morphology, Phylogeny and a Classification of Bees. *Bull. Amer. Mus. Nat. Hist.* Vol. 82, p. 251, 1944.

Although there had been considerable research in the taxonomy of nomiine bees, yet no student had studied the biology of any Australian nomiine species until the present author published in the magazine Walkabout, his account of a strange little bee, *N. halictella* Ckll., from Northern Queensland, and which has the aspect of a small black and gold *Halictus*.

The morphology and architecture of the very much larger metallic *N. australica* Sm. are very different, and that alone is sufficient warrant for publication. The author's observations of these bees extend over 20 years, but as the bees are fossorial in habit, investigation is not easy, and opportunities are few when the colonies are so far distant.

Many specimens, and some observations, have been received from Owen Dawson, Clyde, Gippsland. Clifford Beauglehole, Gorae, Western Victoria, was most enthusiastic in his endeavours to confirm the observations of Dawson and the author. This correspondent is a member of the Portland Field Naturalists' Club, and has made many valuable contributions to our knowledge of the fauna and flora of his historic district.

The author's researches in the Hymenoptera of Australia are assisted with a small grant from the Trustees of the Commonwealth Science and Industry Endowment Fund. The high costs of printing have delayed the publication of this paper for several years.

TAXONOMIC POSITION

DIVISION ANDRENIFORMES

Family ANDRENIDAE

Subfamily NOMIINAE

Genus *Nomia Latr.*

(Hist. Nat., xiii, p. 369, 1805.)

Nomia australica Sm.

(Trans. Ent. Soc. Lond., p. 60, 1875.)

Nomia australica Ckll.

(Bees of Australia, Aust. Zool., Vol. vii, p. 46, 1931.)

Sub. *regis* Ckll.

(Trans. Amer. Ent. Soc. xxxvi, p. 221, 1910.)

Sub. *reginae* Ckll.

(Entomologist, p. 221, 1905.)

Nomia australica Raym.

(A Cluster of Bees, p. 230, 1935.)

Nomia miranda Raym.

(Aust. Zool., Vol. xii, Part I, p. 55, Mar., 1954.)

GROSS MORPHOLOGY

N. australica Sm. and the several allies discussed in this paper are beautiful robust hairy bees, about 12 mm. in length, with a shining black head and thorax, and abdomen of dull metallic blue or shining bright-green ornamented with two or three broad faciae of yellow, reddish-gold or even white hair.

The small head-capsule is almost circular from the front, and unlike that of *Megachile*. does not bear any characters of much specific value. The sculpture of the face is usually masked by much hair, and in typical specimens of *N. australica*, the tegument of the anterior half of the clypeus, and also the entire slender scapes, are amber-coloured. These portions are black in the subspecies *reginae*. The flagellum in all is submoniliform; longer in the males with thirteen segments. Mandibulae bidentate in females, but acute in males.

The glossa is dagger-shaped; there are four segments in the labial palpus and six in the maxillary; the pharyngeal pores are only of medium development; labrum a long narrow oval with a fringe of stiff setae.

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Prothorax small and closely adapted to the mesothorax, which carries few specific characters apart from the vestiture and sculpture of the integument; tegulae large, and the postscutellum of certain nomiine bees bears a long bifid process, or even a pair of spines, and those species may be referred to the subgenus *Hoplonomia* Ashmead. The metathorax is shorter than *Halictus*, and has a number of coarse rugae much shorter than *Halictus*.

The abdomen is rarely clavate, and apart from the sculpture of the integument and faciae, possesses few specific characters in females, but the apical sterna of males are often of such remarkable structure as almost to defeat intelligible description.

The abdominal faciae show considerable variation in number and colour. In Croydon, Victoria, specimens (identified by Prof. Cockerell as typical) the bands are bright ferruginious, and three in number. Meningie, S.A., females have two only of golden colour; Katherine, N.T., three of pale-straw colour; Gunbower, Victoria, has a scanty white fringe on segments one and two; three, four and five with straw-colour faciae; Gorae, Victoria, has three faciae of golden-yellow with much white hair laterally, which extends to the bands on segments one and two; type of subsp. *regis* has the white abdominal faciae slightly tinted with yellow.

The legs are usually stout in females, and bear dense scopae on the posterior trochanters, femora, tibiae and tarsi; the posterior femora and tibiae of the males are often crassate and angulated, and so form good specific characters.

The form of the strigilis of the anterior leg is of generic, but not specific value the subquadrate velum being large and developed to an acute angle apically; the malus has a number of coarse teeth; the posterior calcar, too, has several coarse serrations, which are not so large as those of *Halictus*.

The scutellar sutures on Clyde bees are quite nude, but on others there is a line of white hair extending as two maculae onto the mesothorax, with the postscutellum entirely covered; on certain others the postscutellum has yellow hair.

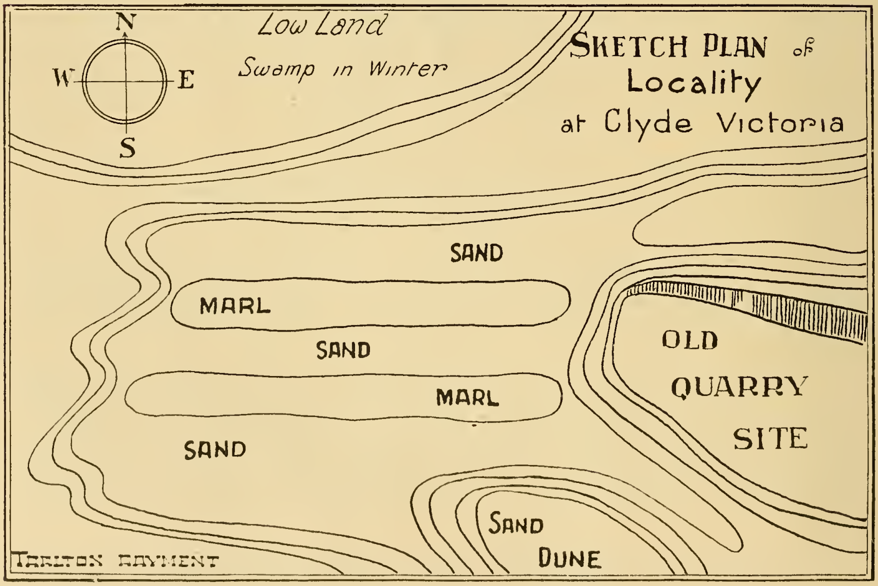

Fig. 1: Sketch Plan of Locality of nomiine colony at Clyde, Victoria.

Fig. 2: Plan of the nomiine colony at Clyde showing concentration of the shafts.

The venation of the wings is of generic, but slight specific value, with three cubital cells, the first and third subequal, the second small and quadrate; radial cell obstusely rounded on the costa, and the basal nervure arcuate in many species, but straight in *Nomia* sensu stricto. Hamuli 12 or so, well-developed.

DISTRIBUTION

The type of *Nomia australica* Sm. was described from Adelaide, S. Australia, but the species is widely distributed, for it has been recorded from Brisbane, Townsville, Stradbroke and Bribie Islands, and Mackay, Q.; Melbourne, V.; Swan River, W.A.

Microscopical dissection of 200 males and females, collected in several states, placed the systematist in the difficult position of having either to separate large numbers of subspecies—and even races—or else conclude that *Nomia australica* is a highly variable species. The author finally adopted the latter concept.

The student might at first feel inclined to refer all females with a black clypeus and antennae, and much white hair, to Cockerell's subspecies *reginae*, and the present author would have agreed had he not found both forms present in a colony at Clyde, Victoria; one, however, burrows in sand, the other in marl. Mutation is, perhaps, the explanation of this phenomenon.

Typical specimens of the species have the anterior half of the clypeus, and also the scapes, yellowish-amber, with the face covered with much fox-red hair, but numerous individuals from other localities are annectant between these two forms; some having the amber clypeus but much white hair on the face; others have red hair and a black clypeus; a few have the clypeus practically nude. Cockerell had noted the black clypeus on certain bees but did not comment on it.

The blue-bodied specimens from Gunbower, Victoria, with pale-coloured hair on the face would have been referred to the subspecies *regis* Ckll. had not the author found other males and females with a black clypeus and antennae in the same colony.

Difference in the sterna and genitalia are more marked in *N. miranda* Raym. and this has, perhaps, the best claims for separation. The tibia and femora of other males vary considerably in form and size, as will be seen from Plate XXIII, but despite these differences, the author believes it is less confusing to have one variable species rather than a multitude of subspecies.

NEW RECORDS

Two females, typical in all characters.
Alexandra, Victoria, leg. J. Urquart.

One female, not typical, but approaching *reginae* Ckll.
Glen Wills, Victoria, 21 Feb. 1952, leg A. N. Burns, per Nat. Mus. Vic.

One female, typical in all characters.
Croydon, Victoria, 1909, leg. Fulton.

A series of females with one male, but typical in all characters.
Croydon, Victoria, Jan. 1933, leg. Rayment.

On flowers of *Leptospermum scoparium.*

One female, not typical, having white hair on face, but half of clypeus and basal half of scapes reddish. This specimen approaches the subspecies *reginae* Ckll.
Ferntree Gully, Victoria, leg. J. E. Dixon.

A series of blue males and females, not typical, having black scapes.
Gunbower, Victoria, 10th Feb., 1933, leg. Rayment and E. Ferris.

Two males approaching *reginae* having white hair on face, but anterior margins of clypeus amber, scapes black, but other specimens have fulvous scapes, with black posterior margins on the abdominal terga.
Meningie, S.A., leg. Hans Minchin.

One female, not typical, having a purple abdomen and white hair on face; clypeus red and scapes black.
Bolgart, W. Australia, 12th Jan. 1950, leg. Rica Erickson.

Females, two, not typical, face being practically nude; scapes and clypeus black, but flagellum light-red beneath.

Donnybrook, W.A., Jan., leg. L. J. Newman.

Females, a long series from "nests," having black clypeus and scapes, but much red hair on face. Another long series of females, with red clypeus and scapes, mesothorax more shining, with fewer punctures.

Clyde, Victoria, 12th Nov. 1944 and 10th Dec. 1944-45, leg. Owen Dawson.

One female, typical in all characters.
Sutherland, N.S.W., 16th Dec. 1951, leg. Alex. Holmes.
Taken on flowers of *Angophora cordifolia.*

One female, typical in all characters.
Wannon, Victoria, 20th Oct. 1949, leg. "B.G." per A. N. Burns.

One female, typical in all characters.
Kangaroo Is., S.A., 4th Dec. 1945, leg. "F.A." per A. N. Burns.

A long series of both males and females not quite typical in all characters.
Bats Ridges, Portland, Victoria, 10th Feb. 1951, leg. C. Beauglehole.
Taken on flowers of *Leucopogon parvifolius,* and *Eucalyptus viminalis,* 19th Nov. 1952.

One female, approaching *N. australica regis.*
Portland, Victoria, Jan. 1950-51, leg. C. Beauglehole.

A series of females; with only two abdominal faciae of dull colour as in *regis.*
Bunbury, W.A., 18th Feb., 1954, leg. A. Snell.
Taken on flowers of *Eucalyptus calophylla.*

A more robust female, with much white hair on face, head not so wide, clypeus with a reddish suffusion, and carina more evident; fulvous

hair on postscutellum; first recurrent nervure meeting second intercubitus.
Bolgart, W.A., 12th Jan., 1950, leg. Rica Erickson.

Three larger, more robust females, approaching *reginae* Ckll. Compared with the Bolgart specimens, these have wider "faces," black clypeus, and white hair on postscutellum; first recurrent nervure received well inside the second cubital cell.
Kangaroo Is., S. Australia, 1954, leg. George A. Lonzar, Ranger. (At "nests" in the ground.)

Two females, indistinguishable from S.A. specimens above; they approach the subspecies *regis* Ckll.
Donnybrook and Dowerin, W.A., leg. L. J. Newman.

A long series of typical females.
Donnybrook, W.A., 21st May 1954, leg. Alfred Snell.

One typical female.
National Park, Perth, W.A., 10th Nov. 1954, leg. "A.B." per W.A. Museum.

One male, with peculiar sternal structures. Type of *Nomia miranda* Raym.
Jamberoo, N.S.W., leg. Norman Rodd.

One not typical male (from a high altitude).
Mt. Donnabuang, Victoria, 5th Feb., 1955, leg. A. Neeboice.

One male, not typical, having large sternal teeth.
Gunbower, Victoria, 3rd March, 1933, leg. Rayment.

One male typical.
Harvey, W.A., leg. L. J. Newman.

A series of males conforming with the description of *regis*, but with two white maculae of hair on scutellar suture.
Katherine, Northern Territory, 10th Mar. 1946, leg. Corp. Shimmin, A.I.F.

One very large robust female.
Alexandra, Victoria, 6th Dec. 1954, leg. A. Neeboice.

One female, much brighter in colour than type.
Bunbury, S.W. Corner, W.A., leg. W. A. Snell.

One female, only base of scape red, clypeus black, abdomen blue.
Gunbower, Victoria, 10th Feb. 1933, leg. Rayment.
On flowers of *Melaleuca pallida*.

One male, typical in all characters.
Cherrypool, Victoria, 24th Feb. 1948, leg. N. Walters.

A series of both sexes from the Murray River have only two coppery faciae, hair of face straw-colour, abdomen blue.
Gunbower, Victoria, 11th Nov. 1935, leg. Rayment.

A series of nine males, not typical.
Glen Wills, Victoria, 21st Feb. 1952, leg. A. N. Burns.

One female, typical in all characters.
Victoria Valley, Victoria, 26th Feb. 1949, leg. "B.G." per A. N. Burns.
Two females, typical in all characters.
Kerang, Victoria, 2nd April, 1948, leg. "E.T." per A. N. Burns.

One female, typical in all characters.
Moe, Victoria, 27th April, 1948, leg. F. E. Wilson.

Several males, not typical, being more slender, with three abdominal faciae, but tergites broadly ferruginous apically; clypeus black; scape black at base, and flagellum ferruginous; conforms with description of subspecies *regis*.
Edungalba, Queensland, 5th Nov. 1940, leg. E. E. Adams.
Taken on flowers of *Plectronia attenuata*.

A long series of males and females, not typical, having very dark-red hair on face; more shining on mesothorax; males with stouter red scapes and clypeus.
Lismore, N.S.W., 19th Jan. 1941, leg. Dudley Townley.

A series of females and males typical in all characters.
Inverell, N.S.W., Nov. 1935, leg. Clive Stephens.
Taken on flowers of *Carduus* sp.

A long series of typical males and females.
Busselton, W.A., 2nd April, 1954., leg. Alfred Snell.
Three males, larger and more robust than type.
Western Midlands, W.A., 1st April 1950, leg. "J.M." per W.A. Museum.
One male, not typical in all characters, the tibiae and femur modified.
Jindabyne, N.S.W., March 1889, leg. R. Helms.

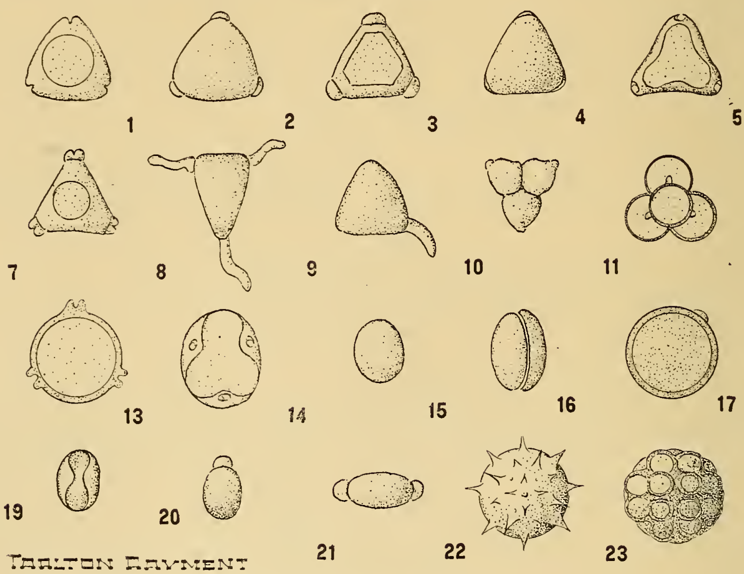

Fig. 3: Pollen grains.

1-4. Pollen-grains from myrtaceous species; *Eucalyptus*, *Melaleuca*, *Leptospermum*, etc.
5-6. From gum-tree *Eucalyptus pauciflora*, which grows about the sunklands of Western Port.
8-9. Were growing pollen-tubules, but could not be identified.
10. A tetrad, unidentified species.
11. Tetrad of a heath Epacridaceae.
12. Probably Leguminosae.
13. Unidentified species.
14. Unidentified species.
15. Unidentified species.
16. Garden rose (dry).
17. Same pollen-grain mounted in glycerine.
18. Unidentified species.
19. Leguminosae—probably *Platylobium* sp.
20. *Oxylobium ellipticum* var. *angustifolium*.
21. Unidentified species.
22. Composite species.
23. Leguminosae—*Acacia* (wattle).
24. Pollen-grains removed from stomodeum of a larva showed the nucleus clearly without staining.

SITES OF THE COLONIES

BATS RIDGES—The vegetation differs very conspicuously on the areas favoured by *Nomia* for the establishment of its very extensive colonies. In the west of the State, at Bats Ridges,(2) the site is located in a veritable wild-flower garden, surrounded by a forest growing on limestone (Miocene) ridges which are buried under a stratum of fine reddish sand, except where the stone outcrops on the surface.

The forest trees are brown stringybark, *Eucalyptus baxteri;* Gippsland mallee, *E. kitsoniana;* peppermint, *E. vitrea,* and manna gum, *E. viminalis;* with wattles, *Acacia sophorae,* and *A. melanoxylon,* and silver banksia, *Banksia marginata*

Throughout the forest are limited areas more or less clear of trees, but which nevertheless support a luxuriant growth of native plants, transforming such areas into wild-flower gardens of delightful beauty at the apex of the inflorescence.

There are several epacrids, *Acrotriche affinis.* and in swampy areas, *Sprengelia incarnata;* common heath, *Epacris impressa,* and *E. lanuginosa;* manuka, *Leptospermum scoparium; Bossiaea cinerea; Correa reflexa;* the coast beard-heath, *Leucopogon parviflorus; Astroloma humifusum;* silky guinea-flower, *Hibbertia sericea;* noon-flower or pig-face *Carpobrotus aequilaterale;* pink fairies, *Caladenia latifolia;* austral bugle, *Ajuga australis;* scented sundew, *Drosera whittakeri;* fan flower, *Scaevola microcarpa* var. *pallida; Exocarpus cupressiformis; Meuhlenbeckia adpressa; Clematis microphylla;* and *Helichrysum apiculatum.*

In addition to the above list, Clifford Beauglehole collected over 30 other species of very small plants growing in the luxuriant garden. All are diminutive, being only a few inches tall, but every one was in flower on 3rd October, 1954, and it will readily be appreciated that there is an ample supply of honey and pollen to support the extremely populous colony of bees. A moss, *Breutelia pendula,* common throughout the area is, of course, of no value to bees.

CLYDE, GIPPSLAND—The vegetation on this eastern site is very different from that on the west, and not nearly so luxuriant. The most conspicuous species is *Eucalyptus viminalis,* but which does not reach any great stature. Another eucalypt *E. pauciflora* which, belying its name, bears a wealth of nectariferous cream-coloured flowers. There are swampy areas of paper-barks, *Melaleuca ericifolia* and *M. squarosa,* while tea-tree thickets, *Leptospermum,* dominate the landscape. There are several terrestrial orchids, and in spring the golden flowers of *Oxylobium ellipticum* furnish a mass of vivid colour; several heaths are present, also a few smaller plants in the genera *Platylobium* and *Daviesia.*

There is wild parsnip, *Trachymene anisocarpa.* and in spring, the ubiquitous capeweed, *Crytostemma calendulaceum.* wanders over any grassy clearings; also several species of coarse spiny *Hakea.*

GUNBOWER ISLAND—An irrigation settlement on the River Murray, northern Victoria. The deep soil is the well-known fine red alluvial silt so typical of the great riverine valley, and which supports an extensive dairying industry allied with the cultivation of field lucerne, *Medicago sativa.*

The vegetation is not remarkable for the richness of its species, but is certainly renowned for its copious secretion of nectar. Along the waterways is the inevitable river red gum, *Eucalyptus camouldensis-rosirata.* and much grey box, *E. hemiphloia.* The few red sandhills are crowned with groups of symmetrical murray pines, *Callitris calcarata,* but these are, however, of little value to bees. On the lower levels are small but dense thickets of *Melaleuca* and *Callistemon.* The cultivated fields often carry many weeds, and also the indigenous grey germander *Teucrium racemosum* sought by bees. The valley is much warmer than the two southern districts, but the bees thrive equally well in all.

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(2) The name is due to the presence of a large colony of bats which inhabit the caves. There are several hundreds of the animals which form dark clusters, many feet in diameter, when at rest on the ceilings.

ARCHITECTURE

The damp earth is pared off by the serrated posterior calcar, and brought up to be heaved out carelessly on the surface, so that a tumulus forms about the mouth of the shaft. The moundlets are most evident at new shafts, but the "spoil" soon dries, and then is quickly dispersed by wind

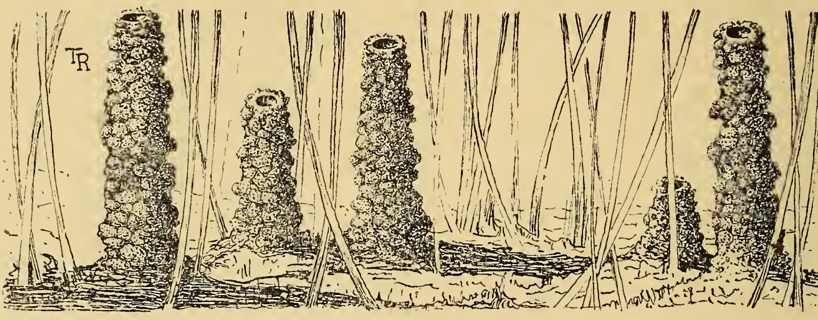

Fig. 4: The "Chimney pots" of *Nomia halictella* Ckll. are built among the grass and sugar cane of Queensland.

and rain. The old shafts may be recognised by the mere clean hole at ground level.

The shafts usually have an "ante-room" excavated at about the 5 cm. level, and the "guard" bee on duty at the door retires into it when the shaft has to be cleared for the descent of another bee. This habit is very marked in all halictine bees.

There are frequently two shafts leading down to one "nest" in the marl, but in the sand, one shaft is the rule. The cells in marl are sometimes encountered at only 8 cm. down, but those in the sand generally are at deeper levels. Since the cells in a group are open contemporaneously during the early phases, it is certain that all the excavating is finished before any provisioning is attempted.

There may, of course, be some other reason, for it is well-known among apiarists that the honey-bee *Apis mellifera* will sometimes delay the sealing of its cells containing well-developed larvae. It has been suggested that, as this phenomenon occurs always in hot weather, the delay is determined in some way by the temperature of the hive. However, the reason for the bees' unusual behaviour has not yet been adequately explained.

The shafts appeared to be plastered with a thin coating of marl to bind the sand. Many shafts in the extensive colonies are separated by only 2 or 3 cm., while others may be as much as a metre or two distant, nevertheless the flight of bees over the site, on a warm clear day, is spectacular. Many of the old cells are used over and over again, and a colony has been known to occupy the original site for several years.

When the shafts were closed in December, the top of the earthen plug was level with the surface of the ground, but concave on the lower surface, forming a neat dome over the shaft, since the plug was constructed from below. Before the cells are used again for brood the wad of excremental debris, and cast larval skins in the base, are meticulously cleaned out, and this habit, too, has survived in the hive-bee.

BUILDING IN SAND

At Bats Ridges, Western Victoria, the geology is very different from that at Clyde, Gippsland, in the east. The low elevations are miocene limestone, forming a few caves which are frequented by numerous bats.

Over the limestone lies a fine sandy soil of reddish-ochre colour and very friable character, breaking down readily when handled. This material is more easily excavated than the marl, but the architectural design presents a few unusual features.

The individual cells conform to the typical pattern, but measure 20 mm. at the long axis, and 8.5 mm. at the short. They are contracted slightly at the mouth, and are a trifle smaller than those in the marl. The interior is trowelled with the mandibles to a smooth finish, and then lined out with a white colloidal skin, slightly thicker than that in the marl.

There is a like compact group of cradles, from 14 to 17 in number, but over the cluster the dome is supported by three or four earthen piers, the bases of which rest between the cells. There are usually four or so much larger apertures among each group, and at first these could be mistaken for incipient large storage cells. A closer investigation, however, revealed that these larger chambers lead down to more or less vertical extensions forming shafts some 5 cm. in depth. The extensions would have been very difficult to explain if the author had not already investigated the exceedingly deep central shaft of a much smaller Queensland species, *Nomia halictella* Ckll., which disposes its cells at various levels.

N. australica still retains the vestiges of the instinct to dig a deep central shaft, but its large cluster of 17 cells taxes the ability of one mother to excavate, build and provision, and the construction of a second group, at a lower level, is not accomplished without the co-operation of another sister or sisters.

These deeper unfinished shafts, however, often serve a strange purpose, for they are used as mating chambers, and two bees, a male and a female, in copula, were often present in one when "nests" were excavated. *N. halictella* constructs a series of cells at fairly regular intervals down its exceedingly deep shaft. This Queensland species, in a much drier climate, finds it essential to dig deeper to attain and maintain the proper degree of humidity to preclude the dessication of the larvae. In winter the extensions serve as hibernacula in which the females shelter.

Cockerell (1931) states that typical specimens of *N. australica* have scapes and anterior margin of clypeus amber, but noted that others have these parts all black. The Clyde bees building in the marl have the latter characteristics, with the mesothorax more polished, and excessively minutely punctured, so that they approach the subspecies *reginae*.

The "spoil" is brought up the shaft by the bee's hind legs and the mandibles, and tipped out at the entrance, where it forms a tumulus. The main shaft has a diameter of 8 mm., approx., and goes down vertically for about 22 cm. before the main cluster of cells is reached.

The group of cells does not break down readily, for the marl is tough; the overall length of the groups was about 7.5 cm. and 3.5 cm. in width. In each cluster were about 17 cells, each separated by a wall approximately 4 mm. thick, the grains of sand being large and sharp.

The larger cells measured 19 mm. in length at the long axis, and 8 mm. at the short, with the mouth contracted to about 6 mm.; these are for the females. Those for the males are slightly smaller, 18 mm. and 7.5 mm. respectively.

The dividing walls between the cells vary somewhat in thickness, from 4 mm. to 7 mm., but whether thick or thin, the interval between the cells is invariably rounded over very smoothly and neatly, and as a rule, slightly below the level of the cell-mouths. When excavating the "nests" it was observed that the composition of shafts below the cluster of cells is much more friable, as though it had less bonding in its composition, whereas the cells are more solidly constructed.

The interior is trowelled by the mandibles to a smooth finish, and then a thin white colloidal membrane, a secretion from the thoracic glands, is licked on by the acute glossa. The skin is very thin, but it may, with care, be separated from the marl in small pieces. Under the microscope it is seen to be laid down as a silky thread which fuses immediately when it touches another.

Over the entire group is a low dome, so that the mother has easy access to all the chambers. There were no piers supporting the domes, for marl does not require them, but such supports are very necessary in sand.

The cells are sealed with a slightly concave plug of marl, 6.5 mm. in diameter, very smooth on the outside, but roughly cast on the interior; the cap is 3 mm. approx. in thickness, and of course, entirely lacking in membranous lining.

BUILDING IN MARL

Numerous colonies of Australian nomiine bees were excavated at critical periods during this research, at widely separated localities. The original one was at Clyde, some 40 miles east of Melbourne, and another was at Bats Ridges, 240 miles west of Melbourne, a third was near the Murray River.

It will be evident from the brief sketches of the localities that the environment of two sites is very different, and the geology, too, is equally diverse. At Clyde, the colony consisted of many hundreds of shafts of *Nomia australica* Sm. At Bats Ridges there were several thousands. The contours are few at Clyde, for the district lies within an ancient sunkland, but here and there are low ridges, 20 or so feet high, the remnants of old sand dunes in which are strata of harder material known as "marl"; a combination of sand and clay stained red with oxide of iron.

Many years ago, a municipal contractor had opened up a small area to quarry a kind of ironstone. During the removal of the "overburden," a coarse sandy loam was scooped off in a series of channels some six feet in width. At approximately three feet down a tough red "marl" was exposed; in this way two very different types of ground are available as nesting sites for the bees. At no great depth is a kind of dark gravel, which stratum is avoided by the bees.

In the sand *Nomia* often constructs two, rarely three, groups of cells, one above the other, but in the much more difficult "country," the marl, the bees are sometimes able to construct only one cluster which rests on the gravel.

The marl was in strong demand for road making in the early days of settlement about Port Phillip and Western Port, and the harder strata uncovered by the roadmakers run east and west; they are, therefore, drier and warmer than the surrounding lower lands, which are often swampy, with areas of black peat.

These rather lengthy details are included to permit the student to visualise the peculiar conditions governing the excavating, for it is a singular fact that the bees delving in the marl are somewhat different from those sinking their shafts in softer sand, since they have black scapes.

It is postulated that mutation is involved here; the change in behaviour being more conspicuous than differences in the morphology. It is readily admitted that mutations cannot be entirely ruled out in *Nomia*, for all the bees are closely related to the fossorial genus *Halictus*. However, since the biology of only two species of *Nomia* has been investigated, and nothing is known of the numerous others, there are insufficient data available to the student to enable him to solve the problem.

The aggregation of cells into a firm compact cluster that can be lifted out of the soil without damage, follows the architectural design favoured by a quite unrelated bee, *Callomelitta anomala* Raym., which is, however, endowed with a higher technical skill, for her slightly smaller cells are of a more delicate construction which the author illustrated in a "Cluster of Bees," 1935, p. 100.

It will be noted that *N. halictella* Ckll. which is not a typical *Nomia*, has evolved a very different design, and although she is a much smaller bee, yet she excavates a deeper main shaft; probably to assure the desired degree of moisture for the larvae, since Queensland experiences much higher temperatures.

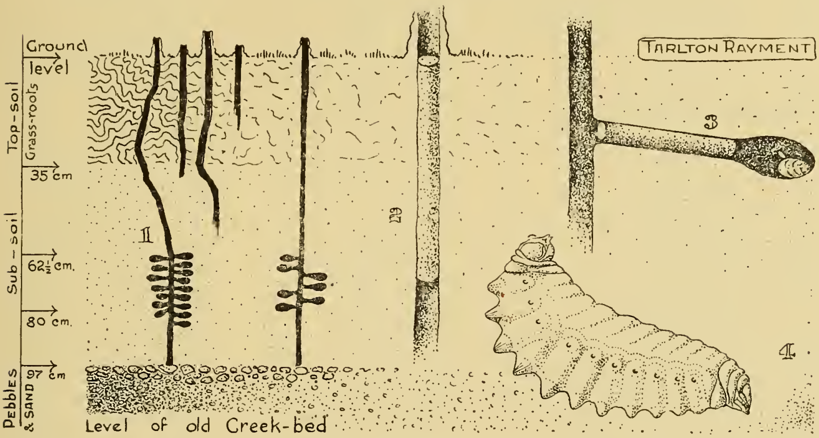

Fig. 5: Graphic section of "nests" of *Nomia halictella* Ckll.

1. Diagrammatic view showing cells between the 62 cm. and the 80 cm. level.
2. Enlarged view of top of shaft with its cylindrical plug of mud.
3. Enlarged view of cell and gallery, 2½ cm. long, and which also is plugged solidly with mud.
4. The fully grown larva of *Nomia* has prominent ridges like those of *Halictus*.

PLANTS VISITED BY NOMIA

It will be concluded, from the plants listed below, that the bees are strongly polylectic, for they have been observed to visit several botanical species during one excursion to the fields. The pollen-grains illustrated in text-figure 3 were all taken by the author from pollen stored in cells.

Of the 25 species of plants recorded below, 13 are in the Family Myrtaceae; but one only in Epacridaceae; 4 belong to Leguminosae; 2 to Compositae; 3 to Rosaceae; one only in Brunoniaceae. All the above plants are, with four exceptions, endemic to Australia.

This preference in food is in marked contrast to the choice of the blue-banded bees, *Anthophora*, which seek introduced plants rather than the endemic ones, and it is postulated that *Anthophora* is a comparatively recent arrival in Australia.

Nomia also is an Asiatic genus, but probably a very much older emigrant to our shores, for one species has been recorded from Tasmania, whereas *Anthophora* has never reached that island State.

Family	Species	Date	Locality
Brun.	*Brunonia australis*	Nov. 1947	Clyde, Victoria
Myrt.	*Angophora cordifolia*	16th Dec. 1951	Sutherland, N.S.W.
,,	*Melaleuca* sp.	10th Feb. 1951.	Gunbower Is., V.
,,	*Leptospermum* sp.	4th Dec. 1954	Kangaroo Is., S.A.
,,	*Leptospermum juniperinum*	16th Jan. 1954	Bats Ridges, V.
,,	*Callistemon pallidus*	Feb. 1932	Gunbower Is., V.
,,	*Eucalyptus viminalis*	Dec. 1944	Tooradin, V.
		20th Dec. 1951	Gorae West, V.
,,	*E. baxteri*	15th Feb. 1952	Bats Ridges, V.
,,	*E. australiana*	Nov. 1951	Clyde, V.
,,	*E. cladocalyx*	Dec. 1950	Clyde, V.
,,	*E. botryoides*	Jan.	Many localities
,,	*E. Calophylla*	18th Feb. 1954	Many localities
,,	*E. ficifolia*	Feb.	Many localities
,,	*E. pauciflora*	Jan.	Many localities
Comp.	*Hypochaeris radicata*	(Intro.)	Many localities
,,	*Carduus* sp.	10th Nov. 1945	Inverell, N.S.W.
Legum.	*Daviesia* ?	Nov. 1954	Gorae West, V.
,,	*Acacia sophorae*	Oct. 1953	Portland, V.
,,	*A. decurrens*	Dec. 1944	Clyde, V.
,,	*Acacia* sp.	Nov.	Clyde, V.
Epac.	*Leucopogon parviflorus*	12th Sept. 1950	Gorae West, V.
Rosa.	*Rubus fruticosus* (*Intro.*)	20th Dec. 1932	Emerald, V.
,,	Roses (garden) (Intro.)	7th Dec. 1947	Clyde, V.
,,	*Plectronia attenuata*	5th Nov. 1940	Edungalba, Q.
,,	*Rosa rubiginosa*	7th Dec. 1947	Clyde, V.

COMPOSITION OF POLLEN-STORES

Twelve completed pollen-puddings were removed from the bees' cells and examined microscopically. The percentage of each plant species is listed below.

No. of Pudding.	Leguminosae %	Myrtaceae %	Rosaceae %	Compositae %	Unident. %
1. Clyde.	60	30	2		8
2. Gorae.	3	80	3	8	6
3. Clyde.	60	40			
4. Cranbourne	98				2
5. Gorae.			98		2
6. Clyde.	60	30		10	
7.*	80	10			10
8. Gorae.	29	70			1
9. Gorae.	90	8			2
10. Gorae.	70	20			10
11. Gorae.	45	45			10
12. Gorae.	45	45			10
13. Clyde.	*Eucalyptus pauciflora* (incomplete).				
14. Clyde.	*Oxylobium ellipticum* (incomplete).				

The Legume from Gorae (16.1.1955) is certainly Acacia species, but that from Clyde is probably *Oxylobium ellipticum* var. *angustifolium*. Some of the unidentified species may have been due to accidental contamination, but tetrads (*Epacris* ?) *Rubus* ? and *Daviesia* ? appear to be represented.

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* No. 7 was extracted from the mesenteron of a fully developed larva from Clyde.

LARVAL FOOD

Pollen from a large number of botanical species is harvested by the female bees, and carried mainly on the posterior legs, femora, tibiae and tarsi, where there are dense scopae of long forked hairs; there are slender curled hairs even on the trochanters.

The grains are raked off the anthers very efficiently by the anterior tibiae and tarsi, which are frequently moistened by the glossa with a secretion, probably from the pharyngeal glands; the pollen then becomes a trifle darker, and coheres better.

The pollen-pudding is definitely more than a crude mixture of honey and pollen, for it not only alters in colour, but is also different in composition, and this can be demonstrated experimentally. A pudding removed from the cells quickly dries quite hard, but a crude mixture of honey and pollen, gathered by hand from the flowers, remains moist owing to the hygroscopic character of the former substance.

Moreover, the author reared several generations of minute beetles, *Brachypeplus*, on crude pollen gathered by hand, and another brood on pollen stored in the bees' cells. The crude mixture produced very much smaller beetles, but on the stored pollen the beetles attained their normal stature. These beetles are invariably symbiotic in the nests of the minute native bee *Trigona*, and normally feed on the stores and pollen debris.

The pudding of *Nomia* is not spherical, like that of *Halictus*, but a thick flattish cake, about 6.5 mm. in diameter and 4.5 mm. thick. The general aspect is that of a sphere slightly compressed on two sides. The colour ranges from orange-russet to dull olive-green, according to the species of pollen harvested. The composite *Hypochaeris* results in bright-orange; *Acacia* somewhat yellowish; and the myrtaceous species, which frequently predominate, give a full olive-green colour, although when in the flowers the pollen is cream-coloured. *Acacia* pollen appears to contain a considerable percentage of yellowish oil,

The pudding is somewhat drier in the middle, like that of *Halictus*, and this mây be due to the exterior receiving a more liberal supply of secretion during the formation of the pudding, which is placed in the centre of the cell, standing upright firmly, wheel-like. In a number of the nests excavated every one of the cells was open, and since larvae in several stages of development could be seen, it might be concluded that the mother practices extended nursing of her babies, but actually progressive feeding does not appear to be involved. The fact that the mother bee constructs a dome over each cluster, a feature that allows her to have direct access to all the cells, might be interpreted to indicate that progressive feeding is the rule, but it was found that other cells, containing only an egg or else a very young larva on the pudding, were permanently sealed with an earthen plug. The honey-bee will, on occasion, open the wax capping of her brood-cells, but the reason for her behaviour is not clear.

Considerable co-operative labour takes place in the colony for two, or rarely three, females occupy the majority of the old shafts. Only one mother is present in the much smaller, newly established, "nests." Just why certain females depart from the parental home to found a new colony could not be established, but it is very evident that the old cells are used over and over again by successive generations, which remodel them and clear away the excremental pellets of the previous brood. The author has a record of a nomiine colony occupying the same site for many successive years.

LARVAL DEVELOPMENT

The slightly bowed centrolecithal egg of *Nomia australica* Sm. is milky white, semi-translucent, a trifle larger at the cephalic pole, with the caudal end firmly attached to the *side* of the pollen-pudding by a clear agglutinative secretion from a gland at the apex of the female abdomen.

It has been demonstrated(3) that the eggs of other bees increase a trifle in length just before hatching, and the author found that to be the case in

(3) Australian Zoologist, xi, p. 295, July, 1951, Rayment.

Nomia. An egg which was removed from its pudding on 16th January, 1955, and almost due to hatch, measured 2.5 mm. in length, and almost 1 mm. in diameter at its widest part. Eggs of the honey-bee average about 1.60 mm. in length.

The sculpture of the chorion (egg shell) is inconspicuous, and when the egg is crushed under a cover-glass, and stained, it is seen to consists of the cytoplasm, the nucleus, and a large mass of granular deutoplasm or "yolk" for the sustenance of the developing embryo.

Limitations over which the author had no control, precluded his being able to determine accurately just how long the egg takes to hatch, but it would appear to be about 85 hours; the period being somewhat influenced by temperature, cold appearing to retard development, and warmth hastening it.

A few hours before hatching, it is possible to discern segmentation in the young embryo within, for it is then of a milky-white opacity, while the agglutinative at the caudal pole remains perfectly clear, but not brittle, so that the egg may be bent over without snapping off at its base.

Commercial apiarists frequently claim that worker-bees will transport an egg from one cell to another, indeed, from one comb to another, but it is no easy matter to remove an egg from its base without breaking the shell, and damaging the contents. Moreover, there is no known way of applying the agglutinative to the caudal pole other than the process which accompanies its original deposition. Attachment at the caudal pole appears to be a sine qua non for the successful issue of the larvae.

When the chorion splits at the cephalic pole, the young larva rests for a while before it begins to feed, which it does by sweeping its head to and fro across the pudding, taking off a layer of food with its dentate mandibles which are modified for the purpose.

The larval mandibulae are of course microscopic in size, truncate and notched apically, where they are somewhat chitinized. The buccal parts seem to "mouthe" the food like a toothless human ingesting porridge. The feeding is punctuated by intervals of rest, when the larva remains quiescent, adhering by its caudal segments to the pudding.

About 8 days later, the larva is fully developed, and the whole of the pudding store has been consumed. The larva then measured 12 mm. in length, and was slightly curved, with three incipient thoracic segments raised dorsally to conspicuous bituberculate ridges. The curved posture is maintained until the junction of the stomodeum (anterior invagination) and the proctodeum (posterior invagination) is effected to complete the alimentary canal. Soon after the junction is effective, the larva straightens, and the excremental debris is then voided as a series of moniliform black strings. This gross waste is ultimately compressed into a dark wad, and encased between the cast larval skins in the base of the cell, where it cannot contaminate the crysal whiteness of the larva.

A faint pale-slate colour soon appears to dull the pearly whiteness of the larva, and against this increasingly darker tint, masses of large creamy-coloured oenocytes, floating free in the body-fluid, are very conspicuous.

PUPAL DEVELOPMENT

At first, the pupae are immaculate, white and crystalline, and ornamented with a number of tubercles and spines on various parts of the body after the manner of halictine larvae. The tubercles are disposed as follows—There are three on the vertex of the head; two minute ones on the apex of the scape, and a microscopic one on the base of the mandibles; two large prominent ones on the scutellum, and two smaller on the postscutellum, also a minute sharp one on the tegula; two on the labrum; one on the coxae, another on the anterior tibiae for the strigilis, and yet another for the calcar.

Each segment of the abdomen, except the basal one, has a row of 15 tubercles on each side, that is, 30 for each tergite, but they are minute, long and acute, so that under low magnification, the tergites appear to be ciliated. Each article of the flagellum is tuberculate, but these are rapidly absorbed before pigmentation sets in.

A few of the last of the pupae were taken from their natal cells at Bats Ridges as late as the 26th of February, 1955, when they were rapidly approaching maturity, measuring 11 mm. in length, and 6 mm. at the broadest part; robust "chubby" pupae. When viewed by transmitted light, even at that early stage, inside the bulbous apical tarsal segments may be seen the clear dark forms of the claws, and in the wing-pads the neuration is clearly outlined in slaty grey. The head and thorax soon acquired the same pale slaty colour, and there were still numbers of large free creamy-coloured oenocytes plainly visible under the skin, now becoming dull and flaccid. Through the skin could be seen clusters of long dark hairs pressed down flat.

The abdomen, however, was of a rich burnt-sienna brown colour, which also suffused the anterior half of the clypeus, the immature mandibles, and the flagellum, but the scapes remained white until later. The wing-pads, and the legs, with the exception of the coxae, also the mouth-parts, were all pale straw-colour. The median and parapsidal lines formed very conspicuous deep furrows. The tubercles were now almost completely absorbed, and the final skin flaccid, soon to be sloughed to reveal the moist imagine.

If, from any cause, the humidity within the cell falls to a degree where the skin, at the final ecdysis, loses its moisture, the struggling imagine is unable to slough its skin, which then dries about the body, and so restricts its movements that the insect dies, more or less encased in its mummy-like shroud—a condition more often present in the laboratory than in the bee's natural environment.

ONE BISEXUAL GENERATION

It will be seen from the calendar that the shafts are opened early in November, and the first eggs were found about 12 days later. By the 25th of December there was brood in all stages, and the first pupa was recorded. By the middle of January pupae were abundant in all nests, but by the 9th of February there was only an odd sealed cell. The time required for development is thus approximately 3 months; i.e. November, December, January.

It is clearly evident that only one bisexual brood is reared each season, the pairs mating in the autumn. The fecundated females semihibernate over the winter in the galleries below the group of cells, and the latest of the males accompany them.

BEHAVIOUR OF THE INDIVIDUAL

The fully-developed adult bee has little difficulty in tearing down the plug of sand that seals her in her natal cradle, and is still damp when she reaches the surface of the shaft. There she rests, sunning herself until her wings are quite dry. She preens herself between whiles, giving a flick or two of her wings now and then, and cleans her antennae. She may even re-enter the shaft for a few minutes, and appears to rest there, but not for long. Soon she reappears, walking about the entrance as though surveying all its details, and then tries her wings on a short flight of half a metre or so. This exercise appears to increase the insect's confidence, and she extends the range of her flight in ever widening circles, but always with her head directed to the aperture in the ground. At length she is out of sight, but soon returns, and after one or two such excursions, during which she orientates the locality, disappears in search of food.

Dissection reveals that her honey-sac is empty when she departs, and on her first flight she voids a droplet or two of white liquid, probably urates and calcium. On her return the honey-sac contains a little clear thin nectar. Indeed, she may even alight on a grass-stalk nearby, and extrude a droplet of nectar on her glossa. She "beats" the liquid, as it were, until it grows visibly thicker, and then returns to the shaft and descends to the cells.

The visits to the flowers for her own sustenance are punctuated by spells of excavating down below; the "spoil" being brought up by the mandibles and the powerful hind legs. The bee just tumbles it out in loose masses until a rough tumulus forms about the "pit-mouth." Her carelessness with the "spoil" is in marked contrast to the careful utilisation of it by the

Queensland bee, *Nomia halictella*, which builds over the entrance a heat chimney, some 7.5 cm. tall, with the exterior revealing the individual pellets of mud; the interior being trowelled to a smooth surface.

It is quite clear that the whole of the digging of the numerous cells is completed before any provisioning with pollen is attempted. At Clyde, on a warm day, the females returned to the colony at the rate of one every 15 seconds, and each was laden with a full load of cream-coloured pollen.

The female performs a peculiar action during the loading of the scopae of the hind legs, for she dextrously curls herself almost into a sphere, and pushes or packs the pollen onto the posterior legs, employing the mandibles in conjunction with the anterior legs, and whilst so engaged, emits a continuous low murmuring sound, but just how she manages to effect this is not at all clear.

The return flight is very fast and direct, until at last the female hovers for a moment over the aperture at a height of about 5 cm. and then suddenly dives down the shaft, which has been "cleared for traffic" by the watcher at the door retreating to the security of the "anteroom."

There is usually, but not invariably, a "guard" on duty at the entrance, closing the aperture with her circular head. After flight for the day has ceased, say about 7 o'clock p.m., the entrance is closed, not with a bee's red face, but with the metallic green of the apical tergites of her stern. Since the colonies are haunted by wolf-spiders, *Lycosa ramosa* ?, the hard curved abdominal plates offer the best defence, for there is no part for the spider to grasp, whereas the antennae of the head could be seized immediately, and the bee dragged forth.

In "nests" excavated at Clyde on the 15th October, 1947, there were many males and females present, ready to fly, and at that early date, both sexes must have overwintered in their natal cells. Dissection of a number revealed that the stomachs of all were empty, and the untattered wings demonstrated that the insects had not yet flown abroad.

In conformity with a law that runs throughout the bee-world, the males issue first, and form the first guards for the "pit-mouth," but later, when the females are excavating and harvesting, the males disappear, and the door-watching duty is undertaken in rotation by the females. When only one female is in residence, there is of necessity no guard during her absence.

At Clyde, between 9 a.m. and 12 noon, on the 1st April, 1945, 25 guard-bees were captured at the pit-mouths, and of that number 7 proved to be males. Their presence would seem to suggest that as the season nears its close, the males either return to shelter in the burrows, or else those present are young ones which have not yet flown.

The hundreds of males from an entire colony will assemble at dusk, in summer, and form giant clusters for "mutual warmth and protection" throughout the night. These nocturnal aggregations of males may contain several thousands of individuals.

Similar clusters of males have been observed by the author in other genera, *Paracolletes*, *Halictus*, *Parasphecodes* and *Lysicolletes*, and there is no doubt that such gatherings are the rudiments of the swarming cluster which reaches its zenith in the hive- or honey bee, *Apis*. However, Henry Hacker published the following note in the Journal of the Queensland Entomological Society, Nov. 1927:—

"Towards the end of January, male bees of *Nomia australica* Sm. assembled every evening for several weeks on long grass-stalks in my garden (Brisbane, Q.). About 20 males settled on each stalk, and their weight bent the grass right over. Before settling down they were very restless, changing their position several times."

Several *Nomia* in Java have males that assemble at night on plant-stems, and this habit is very strongly developed in the genera *Anthophora*, *Asaropoda*, *Halictus*, *Paracolletes* and *Parasphecodes*. The males grip the stalk with their mandibles, and prop themselves with their legs.

Nomia is not at all irascible in temperament, for the observer can sit down in the middle of a populous colony, and even excavate its shafts, but neither individual nor concerted attack is ever offered by the bees. The presence of a human intruder is utterly ignored by all. When a female bee is unearthed, during excavation of the nest, she rarely takes wing, but endeavours to disappear from sight by digging vigorously in the soft sand; a task which is quickly accomplished.

Early in April 1945 many shafts in marl were excavated at Clyde, and in several, a pair of bees, a male and a female, were present in the extension shafts below the main group of cells, and they appeared to be copulating. However, since no one has yet observed the mating of *Nomia* in the air, it is possible that, as in the case of *Anthophora*, copulation takes place in the auxiliary shafts. The position of the pairs is peculiar, for they stand erect, venter to venter, held together by the legs. The present author has observed the queen and drone of the hive-bee assume a similar position in the air when copulating, and his observations have been borne out by two commercial apiarists, the Messrs. Rush Brothers, Black Rock, Victoria.

Indeed, one of the author's correspondents in Queensland, observing a large "swarm" of *Nomia australica* bees, promptly hived it in a bee-box, and was very disappointed indeed when the bees gradually deserted his hive, and disappeared, probably to reform their nightly cluster on another tree.

CALENDAR

Bats Ridges 26th Sept. 1954.	Weather: dull, but warm. Time: 2-3 p.m. Not one of the thousands of shafts open, but all sealed permanently at ground level.
Bats Ridges 3rd Oct. 1954.	Weather: clear and hot. Time: 11 a.m.-2 p.m. All shafts still sealed, but two "nests" were excavated. Only adult bees, but no larvae, present. No. 1 had 17 cells, all polished, with excreta removed. Two adult females were present, one on the top of the cells, and the other at the base in an extension.
Clyde 14th Nov. 1947.	Many shafts were opening, with both sexes a-wing. Females had stocked the first cells with a pudding of pollen. Both sexes must have overwintered in their natal cells.
Clyde 24th Nov. 1944.	Weather: clear and warm. Time: 7 a.m. Excavated several burrows, and each had 3 females in residence. Clusters in marl contained 15 cells, those in sand 16 cells. One female was digging at base, the second on guard duty, and the third inside a cell.
Bats Ridges 5th Dec. 1954.	Weather: clear and hot. Time: 10 a.m. to 5 p.m. Thousands of shafts open. A dozen "nests" were excavated. All had 2 cells in each group with puddings and an egg or larva. Few moundlets of spoil visible as no excavating was in progress. One or two tumuli were excavated, and the new nests contained only a few cells.
Clyde 7th Dec. 1947.	Weather: hot. Time: noon. All shafts open, and approximately 50 per cent active, but no guards posted at entrance to others.
Clyde 25th Dec. 1944.	Weather: Bright and hot. Time: 2 p.m. Considerable flight of bees over the colony. 12 shafts were excavated, and cells contained brood in all stages, puddings; eggs; young and old larvae; all of which were in sealed cells. Adult females were present in all shafts. One matured male was present in a group of old cells, and two males were found in other cells. One cell contained an older pupa with eyes just beginning to darken. This would be the earliest of the midsummer brood.
Bats Ridges 28th Dec. 1954.	Weather: clear and hot. Time: 10 a.m. to 4 p.m. Three nests were excavated, and each contained one female—others could have been absent in the field, for the flight was heavy. No. 1: 1 male pupa; 1 female pupa with numbers of mites over the body; one large larva; one pudding with egg attached.

No. 2: 2 male pupae, one heavily infested with mites; a large larva; 1 pudding with egg attached.
No. 3: Only three new cells had been constructed.

Bats Ridges 16th Jan. 1955.

Weather: clear and hot. Time: 10 a.m. to 6.30 p.m.
Six "nests" were excavated. Mites and collembola present in many cells, and many mites on one male pupa. On several occasions two females were seen to enter the same shaft. Numbers of females laden with pollen were returning to the nests, but probably only 25 per cent of the shafts were working.
No. 1: 3 adult females with 4 sealed cells; 2 cells with larva fully developed; 2 cells with puddings and eggs attached.
No. 2: 2 adult females; 4 sealed cells; 1 female pupa, and 1 male pupa; 2 puddings with eggs attached.
No. 3: 2 adult females; 2 sealed cells; 1 female pupa; 1 pudding and egg.
No. 4: 1 adult female; 1 sealed cell; 1 pudding with egg attached.
No. 5: 1 adult female; 2 sealed cells; 1 female pupa; 1 male pupa.
No. 6: 1 adult female, 1 sealed cell; and a fully-developed female ready to emerge. These are undoubtedly the progeny of the overwintered females.

Bats Ridges 23rd Jan. 1955.

Weather: Clear and hot. Time: 11 a.m. to 4 p.m.
Scene of great activity in colony. Laden females on *Eucalyptus viminalis* and *E. baxteri*. Apparently only one female working from each shaft.

Bats Ridges 27th Jan. 1955.

Weather: dull; rained later. Time 11 a.m. to 3 p.m.
Eight "nests" were excavated. One male, chilled by rain, hung dejectedly down a twig of *Lepidosperma semiteres*.
No. 1: No adult females; old excreta pads in two cells.
No. 2: 3 adult females; 1 larva fully developed; 1 larva; $\frac{1}{2}$ of a pudding with egg; 1 black female pupa.
No. 3: 2 adult females; 1 pudding with egg; 1 black female pupa.
No. 4: 1 adult female; 1 dead adult female in open cell.
No. 5: 1 adult female; 1 pudding with egg.
No. 6: 1 adult female; 1 male dark pupa; 2 female pupae (1 dark, 1 light).
No. 7: 2 adult females; no closed cells.
No. 8: 2 adult females; 1 larva; 1 male black pupa; 1 female black pupa with numerous mites attached. The dead female had a fungal growth on it—pin-like fruiting bodies yellow in colour.

Bats Ridges 9th Feb. 1955.

Weather: dull, warm. Time: 11 a.m. to 3 p.m.
Numerous fresh moundlets of red sand each up to 7 cm. across. All entrances now blocked by rain which had fallen again, but eight shafts were dug out with the results tabled below.
No. 1: 1 adult female; no sealed cells. All new season's brood of males and females.
No. 2: 3 adult females; no sealed cells. All new season's brood of males and females.
No. 3: 3 adult females; no sealed cells. All new season's brood of males and females.
No. 4: 2 adult females; no sealed cells. All new season's brood of males and females.
No. 5: 3 adult females; 2 larva with mites; 1 male pupa—light; 1 female pupa—black.
No. 6: 2 adult females; 2 larvae.
No. 7: 2 adult females; 1 larva.
No. 8: 2 adult females; 1 larva; 1 male pupa still white.

Clyde 20th Feb. 1947.	Weather: hot. Time: 11 a.m. to 3 p.m. Hundreds of shafts open, and a heavy traffic of laden females, but no mating of the sexes was observed.
Clyde 10th Mar. 1945.	Weather: warm and clear. Time: noon. A large number of shafts closed, but a few still active.
Clyde 1st April 1945.	Weather: dull, with mild breeze. Time: 9.30 a.m. to 12 noon. This colony was first observed in the spring of 1939. Only two females observed in flight over the entire colony. 75 per cent of the shafts were still open, 50 per cent of which had no guards. 12 groups of cells were excavated, but neither puddings nor larvae were present; only 2 immature bees, which were nearly due to emerge. Occupants varied in number, from 1 to 6 females in each shaft.
Bats Ridges 11th April 1955.	Weather: cool and cloudy. Time: 11 a.m. to 2 p.m. 99 per cent of the shafts sealed permanently. It is evident that the active season is about to end.
Bats Ridges 20th May 1955.	Weather: Light drizzle of rain. Time: 11 a.m. to 3 p.m. No activity above ground, but one dozen shafts were excavated, and it was plain that the active season had terminated for the colony.

No. 1: One female.	No. 7: Three females.
No. 2: One female.	No. 8: Four females.
No. 3: One female.	No. 9: Six females.
No. 4: One female.	No. 10: Three females.
No. 5: Two females.	No. 11: Three females.
No. 6: Two females.	No. 12: Five females.

Neither pollen, nor eggs, or larvae were present in any cells.

SYMBIOTES, COMMENSALS AND PARASITES

The colonies of *Nomia australica* Sm. shelter a huge population of other animals, the most numerous, of course, being acarine mites, for they are present in untold numbers. They are, however, not parasites, but true symbiotes, for the walls of certain galleries and shafts are literally covered with the minute white creatures.

The author has already described how the mites function as cleaners in halictine colonies, maintaining them in a sanitary condition by consuming all the biological debris, such as moulds, dead bees and enemies, cast larval skins, excreta and, indeed, any other matter that would soon accumulate in a subearthen "nest."

Similar behaviour has been observed in the nomiine colonies, where the mites consumed even the colloidal lining of the cell-walls. A mite exudes a droplet of clear liquid on the skin, which it then dissolved and ingested by sucking, for the mites possess no biting apparatus.

Since each bee remains constant to its own group of cells, it is therefore not a reliable agent in the dispersal of the mites, consequently the symbiotes must utilise some vehicle other than the bees. A very efficient one is, however, ready at hand in a species of mutillid wasp. This insect is a true parasite on the bee, descending any unguarded shaft, and depositing its egg on the larva. At that auspicious moment, several mites cling about the region of the ovipositor, and are thus transported to new "territory," for the female mutillids are constantly ranging over the nests.

The author(4) has already recorded that he had found in halictine colonies a curious segregation of the sexes of the symbiotes. In certain galleries and shafts all the mites will be males, but in others only females will be present. This strange condition is present also in nomiine "nests," but the author is unable to advance any reason for the segregation.

(4) Rayment, Arbeiten uber physiologische und angewandte Entomologie, Band 3, p. 289, Mar. 9, 1951.

Only very rarely indeed are mites present on these bees, but Clifford Beauglehole took two females out of the "nest," and one had six mites attached to the metathorax, and the other twelve on the same region of the body, but it must be admitted that these were exceptional infestations.

In the vast nomiine and halictine colonies, the mites are undoubtedly true symbiotes, and certainly are not parasites, for both bees and mites benefit from their remarkable association—the acarines find a supply of food, and the bees have the benefit of an efficient sanitary service.

Slender graceful cryptine wasps, in the genus *Labium*, and red, yellow, orange and black in colour, range tirelessly to and fro over the mouths of the shafts, and like the wingless mutillids, are truly parasitic. With their long filiform antennae fully extended, they apparently ascertain by scent whether or not the rightful owner, the mother bee, is at home. Of course, she may be warned by vibrations, but whatever the means employed, should she finally decide that the "coast is clear," she will quickly descend and deposit an egg on the larval bee, and then make an equally hurried exit. The author is convinced that all intruders are anxious to avoid an actual encounter with an irate bee. After all, the stinging mechanism of the honey-gatherer is very efficient, and the poison an exceedingly lethal one.

The wasps from Gorae West are very close to, if not conspecific, with *Labium rufiscutum* Cush., the type of which was collected by the author at bee-colonies at Sandringham, Victoria. The ovipositor is very short in this genus, and therefore unlike the tenuous one of other ichneumonids, but there is here no use for a longer weapon, since the victim is always encountered at close quarters. The thin brown papery cocoons of these wasps are often found during the excavation of bee-colonies, but neither the author nor his honorary collaborators have been fortunate enough to discover a pupa, so it would appear that *Labium* is not spectacularly successful.

It was indicated above, that red and black mutillid wasps, too, are present as parasites, and being more numerous, experience more frequent encounters with the bees. However, the mother bee has only to rush at the intruder with gnashing mandibles, and the mutillid will beat a hasty retreat. At times, a wasp may be seen scurrying out of a shaft backwards before the ferocious advance of the bee which she had surprised at home. The species involved here appears to be new, and the specific description is appended.

The wild-flower "garden" was shared with numerous colonies of ants of several genera, the largest of which is that formidable fighter, the bull-ant, *Myrmecia forficata* Fab.; there were also present *Nystalomyrma longiceps* Sm., *Iridomyrmex rufoniger* Lowne and *Myrmaturba claripes* Mayr. and some others.

Commercial apiarists are agreed that ants are one of the honey-bee's most persistent enemies, but the close proximity of so many ants' nests—indeed, that of the bull-ant is situated in the middle of one very large aggregation of shafts—leaves little doubt that the bees are well able to defend themselves. It is only when the "morale" of the honey-gatherers has been lowered by starvation or sickness that they succumb to the steady offensive of the marauding ants. This applies equally well to the honey-bee.

ENEMIES

Few of the larger animals constitute a serious threat to the success of the bees. Birds are probably the most avaricious of the foes, for they catch and consume many of the heavily laden females. The common sparrow, *Passer domesticus*, will sometimes discover that laden bees are a sweet morsel and, having once acquired the taste for them, will establish a base near a colony and exact a heavy toll of the population, until the bird becomes lax in its technique, and a sting in the throat terminates its life. Bee-hives are often singled out for attack, and sparrows inflict heavy casualties.

Perhaps the worst culprits are the sordid wood swallows, *Artamus tenebrosus*, which consume hundreds, especially hive-bees. The beautiful bee-eater, *Merops ornatus*, is an alarming predator of the commercial apiaries, for it concentrates on young queen-bees venturing forth on their mating flight.

Arachnids, especially the wolf-spider, *Lycosa ramosa*, are continually hunting over the colonies, and the web-spinners, too, capture a few of the honey-gatherers, but the ferocious bull-ant is ultimately defeated in mortal combat by honey-bees, and the battle is a thrilling one to observe.

The wombat of south-eastern Australia, *Phascolomys mitchelli*, is common about Bats Ridges, and causes extensive damage by burrowing through the nomiine colonies. In the Murray Valley, periodical flooding by the river drowns myriads of fossorial bees. Man himself often exterminates entire colonies with his excavations and cultivation of the soil.

Family MUTILLIDAE

Genus EPHUTOMORPHA Andre, 1903

(Gen. Insect xi, p. 15, 1903.)

Ephutomorpha sagittifera, sp. nov.

(Figure 6.)

Type, female—length, 10 mm. approx. Black head and thorax; reddish abdomen.

Head large and quadrate, coarsely rugoso-punctate, the punctures almost pyriform; face with a few pale fine hairs; clypeus with anterior margin produced to a sharp rim and an angular structure, with two large median black tubercles between the scapes; vertex very long, coarsely punctured;

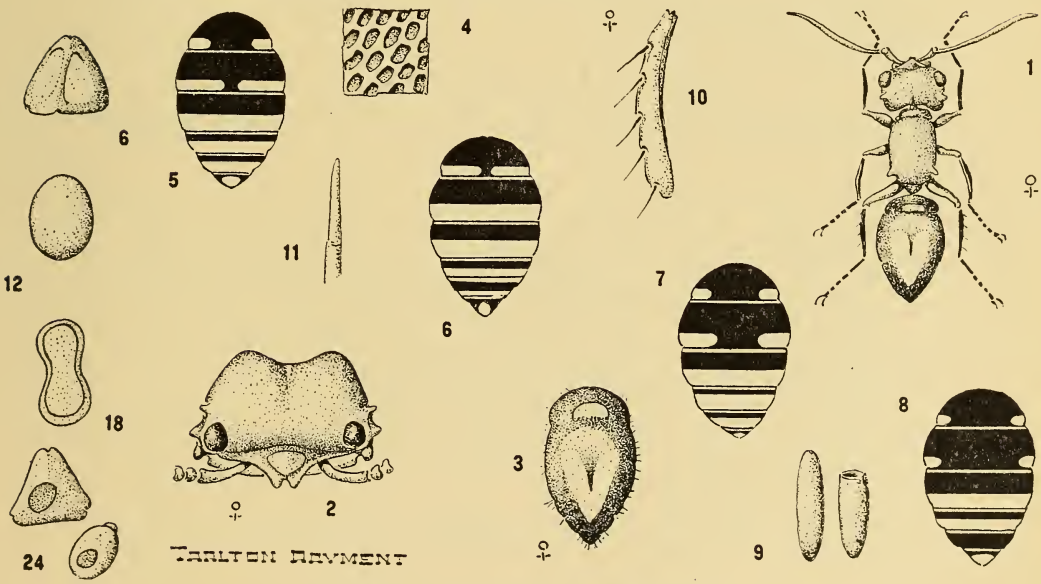

Fig. 6: The mutillid and the bee.

1. Adult female mutillid wasp, *Ephutomorpha sagittifera*, sp. nov.
2. Oblique dorsal view of head.
3. Dorsal view of abdomen of female showing the arrow-shaped mark.
4. Rugoso-punctate sculpture of mutillid head.

5-6-7-8. Four diagrams showing variation in the abdominal faciae of the bee, *Nomia australica* Sm.

9. Cocoons of the wasp parasite.
10. Spiculae on the posterior tibiae of the mutillid.
11. Apical segment of the antennae of the mutillid *Ephutomorpha sagittifera*.

compound eyes excessively small; genae large, black, coarsely rugoso-punctate, a number of coarse white hairs; labrum dark-reddish; mandibulae long, acute, dark-red, strongly bent, black at base; antennae black, acute apically, considerable long white hair, the scapes arcuate, stout and long for the genus. A small tubercle laterally above the eye.

Prothorax suffused with reddish, polished dorsally; tubercles black; mesothorax small, black, bright, excessively coarsely punctured, with a pair of minute sharp tubercles laterally on the metathorax; a few scattered black hairs; metathorax with the posterior declivity polished; abdominal dorsal segments black, shining, with long pyriform punctures, and some stiff black hair dorsally; basally there is a red patch, and on the first segment a yellow spot on which the long hair is golden; there is a large red patch on the second segment, but on this and also on segments 3-4-5 there is a dull creamy mark, shaped like an arrow-head and covered with glistening golden hair; ventral segments polished, suffused with reddish colour.

Legs slender, red, with long white hair; on each tibia are four fine long black spiculae; tarsi red; claws red; hind calcar pale-amber, finely serrated.

Locality: Bats Ridges, Portland, Victoria, 15th Feb. 1955, Clifford Beauglehole.

Taken from the "nest" of the bee, *Nomia australica*, by the collector.

Type in the collection of the National Museum of Victoria.

Allies: Apparently approaches *E. ferruginata* Wwd., but is clearly distinct by the abdominal "arrow."

EXPLANATION OF PLATE XXIII

Posterior femur and tibia of nine male bees, from widely separated localities, in the *Nomia australica* Sm. complex.

Fig.

1. Gorae West, Victoria; conforms with the description of the subspecies *reginae* Ckll.
2. Gunbower, Victoria; annectant between *australica* and *reginae* Ckll.
3. Donnybrook, Western Australia; annectant between *australica* Sm. and *regis* Ckll.
4. Katherine, Northern Territory; conforms with the description of subspecies *regis* Ckll. Note the short tibia.
5. Croydon, Victoria; conforms with the description of the type, and identified by Cockerell as *Nomia australica* Sm.
6. Lismore, northern New South Wales; not quite typical.
7. Jamberoo, southern New South Wales; differs by the structure of the sternal plates, type of *miranda* Raym.
8. Glen Wills, Victoria; annectant between *australica* and *reginae* Ckll., with very long tibia.
9. Jindabyne, New South Wales; annectant between *regis* and *reginae* Ckll., but tibia and femur much modified.

EXPLANATION OF PLATE XXIV

Architecture of the bee, *Nomia australica* Sm.

Fig.

1. The "spoil" from the excavations is thrown up to form tumuli.
2. In early December, during the pupation of the larvae, the shafts are sealed with an earthen plug.
3. Looking down onto a cluster of 18 open cells; three of the largest ones were deepened to form shaft-like extensions below the cluster. The black squares indicate the position of the pillars or piers.
4. Graphic section to show the extensions: note the two pillars supporting the dome over the cells.

EXPLANATION OF PLATE XXIV—*cont'd*

5 Graphic section showing another cluster of cells, below the original group, built by a second female.

6. The extensions are used in summer as copulating chambers, and in winter as hibernacula. Horizontal extensions are very rare.

7. The sandy "matrix" of the cell, on the interior of which the white colloidal membrane is woven.

8. Membrane viewed by transmitted light to show silken threads.

9. Cast larval skins, in the base, containing the excremental debris, are meticulously removed before the cells are used again.

10. Earthen plug to seal the mouth of the cells.

11. The three sizes of cells made by *Nomia australica* Sm. The largest is for the extensions below.

12. One of the larger cells being extended to form a shaft.

13. Transverse section of "turret" built by *Nomia halictella* Ckll.

14. Anteroom or "sentry-box" for the guard bee on duty.

15. Each load of mud forms a "brick" in the turret.

16. The tarsal combs assist in digging and cleaning.

17. The sand-grains are cemented together with a secretion from the salivary glands.

18. Mud turrets erected over its shafts by the bee, *Nomia halictella* Ckll.

19. Graphic view of sealed cells with pollen-pudding and egg.

20. With care, pieces of the colloidal membrane may be lifted from the cell-wall.

EXPLANATION OF PLATE XXV

Fig.

1. The egg of *Nomia australica* Sm. is glued to the side of the pollen-store.
2. Egg enlarged to show clear agglutinative at base.
3. Young larva feeding on the pollen-pudding.
4. Fully-grown larva after the store has been ingested.
5. Dorsal view of pupa just before pigmentation set in.
6. Lateral view of male pupa.
7. Ventral view of female pupa.
8. Early phase of invagination of apical segments of larva.
9. Wing pads from a pupa.
10. Early phase of development of the mouth-parts.
11. A later stage.
12. Each tergite (not including the basal one) has a fringe of elongated tubercles.
13. The anterior coxae have a stout spine which is later absorbed, but *Megachile* males (leaf-cutters) retain it.
14. Before the final ecdysis the tarsal hooks may be seen by transmitted light.
15. The tibiae, too, have a spine, which later becomes the strigilis.
16. One of the abdominal elongated tubercles enlarged.
17. Each article of the flagellum has a tubercle which is later absorbed.
18. Apical segments of the larva have a number of papillae.
19. The tegulae bear a microscopic tubercle.
20. Larval mandibles are minute.
21. Two of the large oenocytes floating free in the body.
22. The dentate larval mandible is exceedingly efficient in scooping off a layer of pudding.
23. Invagination of the apical segments of a pupa.
24. By transmitted light, the neuration may clearly be seen in the pupal wing-pads.

EXPLANATION OF PLATE XXVI

Fig.

1. Typical adult female bee, *Nomia australica* Sm. from Croydon, Victoria.
2-3. Sternal plates of male from Lismore, N.S.W.
4. Apical sternite of male from Gunbower, Victoria; compare with corresponding plate, No. 3, at same magnification.
5. Apical tergite of male from Gunbower. This plate does not vary in any of the males.
6. Inner surface of acute mandible of same male.
7. Mouth parts of male bee from Lismore; note the dagger-shaped glossa.
8. Pharyngeal rods of same male; note poor development of glands at "B" on pharyngeal plate.
9. Pharyngeal glands more highly magnified.
10. Maxillary comb at "A" from same male.
11. Apical sternal plate of male from Gunbower; compare with No. 25 at same magnification.
12. Strigilis from anterior leg of female bee from Clyde, Victoria.
13. Clypeus and labrum of male from Lismore. By transmitted light, the pale clypeal mark is seen to be typical of halictine bees.
14. Bidentate mandible of female bee from Clyde, Victoria.
15. Mesophragma from Lismore male.
16. Sculpture of mesothorax of female from Clyde.
17. Apical fringe of sternite from Lismore male. Compare with Nos. 22 and 23.
18. Sculpture of mesothorax of male (*N.a. regis* ?) from Katherine, N.T.
19. Sculpture of second abdominal tergite from Clyde female.
20. Hind calcar of same female.
21. Genital capsule of male bee, (*N.a. regis* ?) from Katherine, N.T.
22. Fringe from sternite of same male.
23. Fringe from sternite of male from Gunbower.
24-25. Apical abdominal sternites of male from Lismore.
26. The numerous strong hamuli of same male.

Announcement

NEW ZOOLOGICAL HANDBOOKS

Two new Handbooks are being prepared and it is hoped that they may be published in the forthcoming year. The first is a completely revised "Reclassification of the Order Odonata, based on some new interpretations of the venation of the dragonfly wing," by Lieut.-Colonel F. C. Fraser. The demand for the earlier "Reclassification," by Tillyard and Fraser, which appeared in the *Australian Zoologist*, vol. ix, 1938-40, exceeded the stock of reprints and back numbers, so the new work is assured of a world-wide welcome.

The second Handbook will deal with the Birds of the Sydney district and County of Cumberland, New South Wales, and is by the noted field ornithologists, Messrs. K. Hindwood and A. R. McGill.

Enquiries may be sent to the Honorary Secretary of the Society.

A New Water-Monitor from Northern Australia

By ERIC WORRELL

(Plates xxvii-xxix.)

In 1944 I collected a number of these large water-monitors at Edith Falls on the upper reaches of the Edith River, Northern Territory, and subsequently a few at the head of the Katherine River, Waterhouse River and Roper River near Mataranka, Northern Territory. Mr. Melbourne Ward of Medlow Bath obtained a large specimen from me collected on the Waterhouse River, and in 1955 I was able to collect two more from Bulliwallah Station, on the Belyando River in Queensland.

This *Varanus* is not particularly common but occurs in isolated colonies in inland areas of the Northern Territory and North Queensland. It is shy, difficult to collect alive, but fairly hardy in captivity.

It is proposed to describe this lizard as a new species after the locality (Bulliwallah Station) in which some of the material was obtained. The type was collected from a waterhole near the Belyando.

ACKNOWLEDGMENTS

Gratitude is expressed to Mr. F. King of Bulliwallah Station who kindly made facilities available and helped me collect material on his property, also to Messrs. L. Robichaux and J. Dwyer for assistance with the collection of specimens.

Varanus bulliwallah, sp. nov.

Form robust; snout broad, depressed on end, distance between anterior margin of orbit and tip of snout a little greater than distance between anterior margin of orbit and tympanum; moderate canthus rostralis; nostrils round, set on upper surface of snout on prominent ridges with longitudinal groove between, about one-third distance from tip of snout to orbit. Limbs stout, digits elongate; tail stout at base, strongly compressed laterally with a rapid taper, double keeled on the dorsal surface from about the first eighth, almost one and a quarter times longer than length of head and body. Tympanum round, exposed, about as large as orbit.

Head short, shields irregular, frontal and prefrontal scales largest, gradually diminishing to supraoculars, supratemporals and loreals; temporals small, granulated; labials and supratemporals somewhat hexagonal and regular; nuchals rounded and granular; dorsals more or less ovate, being entirely keeled; upper surface of limbs and tail with keeled scales. Scales on throat and under surface of limbs smooth, ovate; palmar scales small and tubercular; abdominals elongate, smooth, in about 126 transverse rows between gular fold and anus; subcaudals elongate, smooth, about 220, but tail incomplete.

Colour: Dark brown on dorsal surface with a small light spot on each scale, snout light brown, this colour extending along side of head to tympanum; ventral surface yellow with a regular series of dark transverse bands about four scale rows wide from gular fold to end of tail. There are a few darkish marks on labials. The iris is light greenish and tongue blue. Juveniles are conspicuously marked on dorsal surface with yellow spots.

Measurements: Total length of type 102 cm. or 40 inches. The tail is incomplete, its length being 55 cm. or 21 inches. The largest specimen we have in captivity at Ocean Beach Aquarium, Woy Woy, was collected at Bulliwallah Station and measures 120 cm. or 47 inches.

Discussion: *Varanus bulliwallah* cannot be easily confused with other monitor lizards as it is a conspicuously marked aquatic form. It occurs inland away from the coastal and mangrove habitat of *indicus*(1) and *salvator*.(2) It is at once distinguished from *indicus* and *salvator* by its short head and position of nostrils on upper surface of snout. The nearest form appears to be *salvator*, it can be separated thus:

Transversely enlarged supraoculars; oval keeled nuchals . . . *salvator*.

Supraoculars irregular, subequal; nuchals irregular without keels . . . *bulliwallah*.

Natural food consists of frogs and fish, and in captivity it is induced only with difficulty to eat anything else.

The type-specimen, in spirits, has been donated to the Australian Museum.

REFERENCES

Mertens, R. (1942).—Die Familie der Warane, pp. 14, 78.
Rooij, N. de (1915).—Rept. Indo-Aust. Arch. i, pp. 146-47.

EXPLANATIONS OF PLATES XXVII—XXIX.

Varanus bulliwallah, sp. nov., in life.
Varanus bulliwallah. Dorsal aspect of head.
Varanus bulliwallah. Lateral aspect of head.

A New Snake from Queensland

By ERIC WORRELL

(Figs. 1-3.)

Several years ago, while examining a collection of snakes at Melbourne Ward's Gallery of Natural History and Aboriginal Art in the Blue Mountains I came across a small snake, superficially resembling "*Denisonia gouldi*," from Dulacca, Queensland. I observed a number of differences, however, which were subsequently borne out in a large series from Queensland collected by Mr. W. Dunmall in the Glenmorgan area. A series of skulls from Queensland was compared with a series of skulls from *Denisonia gouldi* (Gray 1841) from Western Australian localities, and many obvious differences were noted. It is proposed to describe the Queensland snakes as a new species which I have pleasure in naming after Mr. J. Dwyer of Cairns, who was instrumental in locating Mr. Dunmall's series and obtaining working specimens.

Loveridge mentions a specimen of "*gouldi*" given by Mrs. H. McKee of Dalby to a member of the Harvard Expedition. Loveridge comments that this specimen, being the first recorded from Queensland, "should be received with caution." Apparently this was the same as the species I propose to describe as new, as Dalby is in the same area as Glenmorgan, and the snake is a common species.

ACKNOWLEDGMENTS

Thanks are due to Mr. W. Dunmall, Mr. M. Ward, Mr. L. Robichaux and Mr. J. Dwyer for specimens, and Mr. H. Chalmers for his assistance and X-rays. Mr. J. Dwyer kindly drew the illustrations.

Denisonia dwyeri, sp. nov.

Maxillary almost as far forward as palatine; ectopterygoid longer than lower aspect of maxillary bone; a pair of straight fangs is followed by four small grooved recurved teeth beginning at posterior of maxillary arch.

The obvious differences between the skulls of *Denisonia gouldi* and *Denisonia dwyeri* are illustrated. The most outstanding feature, however, is the greater prolongation of *dwyeri*, the smaller frontal foramen, the differently shaped premaxilla, fronto-nasals, prefrontals and post-parietal area.

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(1) *Tupinambis indicus*, Daudin, Rept. iii, 1802, p. 46, pl. XXX.
Varanus indicus, Boulenger, Cat. Liz. ii, 1885, p. 316 (s. syn.).
(2) *Stellio salvator* Laurenti, Syn. Rept., 1768, p. 56.
Varanus salvator Boulenger, Cat. Liz. ii, 1885, p. 314 (s. syn.).

In general form the head is larger and snout more depressed than in *gouldi* and the neck is a little more distinct. The snout is more pointed. There is no canthus rostralis. Eye about as large as its distance from mouth, pupil round. Body cylindrical to depressed, scales smooth in 15 rows, ventrals rounded.

Scalation: Rostral broader than deep, sharply angulate, in front, visible dorsally; nasal entire; internasals a little smaller than prefrontals; single prefrontal in contact with nasal; frontal posteriorly acute, almost $1\frac{1}{2}$ times as long as broad, longer than its distance to snout, about twice as broad and $1\frac{1}{2}$ times length of supraoculars; parietals large, temporals 2+2, anteriors larger; two postoculars; 6 supralabials, 3rd and 4th enter eye; 7 infralabials, 4th largest; two pairs of chinshields of similar size, both pairs in contact; 1st to 3rd or 4th infralabials in contact with anterior chin-shields; 4th, or 3rd and 4th infralabials in contact with posterior chin-shields.

The head-shields of paratypes agree with the type except that in the paratype lodged at Ocean Beach Aquarium a small pair of scales follows rostral, abnormally occupying part of interanasal area.
Glenmorgan type: 15 scale rows; ventrals 148; anal 1; subcaudals 31, entire.

Specimen donated to Australian Museum.

1a 1b 1c

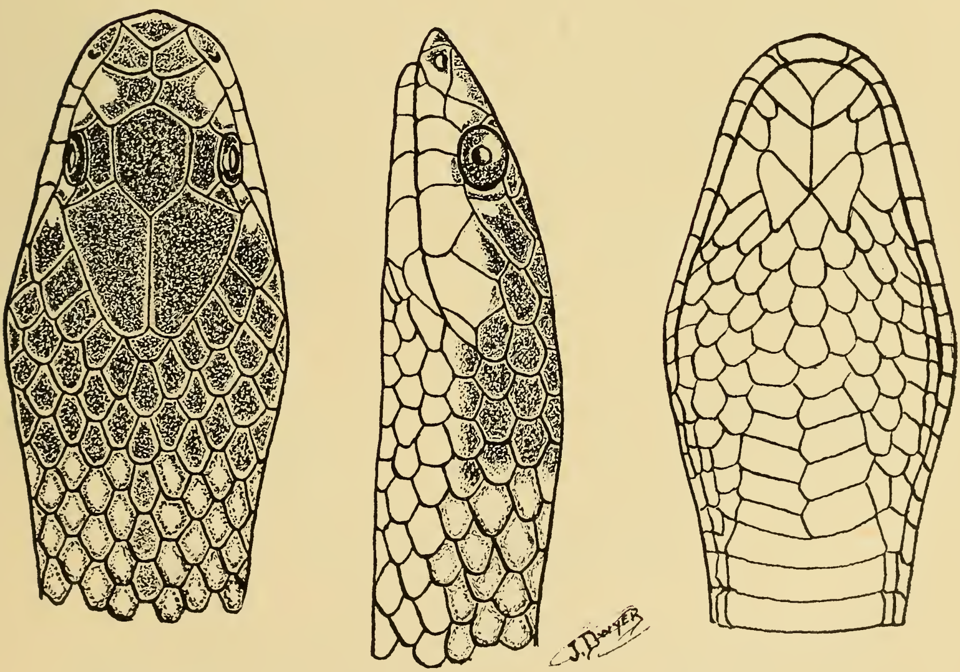


Fig. 1a. Dorsal aspect *Denisonia dwyeri.*
Fig. 1b. Lateral aspect *Denisonia dwyeri.*
Fig. 1c. Ventral aspect *Denisonia dwyeri.*

Glenmorgan paratype: 15 scale rows; ventrals 152; anal 1; subcaudals 25 entire. Specimen lodged in author's collection at Ocean Beach Aquarium, Woy Woy, N.S.W.

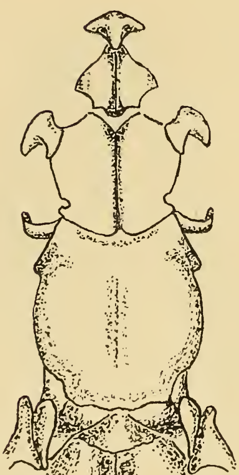
Dulacca paratype: 15 scale rows; ventrals 147; anal 1; subcaudals 27 entire. Specimen lodged at Melbourne Ward's Gallery of Natural History and Aboriginal Art, Medlow Bath, Blue Mountains, New South Wales.

Goorganga Ranges paratype: 15 scale rows; ventrals 152; anal 1; subcaudals 34 entire. Being the largest specimen from which a skull was taken, the body, collected damaged on the road, has been kept and is lodged at Ocean Beach Aquarium.

Colour: Juvenile to medium specimens black-headed with front of snout and sides of head whitish, body light brown with black reticulations around scales, the belly is white. In adult forms the body scales are dark brown to black.

Measurements: (Type) length 309 mm. or 12$\frac{1}{8}$ inches. Tail 40 mm., head 13 mm. The Goorganga specimen measures 484 mm. or 19 inches with a body-diameter of about 13 mm. or $\frac{1}{2}$ inch.

2



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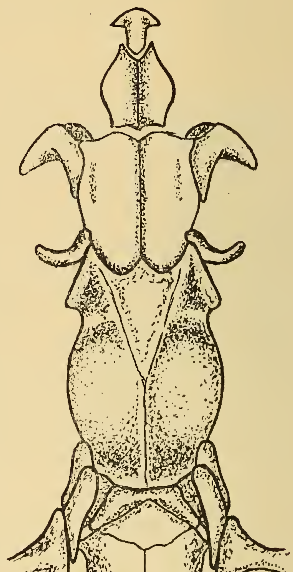


Fig. 2. Skull of *Denisonia gouldi.*
Fig. 3. Skull of *Denisonia dwyeri.*

Discussion.

These small snakes were all collected under flat stones, and a number I kept in captivity were nocturnal and fed on small skinks. While there are numerous osteological differences between *gouldi* and *dwyeri* the small size of most specimens of both snakes makes confusion likely on external characters alone. Adult specimens, when compared, are readily distinguishable.

The most consistent external features in which they differ to any marked degree are as follows:

Head large; rostral sharply angulate in front; frontal longer than its distance to snout .... *dwyeri*

Head smaller; rostral obtusely angulate; frontal about as long as its distance to tip of snout .... *gouldi*

REFERENCES

Boulenger, G. A. (1896).—Cat. Snakes Brit. Mus. iii, pp. 342-3.

Gray, J. E. (1841).—In G. Grey's Journ. Exped. West Aust. ii, pp. 432, 444.

Loveridge, A. (1934).—Bull. Mus. Comp. Zool. LXXVII, 6, p. 288.

Notes on Skull-characters of Some Australian Snakes

By ERIC WORRELL

(Plate XXX; Text-figures 3-8.)

In this paper obvious and consistent skull-characters are used to separate controversial species of snakes which are not readily separable by external features alone. Most systems based on scalation alone break down on a large enough series, especially when small snakes are concerned and infinitesimal dimensions must be considered. Colour on its own is unsatisfactory, although in this paper osteological differences are also supported by colour-differences. There are also ecological differences.

It is proposed to show that specific distinctions are present in the skulls of the following snakes: *Liasis fuscus*, *Liasis albertisii*, *Denisonia maculata*, *Denisonia devisii*, *Denisonia nigrescens*, *Denisonia pallidiceps*, *Denisonia coronoides*, *Denisonia mastersi*, *Denisonia nigrostriata*, *Denisonia gouldi*, *Demansia olivacea*, and *Demansia psammophis*.

In most part the illustrations are self-explanatory, so unnecessary measurements are not included in these notes. The characters are consistent in a series, and age-changes have been taken into consideration. The most variable age-changes take place in the parietal bone which in the juvenile stage is shorter and more bulbous at its proximation to the frontals which broaden slightly with age.

ACKNOWLEDGMENTS

I am grateful to Dr. N. G. Stephenson of the School of Zoology, Sydney University, and Mr. H. Chalmers of The Entrance, New South Wales, for their assistance with the preparation of this paper. Dr. Stephenson was kind enough to check some of my material and pointed out several important distinguishing features that I had overlooked besides making other helpful suggestions. Messrs. A. I. Ormsby, M. Ward, W. Dunmall, J. Dwyer, L. Robichaux and K. Slater supplied additional material for comparison with specimens lodged at Ocean Beach Aquarium, Umina, N.S.W.

Special thanks are due to Mr. J. Dwyer for his finely executed figures.

Subfamily PYTHONINAE.

Liasis fuscus Peters. Frontal bones as broad as deep; nasals small; postorbital laterally broadest at its suture with the maxillary; orbital periphery larger in diameter than in *L. albertisii*. Mandibular foramen reduced.

Dentition: Maxillaries about 21, slightly enlarged anteriorly with gradual degradation posteriorly; palatines 7, slightly enlarged anteriorly; pterygoids about 12, subequal; dentaries about 20, slightly enlarged anteriorly with slight posterior degradation. All teeth in both jaws more or less uniformly recurved.

Liasis albertisii Peters & Doria. Frontals broader than deep; nasals large; postorbital laterally narrowest at its suture with the maxillary. Mandibular foramen enlarged.

Dentition: Maxillaries about 23, greatly enlarged anteriorly, with a rapid degradation posteriorly; palatines 6, greatly enlarged anteriorly with rapid degradation; pterygoids subequal, about 17; dentaries about 23, greatly enlarged anteriorly, a rapid degradation, then a slightly perceptible degradation of the posterior half. Only the anterior teeth of both jaws are recurved to any exaggerated extent.

Family Elapidae.

Denisonia maculata (Steindachner). Colour blackish brown above with black-striped lips. Belly yellow, black spotted on outside edges. Specimens in this collection are from Rockhampton and districts west to Clermont and north to Bulliwallah Station, Queensland.

Frontal and nasal bones broader than deep; nasal and prefrontal in close proximation; pre- and postfrontal in closer proximation than in *devisii;* differences in the parietal and post-parietal area are illustrated.

Denisonia devisii Waite & Longman. Colour pale brown with multiple dark brown cross bars. Ventrals cream to yellow. Specimens examined from north of Cairns, western Queensland, inland northern New South Wales and western Murray River, New South Wales.

Frontal and nasal bones deeper than broad; nasal and prefrontal not in close proximation; prefrontal and postfrontal widely separated.

Denisonia nigrescens Gunther. Colour dark brown to black above, ventrals whitish to pink, sometimes blotched with black. Melanotic forms are not uncommon. Material examined from Cape York to Sydney area.

Frontal area as deep as broad; anterior border of prefrontal approximates nasal on lateral edge less than in *pallidiceps;* postfrontal sutured more forward on frontal on which foramen is prominent. Other differences are illustrated.

Denisonia pallidiceps Gunther. Colour rich brown with paler head and creamish abdominals. Specimens collected by author from Darwin, West Arm, Katherine and Mataranka, Northern Territory.

Frontals much deeper than broad; nasals prominently larger and frontals more angulate posteriorly than in *nigrescens.*

Demansia olivacea (Gray). Colour dark brownish above, olivaceus belly. In Mackay district colour is melanotic. Grows to a greater size than *D.p. psammophis* and its allies and ranges with this species in eastern Queensland from parts of Atherton Tablelands to south of Rockhampton. In north-western Australia, Northern Territory and northern islands *D. olivacea* ranges with *D.p. ornaticeps*, and in some localities in north Queensland it occurs with *D.p. torquata*. The largest *D. olivacea* in this collection measures 210 cm., or 6 feet 3 inches.

The posterior lobe of the parietal shows the same differences in material ranging from late embryonic to aged specimens, likewise the relationship of the postfrontal to maxillary bone; the septo-maxilla is in closer proximity to the maxillary than in *psammophis.*

Demansia psammophis psammophis (Schlegel). Colour greyish to pale russet with a yellow mark bordering eye. Ventrals greenish. Eastern Australia from north to south.

Denisonia coronoides (Gunther). Coloured sombre olive brown, greenish or brick red with white upper lip and grey to salmon or yellowish ventrals. Specimens in this collection examined from eastern New South Wales, Tasmania, Flinders Island and Mt. Gambier, South Australia.

Maxillary anterior to palatine; prefrontals not dilated at their suture with frontals; pterygoids posteriorly dilated.

Denisonia mastersi (Krefft). Colour brownish with dark peppering above, ventrals yellowish. Head is dark with yellowish collar. This collar is conspicuous in late embryonic material and loses little brilliance with age. Material examined from Moruya, Blue Mountains, and surrounding districts, New South Wales.

Maxillary not anterior to palatine; septo-maxilla in closer proximity to maxillary than in *coronoides;* prefrontals dilated at their suture with the frontals; pterygoids not dilated posteriorly.

Denisonia nigrostriata (Krefft). Colour reddish with conspicuous black vertebral strip usually present. Ventrals creamish. Series from north-eastern Queensland.

Nasals enlarged; frontal foramen enlarged; prefrontal closely proximates nasal; prefrontals dilated at suture with frontals. Other differences are illustrated.

Denisonia gouldi Gray. Colour pale brown to blackish with black head, white lips and creamish belly. Series examined from type locality, south-west Western Australia.

Nasals small; prefrontal spaced further from nasals than in *nigrostriata;* prefrontals not dilated at suture with frontals; frontal foramen less conspicuous than in *nigrostriata.*

ILLUSTRATIONS

Fig. 3a. *Liasis albertisii* (Dentition).
Fig. 3b. *Liasis albertisii* (Dorsal aspect of skull).
Fig. 3c. *Liasis fuscus* (Dentition).
Fig. 3d. *Liasis fuscus* (Dorsal aspect of skull).
Fig. 4a. *Denisonia maculata* (Dorsal aspect of skull).
Fig. 4b. *Denisonia devisii* (Dorsal aspect of skull).
Fig. 5a. *Denisonia nigrescens* (Dorsal aspect of skull).
Fig. 5b. *Denisonia pallidiceps* (Dorsal aspect of skull).
Fig. 6a. *Demansia olivacea* (Dorsal aspect of parietal).
Fig. 6b. *Demansia olivacea* (Dorsal aspect of prefrontal in relationship to maxillary).
Fig. 6c. *Demansia p. psammophis* (Dorsal aspect of parietal).
Fig. 6d. *Demansia p. psammophis* (Dorsal aspect of prefrontal in relationship to maxillary).
Fig. 7a. *Denisonia coronoides* (Dorsal aspect of fronto-nasals).
Fig. 7b. *Denisonia coronoides* (Ventral aspect of pterygoids).
Fig. 7c. *Denisonia mastersi* (Dorsal aspect of fronto-nasals).
Fig. 7d. *Denisonia mastersi* (Ventral aspect of pterygoids).
Fig. 8a. *Denisonia nigrostriata* (Dorsal aspect of skull).
Fig. 8b. *Denisonia gouldi* (Dorsal aspect of skull).

REFERENCES

Boulenger, G. A. (1896).—Cat. Snakes Brit. Mus. III, pp. 336-337, 341.

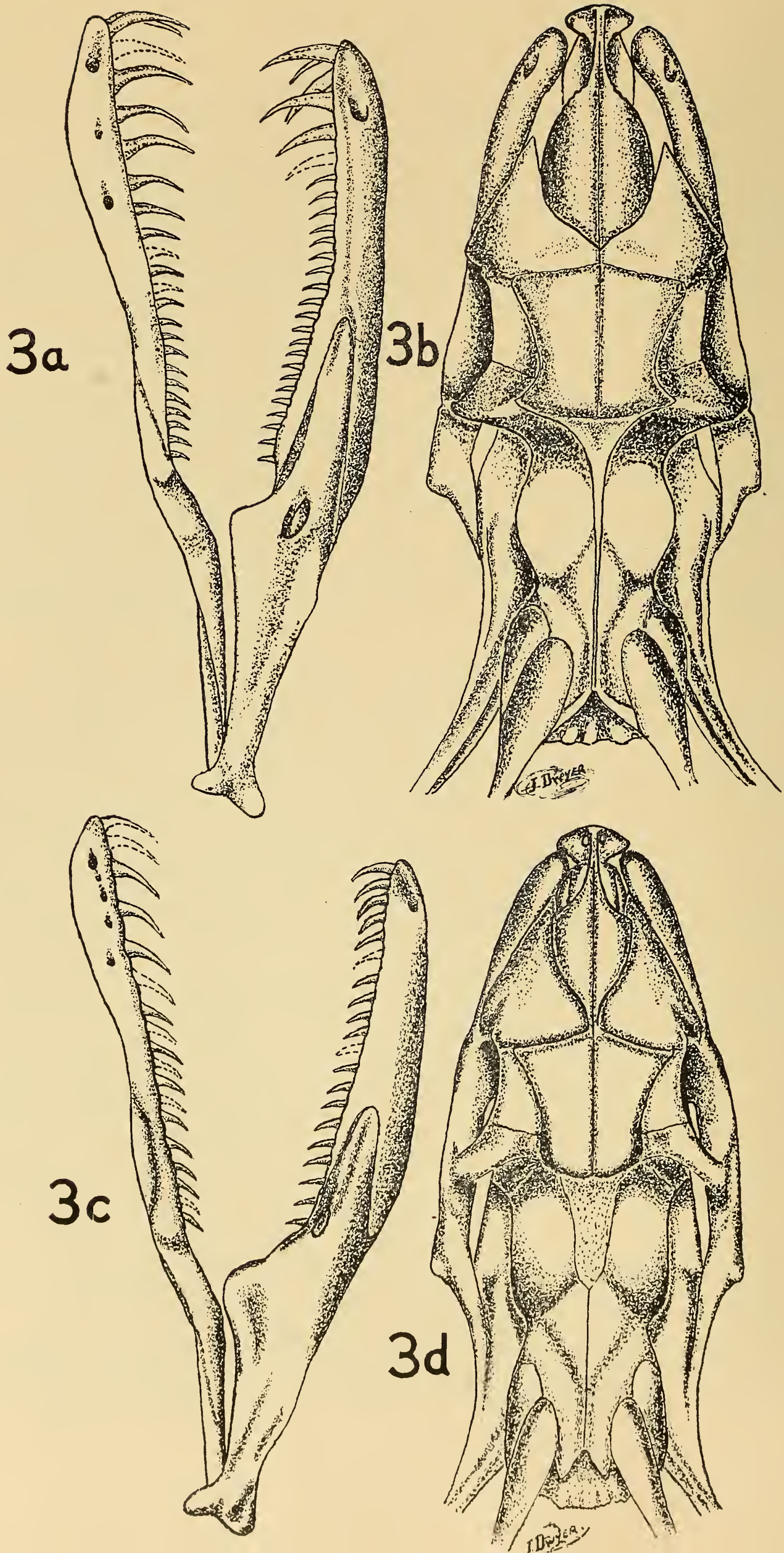
Kinghorn, J. R. (1929).—Snakes Aust. pp. 42-43, 103, 105, 110-111.

Kinghorn, J. R. (1942).—Rec. Aust. Mus. XXI, pp. 118-119.

Loveridge, A. (1934).—Bull. Mus. Comp. Zool. LXXVII, pp. 276-278, 287-289.

Loveridge, A. (1948).—Bull. Mus. Comp. Zool. CI, No. 2, p. 377.

Worrell, E. (1951).—Proc. Roy. Zool. Soc. of N.S.W., 1949-50, pp. 22-23.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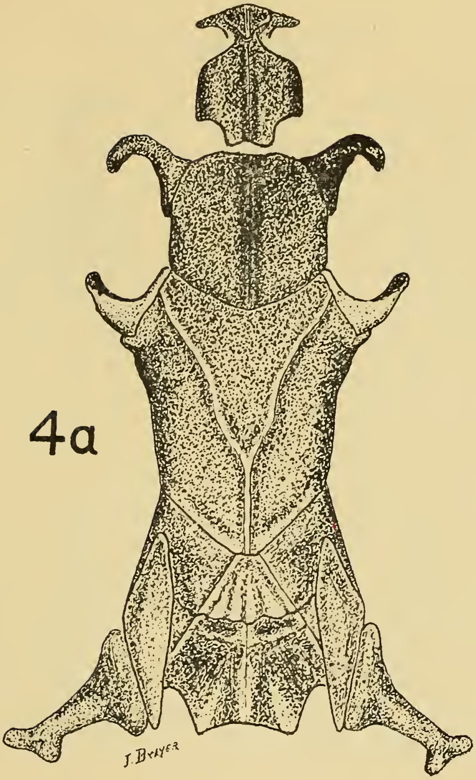
4a



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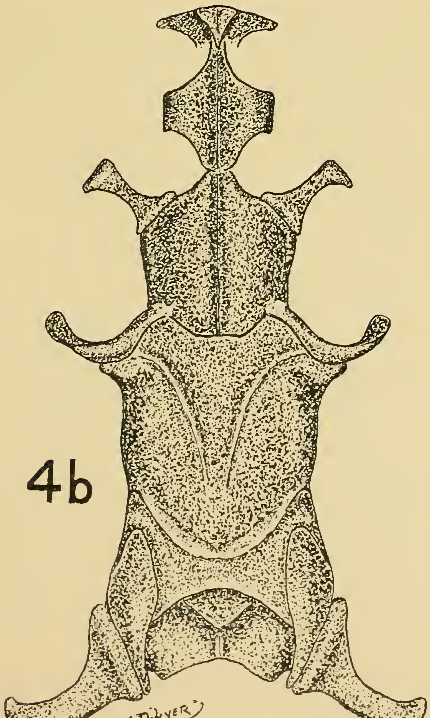

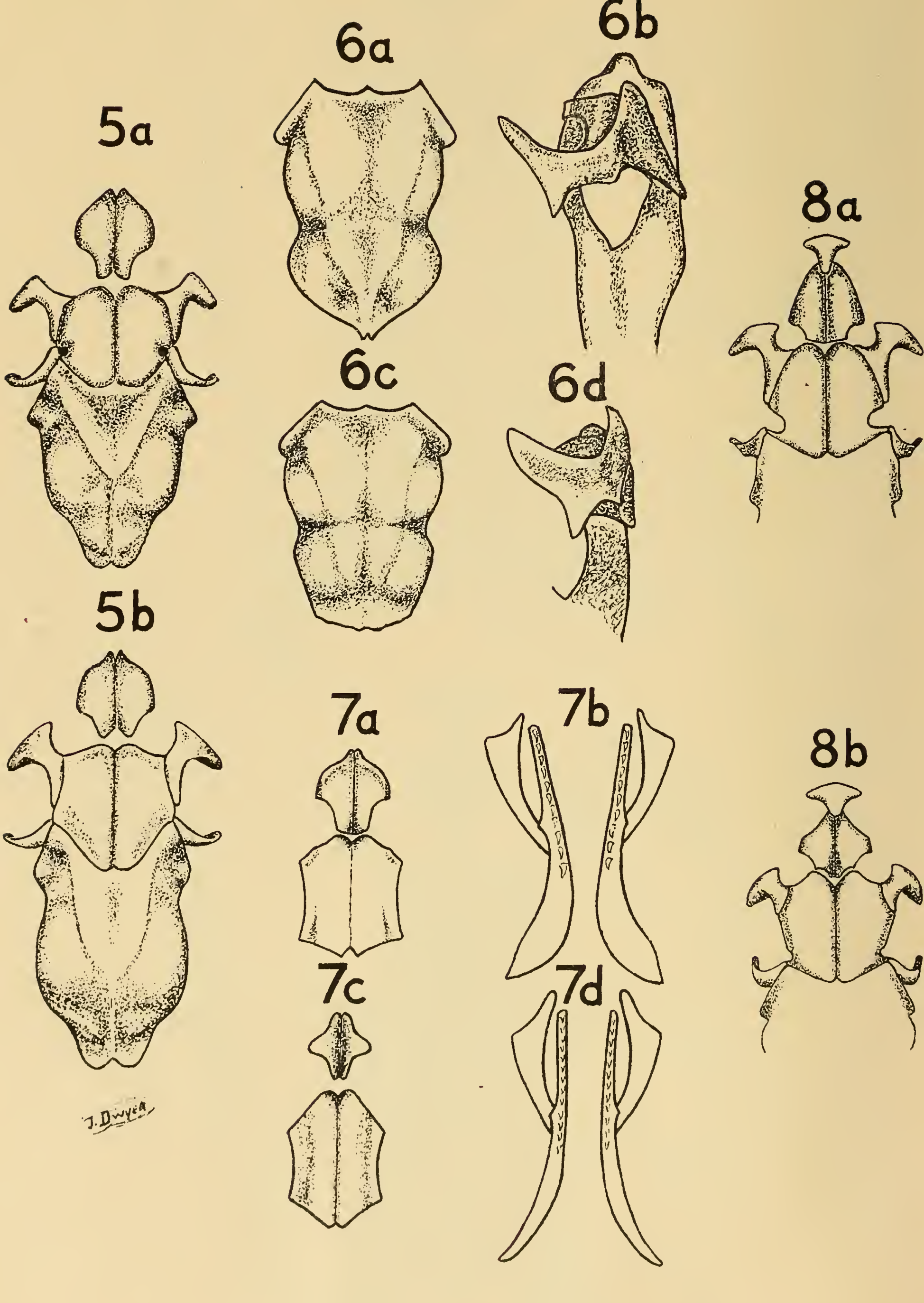
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J. Dwyer

The Published Writings of Tom Iredale with an Index of his New Scientific Names

By DONALD F. McMICHAEL and GILBERT P. WHITLEY
(Contribution from The Australian Museum, Sydney)

About 50 years ago in New Zealand, Mr. Tom Iredale began his scientific career with a short note on ornithology. Today, his published papers number well over 300, and range through many fields of scientific endeavour. We have known Tom Iredale for some years, and during that time, his willingness to help in every possible way has been of considerable importance to each of us. Therefore, as a tribute to his work and to himself, we present this list of his scientific papers, with an index to the new generic, subgeneric, specific and subspecific names which he has proposed in them. Tom Iredale is now approaching his seventy-seventh year, and still is as vigorous as ever in his scientific work. This list will thus only be complete to the time of its appearance, but it is felt that publication at this time will be of value to those taxonomists who have cause to refer to his writings, and also will serve to celebrate the golden anniversary of his scientific career.

In 1932, Iredale commenced the preparation of this list and index; he wrote then as follows:—

"There comes a time in the life of every scientific worker, engaged in taxonomic research, when memory will not recall easily every detail of past service. To anticipate such an event, the present account of twenty-five years' work has been prepared, and to facilitate access to other students is now printed and indexed.

"One hundred and seventy-five titles appear, and a series of almost one thousand names has been indexed. Many papers have been prepared in collaboration with other workers, and these are noted in connection with the paper they are concerned in, the essays being arranged strictly in chronological order."

Iredale's original list was never published, and he has kindly handed the manuscript over to us. Since that time, twenty-five more years have elapsed, and the list has almost doubled in size, while the index of names (2,542 new names are now recorded) has increased to an even greater extent. Chronological order has been maintained here, and it is believed that all papers are now included; practically every paper has been examined by one or other of us.

The names of Iredale's collaborators are listed below, and the papers in which they are concerned indicated. It should be noted here that Mr. Tom Iredale, who is still an Honorary Zoologist of the Australian Museum, Sydney, should not be confused with Dr. Thomas Iredale of the University of Sydney, author of papers in the field of physical chemistry.

All of the generic and subgeneric names which Iredale has proposed have been checked by us with Neave's *Nomenclator Zoologicus* (five volumes, including corrigenda and supplements, published 1939 to 1945) and the *Zoological Record* for the years 1945 to 1952. Of the many hundreds of names which he has proposed, very few are preoccupied, but quite a number have been missed from the above works. Some, of course, are later than the years covered by Neave and the *Zoological Record* to date. The preoccupied names and those not yet recorded are listed here, and we invite the attention of students and *Record* editors to them.

Preoccupied Names: Allenella, Botellus (=*Botelloides* Strand), *Cacozelia* (=*Cacozeliana* Strand), *Dotona* (=*Idulia* Leach), *Glyptelasma* (=*Bassethullia* Pilsbry), *Obrussa* (=*Obrussena* Iredale), *Oligotomus* (ex MacGillivray m.s., may be allowed to lapse), *Sheba*, *Stipator* (=*Starkeyna* Iredale), and *Vacerra.*

Unrecorded Names: Anisoperna, Atrocyclus, Baccalena, Badepigrus, Buffetia, Caporista, Cetothrax, Ciboticola, Cosatova, Coxielladda, Dialessa, Dirutrachia, Distuestoma, Doliolabis, Dyraspis, Edentiplica, Eltopera, *Emblanda. Epitrisis, Exocholeda, Exodiberus, Fatulabia. Feldestea, Findomelon, Fiscisepia, Glacipisum, Glyptanisus, Gyrodaria, Gyropena, Herewardia, Hildapina, Huonodon, Indacar, Inequarista, Insullaoma, Jardinella, Kamaleda, Kermarion. Kermodon. Lacustrelix, Lanilda, Loboptiloris, Maripythia, Melostrachia, Memonella, Miridas, Modonitor, Mussonula, Myapalmula, Nannochloritis, Nannoscutum, Neclarina, Nodulestea, Obescrobs, Oligotomus, Oppletora, Oppomorus, Opularca, Papualbinula, Parcolena, Parmavitrina, Patrubella, Peloparion, Penescosta, Periclocystis, Phintorene, Plananisus, Pravonitor, Pretostrea, Pterelectroma, Pupidrobia, Pygmanisus, Quaesiparens, Qualgibba, Salebrolabis, Scrobicoplax, Semilaoma, Sponvola, Stomatolina, Tucetopsis, Ultiscrobs, Varostium* and *Visendavis*.

Of these, only *Oligotomus* is preoccupied according to the records.

Collaborators with Tom Iredale:

Allan, Joyce, 249, 263, 314.
Bannerman, D. A., 84.
Barrett, Charles, 185.
Boardman, W., 129, 141, 170.
Cayley, N. W., 121.
Cooper, Roy, 217.
Cotton, B. C., 314.
Hull, A. F. Basset, 104, 109, 114, 118, 128, 131, 138, 142, 147, 148, 154, 162, 166, 180, 181.
Johnson, R. A., 182, 208, 212.
Kinghorn, J. R., 110.
Livingstone, A., 129, 141.
Marshall, A. J., 191.
Mathews, G. M., 19, 24, 27, 31, 33, 42, 49, 52, 56, 66, 67, 71, 73, 74, 76, 77, 78, 79, 80, 83, 86, 89, 90, 93, 94, 97, 98, 100, 133, 199, 200, 235.
May, W. L., 62.
McNeill, F. A., 129, 141.
Mestayer, M. K., 6.
O'Donoghue, C. D., 81.
Roughley, T. C., 189.
Sherborn, C. D., 81.
Hodge Smith, T., 115.
Tomlin, J. R. le B., 63.
Troughton, E. le G., 117, 187, 195, 216 .
Watson, C. J. J., 208.
Whitley, G. P., 140, 152, 164, 183, 185, 198, 233, 279.

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CHRONOLOGICAL LIST

1907

1. On the Occurrence in New Zealand of *Platalea regia*, Gould.
Trans. New Zealand Inst., 39: 137, June, 1907.

1908

2. *Synoecus australis* in New Zealand.
Emu, 7: 165, January, 1908.
3. Notes on some New Zealand Marine Molluscs.
Trans. New Zealand Inst., 40: 373-378, pl. 31, "June" (=October), 1908.
4. A Preliminary List of the Marine Mollusca of Banks Peninsula, New Zealand.
Trans. New Zealand Inst., 40: 387-403, "June" (=October), 1908.
5. List of Marine Molluscs collected in Otago.
Trans. New Zealand Inst., 40: 404-410, "June" (=October), 1908.

6. List of Marine Mollusca from Lyall Bay, near Wellington, New Zealand. (By T.I. and M. K. Mestayer.)
Trans. New Zealand Inst., 40: 410-415, "June" (=October), 1908.
7. Additional List of Mollusca: Minute species found in Sand at Titahi Bay, New Zealand.
Trans. New Zealand Inst., 40: 559, "June" (=October), 1908.

1910

8. Bird Life on the Kermadec Islands.
Emu, 10: 2-16, pls. 2-5, January, 1910.
9. On Marine Mollusca from the Kermadec Islands, and on the "*Sinusigera* Apex."
Proc. Mal. Soc. London, 9: 68-79, March 31, 1910.
10. Notes on Polyplacophora, chiefly Australasian. (Part 1.)
Proc. Mal. Soc. London, 9: 90-105, June 30, 1910.
11. Some Notes on Pyramidellid Nomenclature.
Nautilus, 24: 52-58, September, 1910.
12. Notes on Polyplacophora, chiefly Australasian. (Part 2.)
Proc. Mal. Soc. London. 9: 153-162 September 26, 1910.

1911

13. On Marine Mollusca from the Kermadec Islands and on the "*Sinusigera* Apex."
Proc. New Zealand Inst. for 1910, pt. 2: 57-58, January 18, 1911. (Abstract and list of names from (9) above.)
14. A new generic name for the Australian Crane.
Bull. British Orn. Club, 27: 47, January 23, 1911.
15. An additional Note on the Birds of Lord Howe and Norfolk Islands.
Proc. Linn. Soc. New South Wales, 25: 773-782, March, 1911.
16. On some misapplied Molluscan Generic Names.
Proc. Mal. Soc. London, 9: 253-263, March 30, 1911.
17. Description of *Cinclorhamphus rufescens mathewsi*.
Bull. British Orn. Club, 27: 97-98, May 26, 1911.
18. On the value of the Gastropod Apex in Classification.
Proc. Mal. Soc. London. 9: 319-323, June 30, 1911.

1912

19. "Perry's Arcana"—an overlooked work. (G. M. Mathews and T.I.)
Victorian Naturalist, 29: 7-16, May 9, 1912.
20. New Generic Names and new species of Marine Mollusca.
Proc. Mal. Soc. London. 10: 217-228, pl. 9, 3 text figs., October 30, 1912.

1913

21. Solander as an Ornithologist.
Ibis, 1913: 127-135, January, 1913.
22. On the type specimen of *Larus affinis* Reinhardt.
Bull. British Orn. Club, 31: 68-69, January, 1913.
23. A Collation of the Molluscan Parts of the Synopses of the Contents of the British Museum, 1835-1845.
Proc. Mal. Soc. London, 10: 294-309, March 28, 1913.
24. A Reference List of the Birds of New Zealand. Part 1. (G. M. Mathews and T.I.)
Ibis, 1913: 201-263, April 2, 1913. (Issued as Separate with Part 2, No. 27 below.)
25. The Lesser Blackbacked Gull of the British Islands.
British Birds, 6: 360-364, pl., May 1, 1913.
26. Concerning the Kermadec Islands Avifauna.
Trans. New Zealand Inst., 45: 78-92, June 9, 1913.
27. A Reference List of the Birds of New Zealand. Part 2. G. M. Mathews and T.I.)
Ibis, 1913: 402-452, July 1, 1913.
28. On some interesting birds in the Vienna Museum.
Austral Avian Rec., 2: 14-32, August 2, 1913.

29. The generic name to be used for *Murex tritonis* Linne.
Nautilus, 27: 55-56, September, 1913.
30. The Land Mollusca of the Kermadec Islands.
Proc. Mal. Soc. London, 10: 364-388, pl. 18, September 22, 1913.
31. Notes on Billberg's Synopsis Faunae Scandinaviae. (G. M. Mathews and T.I.)
Austral Avian Rec., 2: 33-48, October 23, 1913.

1914

32. The Chiton Fauna of the Kermadec Islands.
Proc. Mal. Soc. London, 11: 25-51, pls. 1 & 2, March 30, 1914.
33. Description of a strange New Zealand Wood-Hen. (G. M. Mathews and T.I.)
Ibis, 1914: 293-297, pl. 11, April 2, 1914.
34. The genus-name *Martensia*, Semper.
Proc. Mal. Soc. London, 11: 120-122, June 24, 1914.
35. Some more notes on Polyplacophora. Part 1.
Proc. Mal. Soc. London, 11: 123-131, June 24, 1914.
36. The Surface Breeding Petrels of the Kermadec Group.
Ibis, 1914: 423-436, pl. 15, July 3, 1914.
37. On *Sterna fuscata* Linne.
Ibis, 1914: 436-437, pl. 16, July 3, 1914.
38. Report on Mollusca collected at the Monte Bello Islands.
Proc. Zoo. Soc. London, 1914: 665-675, 3 text figs., September, 1914.
39. On Some Invalid Molluscan Generic Names.
Proc. Mal. Soc. London, 11: 170-178, September 5, 1914.
40. Description of a new species of *Cassidea*.
Proc. Mal. Soc. London, 11: 179-180, text fig., September 5, 1914.
41. On the Genus-name *Mathewsia*.
Austral Avian Rec., 2: 81-82, September 24, 1914.
42. Notes on some Birds from the Kermadec Islands. (G. M. Mathews and T.I.)
Austral Avian Rec., 2: 113-114, September 24, 1914.
43. On *Herodias eulophates* Swinhoe.
Ibis, 1914: 541-545, pl. 20, October 1, 1914.

1915

44. Review: "Manual of the New Zealand Mollusca."
Journ. of Conchol., 14: 287-288, January 1, 1915.
45. Discussion of "Coloration as a Factor in Family Differentiation."
Bull. British Orn. Club, 35: 82-83, February 27, 1915.
46. The New B.O.U. List; more corrections.
Ibis, 1915: 388-390, April 8, 1915.
47. Some more misused Molluscan Generic Names.
Proc. Mal. Soc. London, 11: 291-306, June 17, 1915.
48. On Humphrey's Conchology.
Proc. Mal. Soc. London, 11: 307-309, June 17, 1915.
49. On the Ornithology of the Dictionnaire des Sciences Naturelles (Levrault). (G. M. Mathews and T.I.)
Austral Avian Rec., 3: 5-20, June 30, 1915.
50. British Bird Names.
British Birds, 9: 53-54, July 1, 1915.
51. The Nomenclature of British Marine Mollusca.
Journ. of Conchol., 14: 341-346, July 1, 1915.
52. On Some Petrels from the North-East Pacific Ocean. (G. M. Mathews and T.I.)
Ibis, 1915: 572-509, text figs., July 2, 1915.
53. A Commentary on Suter's "Manual of the New Zealand Mollusca."
Trans. New Zealand Inst., 47: 417-497, July 12, 1915.
54. A Comparison of the Land Molluscan Faunas of the Kermadec Group and Norfolk Island.
Trans. New Zealand Inst., 47: 498-508, July 12, 1915.

55. Notes on the Names of Some British Marine Mollusca.
Proc. Mal. Soc. London, 11: 329-342, August 20, 1915.
56. On the "Table des Planches Enlum." of Boddaert. (G .M. Mathews and T.I.)
Austral Avian Rec., 3: 31-51, November 19, 1915.

1916

57. Discussion of "Bird Parasites and Bird Phylogeny."
Bull. British Orn. Club, 36: 53-54, February 3, 1916.
58. On Some New and Old Molluscan Generic Names.
Proc. Mal. Soc. London, 12: 27-37, March 20, 1916.
59. Questions de Nomenclature.
Revue Critique de Paleozoologie, 20th year, No. 3: 128-131, July, 1916.
60. On Two Editions of Dumeril's Zoologie Analytique.
Proc. Mal. Soc. London, 12: 79-84, November 28, 1916.
61. Solander as a Conchologist.
Proc. Mal. Soc. London, 12: 85-93, November 28, 1916.
62. Misnamed Tasmanian Chitons. (T. I. and W. L. May.)
Proc. Mal. Soc. London, 12: 94-117, pls. 4 & 5, November 28, 1916.

1917

63. *Lienardia mighelsi* nom. nov. (T.I. and J. R. le B. Tomlin.)
Journ. of Conchol., 15: 216, August 15, 1917.
64. More Molluscan Name-Changes, Generic and Specific.
Proc. Mal. Soc. London, 12: 322-330, November 10, 1917.
65. On some new species of Marine Mollusca from Christmas Island, Indian Ocean.
Proc. Mal. Soc. London, 12: 331-334, pl. 13, November 10, 1917.
66. Avian Nomenclatorial Notes. (G. M. Mathews and T.I.)
Austral Avian Rec., 3: 113-126, December 28, 1917.

1918

67. A Forgotten Ornithologist. (G. M. Mathews and T.I.)
Austral Avian Rec., 3: 142-150, June 25, 1918.
68. The Validity of Some Generic Terms. (G. M. Mathews and T.I.)
Austral Avian Rec., 3: 151-158, June 25, 1918.
69. Review: "Loomis on the Petrels etc."
Ibis, 1918: 502-505, July 15, 1918.
70. Molluscan Nomenclatural Problems and Solutions—No. 1.
Proc. Mal. Soc. London, 13: 28-40, September 9, 1918.

1919

71. Proper Name of the Tree Sparrow. (G. M. Mathews and T.I.)
Auk, 36: 114, January 5, 1919.

1920

72. Avian Taxonomy. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 29-48, July 28, 1920.
73. A Name-List of the Birds of New Zealand. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 49-64, July 28, 1920.
74. A Name-List of the Birds of Australia. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 65-72, July 28, 1920. (See No. 76 below.)
75. Preliminary Notice of Roy Bell's Molluscan Collections.
Proc. Mal. Soc. London, 14: 48, September 20, 1920.
76. A Name-List of the Birds of Australia (Concluded). (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 73-113, December 16, 1920.
77. Forgotten Bird-Artists and an Old-Time Ornithologist. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 114-122, December 16, 1920.
78. Snipe and Sandpipers: A Rearrangement. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 123-219, December 16, 1920.
79. Sherborn and the Systematist. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 130-134, December 16, 1920.

1921

80. A Manual of the Birds of Australia. (G. M. Mathews and T.I.)
4to. Witherby & Co., London, Vol. 1, pp. I-XXIV, 1-279, col. pls. 1-10, b. & w. pls. 1-36, March 9, 1921.
81. J. F. Miller's Icones. (C. D. Sherborn and T.I.)
Ibis, 1921: 302-309, April 4, 1921.
82. Report of the B.O.U. Sub-committee. (E. Hartert, T.I. and W. L. Sclater.)
Ibis, 1921: 310-316, April 4, 1921.
83. The Nature of the New Zealand Avifauna. (G. M. Mathews and T.I.)
Emu, 20: 210-221, April 23, 1921.
84. Note on the generic names *Textor* and *Hyphantornis*. (T.I. and D. A. Bannerman).
Bull. British Orn. Club, 41: 128-219, May 26, 1921.
85. Unpublished Plates of Thomas Martyn, Conchologist.
Proc. Mal. Soc. London, 14: 131-134, June 23, 1921.
86. Notes of Interest. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 139-164, August 1, 1921.
87. Molluscan Nomenclatural Problems and Solutions. No. 2.
Proc. Mal. Soc. London, 14: 198-208, October 24, 1921.
88. Description of *Phalaropus fulicarius jourdaini*.
Bull. British Orn. Club. 42: 8, October 29, 1921.

1922

89. An Extraordinary Bird Book. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 172-175, March 7, 1922.
90. Captain Thomas Brown, Ornithologist. (G. M. Mathews and T.I.)
Austral Avian Rec., 4: 176-194, March 7, 1922.
91. A reply on the genera *Neptunea* and *Syncera*.
Proc. Mal. Soc. London, 15: 37, April, 1922.
92. The nomination of "Recent" Fossil Mollusca.
Proc. Mal. Soc. London, 15: 37-38, April, 1922.
93. Jarocki Again. (G. M. Mathews and T.I.)
Austral Avian Rec., 5: 20-21, July 17, 1922.
94. Thomas Watling, Artist. (G. M. Mathews and T.I.)
Austral Avian Rec., 5: 22-32, 7 col. pls., July 17, 1922.
95. *Mathewsiella*, a new generic name.
Bull. British Orn. Club, 43: 39, November 29, 1922.
96. Book Notes.
Proc. Mal. Soc. London, 15: 78-92, December, 1922.

1923

97. More Notes of Interest. (G. M. Mathews and T.I.)
Austral Avian Rec., 5: 45-73, February 21, 1923.
98. On Type Designation of Avian Genera. (G. M. Mathews and T.I.)
Austral Avian Rec., 5: 74-80, February 21, 1923.
99. List of British Nudibranchiate Mollusca. (T.I. and C. D. O'Donoghue.)
Proc. Mal. Soc. London, 15: 195-233, March, 1923.
100. The Name of the British Song-Thrush. (G. M. Mathews and T.I.)
British Birds, 17: 47-48, July 2, 1923.
101. Report of the (B.O.U.) Committee on . . . Nomenclature . . . of Birds. (T.I. and others.)
Ibis, 1923: 424-435, July, 1923.
102. Australian Petrel Forms: Still More to Learn.
Emu, 23: 96-100, October 1, 1923.
103. The Snowy Albatross in Sydney Harbour.
Australian Zoologist, 3: 168, December 18, 1923.
104. A Monograph of the Australian Loricates. Part 1. (T.I. and A. F. Basset Hull).
Australian Zoologist, 3: 186-194, 4 text figs., December 18, 1923.

1924

105. Fourth Report of the (B.O.U.) Committee on . . . Nomenclature . . . (T.I. and others.)
Ibis, 1924: 152-158, January, 1924.

106. Living on a Volcano.
Australian Museum Mag., 2: 24-29, 7 text figs., January, 1924.

107. Book Review: "Linnaeus."
Australian Museum Mag., 2: 71-72, April, 1924.

108. Lhotsky's Lament.
Australian Zoologist, 3: 223-226, May 9, 1924.

109. A Monograph of the Australian Loricates. Part 2. (T.I. and A. F. Basset Hull.)
Australian Zoologist, 3: 227-238, pls. 33 & 34, May 9, 1924.

110. The Rediscovery of the Whitebacked Wren, *Malurus leuconotus* Gould. (J. R. Kinghorn and T.I.)
Emu, 24: 59-60, July 4, 1924.

111. Museums of the Past.
Australian Museum Mag., 2: 88-93, 2 pls., 2 text figs., July 8, 1924. Abstracted in *The Naturalist* (ed. T. Sheppard), 819: 99-101, 2 figs., April 1925.

112. As Extinct as the Dodo.
Australian Museum Mag., 2: 117-120, 4 text figs., October, 1924.

113. Fairy Wrens.
Australian Zoologist, 3: 264-268, text figs., October 7, 1924.

114. A Monograph of the Australian Loricates. Part 3. (T.I. and A. F. Basset Hull.)
Australian Zoologist, 3: 277-297, pls. 35-37, text figs., October 7, 1924.

115. Evidence of a Negative Movement of the Strand Line of 400 Feet in New South Wales. (T. Hodge Smith and T.I.)
Journ. Roy. Soc. New South Wales, 58: 157-168, pl. 7, 2 text figs., October 20, 1924.

116. Results from Roy Bell's Molluscan Collections.
Proc. Linn. Soc. New South Wales, 49: 179-278, pl. 33 & 34, October 24, 1924.

1925

117. Captain Cook's Kangaroo. (T.I. and E. le G. Troughton.)
Australian Zoologist, 3: 311-316, pl. 41, January 14, 1925.

118. A Monograph of the Australian Loricates. Part 4. (T.I. and A. F. Basset Hull.)
Australian Zoologist, 3: 339-362, pls. 39 & 40, January 14, 1925.

119. Mollusca from the Continental Shelf of Eastern Australia.
Rec. Australian Museum, 14: 243-270, pls. 41-42, text figs., April 9, 1925.

120. Cook's Artists.
Sydney Morning Herald, May 30, 1925, p. 13, text fig.

121. Australian Crested Penguins. (T.I. and N. W. Cayley.)
Emu, 25: 1-6, 3 pls., July, 1925.

122. Captain Cook's Artists.
Australian Museum Mag., 2: 224-230, 2 pls., 5 text figs., July, 1925.

123. The Scientific Name of our Club's Badge.
Victorian Naturalist, 42: 128, September, 1925.

124. The Status of *Amicula*.
Nautilus, 39: 47-49, October, 1925.

125. W. H. Hargraves. (Obituary Notice.)
Nautilus, 39: 68-69, October, 1925.

126. R. Murdoch. (Obituary Notice.)
Nautilus, 39: 69-70, October, 1925.

127. George Forster's Paintings.
Australian Zoologist, 4: 48-53, pls. 6-8, text figs., November 10, 1925.

128. A Monograph of the Australian Loricates. Part 5. (T.I. and A. F. Basset Hull.)

Australian Zoologist. 4: 75-111, pls. 9-12, 3 text figs., November 10, 1925.

129. Life of the Tidal Flats. (T.I. and others.)
Australian Museum Mag., 2: 285-290, 7 text figs., October-December, 1925. (Reprinted in *Sydney Harbour Trust Officers' Journ.*, 5, No. 5, 2-10, October, 1929.)

1926

130. J. Douglas Ogilby.
Auk, 1926: 138, January, 1926. (Reprinted in Biographies of Members of the American Ornithologists' Union (Washington, D.C.), p. 432, 1954.)
131. A Monograph of the Australian Loricates. Part 6. (T.I. and A. F. Basset Hull.)
Australian Zoologist, 4: 164-185, pls. 18-20, 4 text figs., February 22, 1926.
132. The Cuttle-Fish 'Bones' of the Sydney Beaches.
Australian Zoologist, 4: 186-196, pls. 21-23, 3 text figs., February 22, 1926.
133. Descriptions of New Genera of Birds. (T.I. and G. M. Mathews.)
Bull. British Orn. Club, 45: 76, February 25, 1926.
134. Three Victorian Species of *Ophicardelus* (Class Mollusca).
Victorian Naturalist, 42: 268-270, 3 text figs., March, 1926.
135. The Last Word on *Ancylastrum*.
Nautilus, 39: 114-115 ,April, 1926.
136. W. Lewis May. (Obituary Notice.)
Nautilus, 39: 140-141, April, 1926.
137. The Biology of North-west Islet, Capricorn Group (D). Marine Molluscs.
Australian Zoologist, 4: 237-240, pl. 35, April 28, 1926.
138. A Monograph of the Australian Loricates. Part 7. (T.I. and A. F. Basset Hull.)
Australian Zoologist, 4: 256-276, pls. 37-39, April 28, 1926.
139. The Cameo Shell.
Australian Museum Mag., 2: 415-417, pl., 2 text figs., October, 1926.
140. The Birth of an Island. (T.I. and G. P. Whitley.)
Australian Museum Mag., 2: 418-421, 5 text figs., October, 1926.
141. More Life of the Tidal Flats. (T.I. and others.)
Australian Museum Mag., 2: 429-434, 8 text figs., October, 1926.
142. A Monograph of the Australian Loricates. Part 8. (T.I. and A. F. Basset Hull.)
Australian Zoologist, 4: 324-328, pl. 45, November 30, 1926.

1927

143. A Review of Australian Helmet Shells. (Family Cassididae—Phylum Mollusca.)
Rec. Australian Museum, 15: 321-353, pls. 31 & 32, April 16, 1927.
144. The Snowy Albatross Again.
Emu, 26: 282-285, pls. 41 & 42, April 30, 1927.
145. The "Resurrected" Snail.
Australian Museum Mag., 3: 71-72, 1 text fig., April, 1927.
146. Caloundra Shells.
Australian Zoologist, 4: 331-336, pl. 46, May 18, 1927.
147. A Monograph of the Australian Loricates. Part 9. (T.I. and A. F. Basset Hull.)
Australian Zoologist, 4: 339-359, pls. 47-49, May 18, 1927.
148. A Monograph of the Australian Loricates. (T.I. and A. F. Basset Hull.)
4to., Roy. Zool. Soc. New South Wales, pp. I-XIII, 1-168, Frontispiece, pls. 1-21, 12 text figs., July 20, 1927.
149. New Molluscs from Vanikoro.
Rec. Australian Museum, 16: 73-78, pl. 5, October 7, 1927.

1928

150. A Waveguarded Kingdom of Birds.
Emu, 27: 271-274, pls. 41 & 42, April 3, 1928.

151. War Against Pests. (T.I. and F. A. McNeill.)
Australian Museum Mag., 3: 197-200, 6 text figs., April-June, 1928.

152. Feathers and Fins. (The Birds and Fishes of Michaelmas Cay, Great Barrier Reef, Queensland.) (T.I. and G. P. Whitley.)
Australian Museum Mag., 3: 248-252, 4 text figs., July 13, 1928.

153. Review: "Contribution a l'etude des Nudibranches Neo Caledoniens, by Jean Risbec, Docteur es sciences . . ."
Australian Zoologist, 5: 261, August 17, 1928.

1929

154. The Loricates of the Neozelanic Region. (T.I. and A. F. Basset Hull.) (See Nos. 162, 166, 180 & 181 below.)
Australian Zoologist, 5: 305-323, pl. 34, 4 text figs., "March 24" (=March 23), 1929.

155. Strange Molluscs in Sydney Harbour.
Australian Zoologist, 5: 337-352, pls. 37 & 38, "March 24" (=March 23), 1929. (Introductory remarks and plates reprinted in *Sydney Harbour Trust Officers' Journal*, 5, No. 2: 20-24, pls. A & B, July 1929.)

156. The Bird of Providence.
Australian Zoologist, 5: 358-361, pls. 39 & 40, "March 24" (=March 23), 1929.

157. The Vicissitudes of a Noddy; a Christmas Story.
Emu, 28: 290-291, April 2, 1929.

158. The Avifaunal Districts of Australia. (Abstract.)
Rept. Austr. Assoc. Adv. Sci. (Hobart, 1928), 19: 244-245, May, 1929.

159. Naturalists in Australia—the Frenchmen.
Australian Museum Mag., 3: 357-360, 5 text figs., April-June, 1929.

160. Queensland Molluscan Notes, No. 1.
Mem. Queensland Museum, 9: 261-297, pls. 30 & 31, June 29, 1929.

161. The Bird Man.
Australian Museum Mag., 3: 375-378, 3 text figs., July 18, 1929. (Reprinted with altered figures in *Gould League Songs and Poems*. Publ. by New South Wales Gould League of Bird Lovers, Sydney, pp. 8-11, 2 figs., August-September, 1934.)

162. The Loricates of the Neozelanic Region. (T.I. and A. F. Basset Hull.) (See Nos. 154 above & 166, 180 & 181 below.)
Australian Zoologist, 6: 75-95, pls. 9 & 10, August 13, 1929.

163. Mollusca from the Continental Shelf of Eastern Australia. No. 2.
Rec. Australian Museum, 17: 157-189, pls. 38-41, September 4, 1929.

164. Captain Cook's Leatherjacket. (T.I. and G. P. Whitley.)
Australian Museum Mag., 3: 421-425, 4 text figs., October 24, 1929.

1930

165. Avian Sea-Toll.
Australian Zoologist, 6: 112-116, pl. 13, January 14, 1930.

166. The Loricates of the Neozelanic Region. (T.I. and A. F. Basset Hull.) (See Nos. 154 & 162 above, & 180 & 181 below.)
Australian Zoologist, 6: 157-168, pl. 16, January 14, 1930.

167. Some Notable Name-changes.
Australian Zoologist, 6: 175, January 14, 1930.

168. The Passing of Campbell and Leach. (Obituary Notices.)
Australian Zoologist, 6: 176-177, January 14, 1930.

169. More Notes on the Marine Mollusca of New South Wales.
Rec. Australian Museum, 17: 384-407, pls. 62-65, June 27, 1930.

170. Marine Zoological Section Annual Report. (T.I. and W. Boardman.)
Australian Zoologist, 6: 186-187, August 20, 1930.

171. Queensland Molluscan Notes, No. 2.
Mem. Queensland Museum, 10: 73-88, pl. 9, August 28, 1930.

172. The Waterhouse Collections—Shells.
Australian Museum Mag., 4: 113-114, October 16, 1930.
173. John Brazier, Conchologist.
Australian Museum Mag., 4: 142-143, portrait, October 16, 1930.
174. Notes on Some Desert Snails.
Victorian Naturalist, 47: 118-120, text fig., November 5, 1930.

1931

175. John Brazier 1842-1930. (Obituary Notice.)
Nautilus, 44: 95-96, January, 1931.
176. Obituary Notice: John Brazier.
Journ. of Conchol., 19: 110, March, 1931.
177. Book Review: "British Antarctic ("Terra Nova") Expedition 1910 . . . Birds."
Emu, 30: 313, April, 1931.
178. Sea Kings of the Air.
Nature Magazine (Washington, D.C.), 17: 390-393, 6 text figs., June, 1931.
179. Australian Molluscan Notes. No. 1.
Rec. Australian Museum. 18: 201-235, pls. 22-25, June 29, 1931. (Reprinted in parts with altered titles and introductory text only in *Sydney Harbour Trust Officers' Journal*, 7, No. 3: 24-25, August, 1931. *Ibid*, 7, No. 4: 10-11, September, 1931; *Ibid*, 7, No. 5: 8-9, October, 1931; *Ibid*, 7, No. 6: 24-25, November 1931.)
180. The Loricates of the Neozelanic Region. (T.I. and A. F. Basset Hull.) (See Nos. 154, 162 & 166 above and 181 below.)
Australian Zoologist, 7: 59-76, pl. 3, text figs. 1 & 2, August 24, 1931.

1932

181. The Loricates of the Neozelanic Region. (T.I. and A. F. Basset Hull.) (See Nos. 154, 162, 166 & 180 above.)
Australian Zoologist, 7: 119-164, pls. 7-10, text figs., February 5, 1932.
182. Destruction of Timber by Marine Organisms in the Port of Sydney. (T.I. and R. A. Johnson and F. A. McNeill.)
8vo, Publ. by the Sydney Harbour Trust, Sydney, pp. 1-148, pls. 1-4, 24 text figs., 1 map, 45 graphs, "May" (=June 17), 1932.
(Included in the above: Cobra or Shipworms. A Systematic Account of the Teredinid Molluscs of Port Jackson (by T.I. alone.) pp. 24-40, pls. 1-4, 5 text figs.)
183. Blandowski. (T.I. and G. P. Whitley.)
Victorian Naturalist, 49: 90-96, August 8, 1932.
184. Ornithological Section Annual Report.
Australian Zoologist, 7: 170-172, September 15, 1932.

1933

185. Water Life. (Charles Barrett, assisted by G. P. Whitley and T.I.)
Sun Nature Book, 4 (Sun News-Pictorial, Melbourne), 44 pp., illustr., February 6, 1933.
186. Branches Reports. New South Wales.
Emu, 32: 276-278, April 1, 1933.
187. The Correct Generic Names for the Grampus or Killer Whale, and the so-called Grampus or Risso's Dolphin. (T.I. and E. le G. Troughton.)
Rec. Australian Museum, 19: 28-36, pl. 10, August 2, 1933.
188. Systematic Notes on Australian Land Shells.
Rec. Australian Museum, 19: 37-59, August 2, 1933.
189. The Scientific Name of the Commercial Oyster of New South Wales. (T.I. and T. C. Roughley.)
Proc. Linn. Soc. New South Wales, 58: 278, September 15, 1933.
190. William David Kerr MacGillivray.
The Medical Journ. Australia, 20th Year, 2: 496-497, portrait, October 7, 1933.

1934

191. Questions of Vernacular Nomenclature. Some suggestions. (T.I. and A. J. Marshall.)
Emu, 33: 189-190, January, 1934. (Title and discussion.)
192. Two New Generic Names for South Australian Marine Mollusca.
South Australian Naturalist, 15: 57-58, March 27, 1934.
193. Thomas Skottowe—Naturalist.
Emu, 33: 273-278, pls. 48-50, April 2, 1934.
194. Abnormal Loricates: The Earliest American Record.
Nautilus, 47: 136, April, 1934.
195. A Check-list of the Mammals Recorded from Australia. (T.I. and E. le G. Troughton.)
Australian Museum Mem., 6: I-XI and 1-122, May 4, 1934.
196. The Fresh-water Mussels of Australia.
Australian Zoologist, 8: 57-78, pls. 3-6, May 9, 1934.
197. Book Review: "Traveling with the Birds."
Australian Museum Mag., 5: 216, "April 16" (=May 17), 1934.
198. The Early History of the Koala. (T.I. and G. P. Whitley.)
Victorian Naturalist, 51: 62-72, 4 text figs., July 6, 1934.

1935

199. Notes on Penguins. (G. M. Mathews and T.I.)
Bull. British Orn. Club, 55: 101, January 28, 1935.
200. A New Subspecies of Maccaroni Penguin. (G. M. Mathews and T.I.)
Bull. British Orn. Club, 55: 102, January 28, 1935.
201. Australian Cowries.
Australian Zoologist, 8: 96-135, pls. 8 & 9, "June 2" (=July 10), 1935. (See No. 250 below.)
202. Fatal Case of Attack by Cone.
Nautilus, 49: 41, October, 1935.
203. The name of the British Redshank.
Bull. British Orn. Club, 56: 5, November 4, 1935.
204. Fatal Cone Bite.
Venus, 5: 294, December, 1935. (In Japanese.)
205. Fatal "Sting" by a Cone.
Journ. of Conchol., 20: 166, December 4, 1935.
206. Fatality from Cone-bite.
Journ. de Conchyl., 79: 264-265, December 15, 1935.

1936

207. Australian Molluscan Notes .No. 2.
Rec. Australian Museum, 19: 267-340, pls. 20-24, April 7, 1936.
208. Destruction of Timber by Marine Organisms in the Port of Brisbane. (C. J. J. Watson, F. A. McNeill, R. A. Johnson and T.I.)
Queensland Forest Service Bull. 12, pp. I-VIII, 1-107, pls. 1-15, text fig., graphs 1-6, map, July, 1936. (Included in the above: Queensland Cobra or Shipworms. A Systematic Account of the Teredinid Molluscs of South Queensland (by T.I. alone), pp. 31-44, text fig., pls. 1 & 2.)
209. List of Papers by Charles Hedley.
Proc. Linn. Soc. New South Wales, 51: 214-220, September 15, 1936.
210. C. M. N. White on Australian Birds.
Emu, 36: 136-137, October 1, 1936.
211. Book Review: "The Birds of the Malay Peninsula. Vol. 111. Sporting Birds; etc."
Emu, 36: 143-144, October 1, 1936.
212. Destruction of Timber by Marine Organisms in the Port of Sydney. Supplementary Report No. 1, 1936. (R. A. Johnson, F. A. McNeill, and T.I.)
8vo. Publ. by The Maritime Services Board of New South Wales, Sydney, pp. 1-99, text figs., graphs, October 23, 1936.
(Reprinted in *The Dock and Harbour Authority* (London), 17: 289-291, 4 figs., August, 1937; *Ibid.* 17: 317-319, 5 figs., September, 1937.)

1937

213. On the Dict. Univ. D'Hist. Nat. of D'Orbigny.
Journ. Soc. Bibliogr. Nat. Hist., 1: 33-34, February 15, 1937.
214. The Middleton and Elizabeth Reefs, South Pacific Ocean. Mollusca.
Australian Zoologist, 8: 232-261, pls. 15-17, March 12, 1937.
215. A Basic List of the Land Mollusca of Australia. (See No. 225 below.)
Australian Zoologist, 8: 287-333, map, March 12, 1937.
216. The Identity of Cook's Kangaroo. (T.I. and E. le G. Troughton.)
Rec. Australian Museum, 20: 67-71, May 15, 1937.
217. Ornithological Section Annual Report. (T.I. and Roy Cooper.)
Proc. Roy. Zoo. Soc. New South Wales, 1936-37: 18-20, August, 1937.
218. The Frost-Fish.
Angling and Gun Sport, 3, No. 1: 6, fig. on page 14, August, 1937.
219. Notes on Neozelanic Deepwater Marine Mollusca.
Rec. Australian Museum, 20: 103-107, pl. 17, August 27, 1937.
220. Rediscovery of *Voluta brazieri* Cox.
Rec. Australian Museum, 20: 128-129, August 27, 1937.
221. *Embrikena*, a new Genus of the Family Conidae (Phylum Mollusca.)
Festschr. 60. Geburtstage Embrik Strand (Riga), 3: 406-408, pl. 18, September 11, 1937.
222. The Truth About the Museum Calonnianum.
Festschr. 60. Geburtstage Embrik Strand (Riga), 3: 408-419, September 11, 1937.
223. An Annotated Check List of the Land Shells of South and Central Australia.
South Australian Naturalist, 18: 6-56, pls. 1 & 2, map on page 7, and index of 2 pages inserted before frontispiece to volume, September 30, 1937.
224. J. R. & G. Forster, Naturalists.
Emu, 37: 95-99, October 1, 1937.
225. A Basic List of the Land Mollusca of Australia—Part 2.
Australian Zoologist, 9: 1-39, pls. 1-3, November 12, 1937.
226. The Last Letters of John MacGillivray.
Australian Zoologist, 9: 40-63, pls. 4 & 5, November 12, 1937.

1938

227. The Question of Species.
Emu, 37: 179-181, January 1, 1938.
228. Book Review: "B.A.N.Z. Antarctic Research Expedition, 1929-31. Reports, Series B, Vol. 1: "Birds" by R. A. Falla, M.A. . . ."
Emu, 37: 243-245, January 1, 1938.
229. The Fluvifaunulae of Australia. (T.I. and G. P. Whitley.)
South Australian Naturalist, 18: 64-68, map, "April 30" (=mid May), 1938.
230. William Anderson—Ornithologist.
Emu, 38: 60-62, July, 1938.
231. Australian Avifaunal Problems.
Australian Journ. Sci., 1: 20-22, August 22, 1938.
(Reprinted in *Proc. Roy. Zoo. Soc. New South Wales*, 1937-38: 7-9, August 26, 1938.)
232. Operculum of *Turbo pulcher* Reeve.
Journ. of Conchol., 21: 65, September 22, 1938.
233. *Clanculus howinsulae* Salisbury.
Journ. of Conchol., 21: 65, September 22, 1938.
234. John Gould: The Bird Man.
Emu, 38: 90-95, October, 1938.
235. Gould as a Systematist. (G. M. Mathews and T.I.)
Emu, 38: 172-175, October, 1938.
236. Book Review: "Australian Parrots; Their Habits in the Field and Aviary, by Neville W. Cayley."
Australian Museum Mag., 6: 396, November 8, 1938.

237. A Basic List of the Land Mollusca of Australia—Part 3.
Australian Zoologist, 9: 83-124, pls. 12 & 13, November 30, 1938.
238. *Raja whitleyi*. The Great Skate.
Australian Zoologist, 9: 169, November 30, 1938.
239. A New Name for an Old Shell.
Australian Zoologist, 9: 172, November 30, 1938.
240. Book Review: "The Molluscs of South Australia."
Australian Zoologist, 9: 190, November 30, 1938 (and another in *Australian Journ. Sci.*, 1: 104, December 21, 1938.)
241. The Faunal Divisions of Western Australia.
Australian Journ. Sci., 1: 102-103, December 21, 1938.

1939

242. The Sea Birds of Sydney Harbour.
Maritime Services Board Officers' Journ., 14, No. 8: 9-12, January, 1939; *Ibid*, 14, No. 9: 9-12, February, 1939.
243. Destruction of Maritime Timberwork in Australia. Review of Experiments dealing with Timber Destruction in Brisbane Waters, Queensland, Australia.
The Dock and Harbour Authority (London), 19: 97-100, 9 text figs., February, 1939.
244. Mollusca. Part 1.
Great Barrier Reef Expedition, 1928-29. Sci. Reports, 5: 209-425, pls. 1-7, map, February 25, 1939.
245. The Eclipse Plumage of the Elfin Wren, (*Ryania melanocephala*).
Emu, 39: 39-40, July, 1939.
246. A Review of the Land Mollusca of Western Australia.
Rec. Western Australian Museum, 2: 1-88, pls. 1-5, map, August 1, 1939. (Reprinted in *Journ. Roy. Soc. Western Australia*, 25: 1-88, pls. 1-5, map, August 21, 1939.)
247. Note on the Genus *Cleidothaerus*.
Journ. de Conchyl., 83: 243-244, August 12, 1939.
248. Royal Zoological Society of New South Wales. Fifty-ninth Annual Report.
Proc. Roy. Zoo. Soc. New South Wales, 1938-39: 1-4, August 24, 1939. (Also the Sixtieth and Sixty-first in ensuing years.)
249. A Review of the Relationships of the Mollusca of Lord Howe Island. (J. Allan and T.I.)
Rept. Austr. New Zeal. Assoc. Adv. Sci. (Canberra, 1939), 24: 113, December, 1939.
250. Australian Cowries, Part 2.
Australian Zoologist, 9: 297-323, pls. 27-29, December 12, 1939.

1940

251. Guide to the Land Shells of New South Wales.
Australian Naturalist, 10: 227-236, text figs. 1-3, May 30, 1940. (See No. 264 below.)
252. A New Guinea Land Shell in Queensland.
Australian Naturalist, 10: 239-240, 1 text fig., May 30, 1940.
253. The Land-Shell *Hedleya*.
North Queensland Naturalist, 8, No. 6: 1-2, 1 text fig., June 1, 1940.
254. The Work of Gregory Mathews, Ornithologist.
Proc. Roy. Zoo. Soc. New South Wales, 1939-40: 31-33, portrait, August 19, 1940. (Reprinted with altered title, and without portrait or first paragraph in *Birds and Books* (by G. M. Mathews) Canberra, pp. 7-10, December, 1942.)
255. *Glaucus*, A Mystery of the Sea.
Proc. Roy. Zoo. Soc. New South Wales, 1939-40: 40-41, August 19, 1940.
256. Review: Sharks!!!
Proc. Roy. Zoo. Soc. New South Wales, 1939-40: 41, August 19, 1940. (Reprinted in *Australian Zoologist*, 9: 451, December 9, 1940.)

257. Recent Palaeoconchology.
Australian Journ. Sci., 3: 9-11, August 21, 1940.
258. All About Sharks. A Novel Book on the Subject. (Book Review.)
Angling and Gun Sport, 6, No. 2: 22-24, 4 text figs., September 30, 1940.
259. Australian Skuas.
Emu, 40: 177-180, pl. 37, October 5, 1940.
260. Australian *Glaucus*.
Australian Zoologist, 9: 428, text fig., December 9, 1940.
261. Marine Molluscs from Lord Howe Island, Norfolk Island, Australia and New Caledonia.
Australian Zoologist. 9: 429-443, pls. 32-34, December 9, 1940.
262. Bali Shells.
Australian Zoologist, 9: 443, December 9, 1940.
263. A Review of the Relationships of the Mollusca of Lord Howe Island. (T.I. and Joyce Allan.)
Australian Zoologist, 9: 444-451, map, December 9, 1940.

1941

264. Guide to the Land Shells of New South Wales. Part 2.
Australian Naturalist, 10: 262-269, text figs. 4-6, April 16, 1941.
265. Book Review: "The Molluscs of South Australia. Part 2."
Australian Journ. Sci., 3: 135, April, 1941. (And another in *Proc. Roy. Zoo. Soc. New South Wales*, 1940-41; 35, August 11, 1941.)
266. Obituary. Edwin Ashby.
Proc. Roy. Zoo. Soc. New South Wales. 1940-41: 45, August 11, 1941 (Anonymous).
267. Guide to the Land Shells of New South Wales. Part 3.
Australian Naturalist, 11: 1-8, text figs. 7 & 8, December 19, 1941.
268. A Basic List of the Land Mollusca of Papua.
Australian Zoologist. 10: 51-94, pls. 3-5, December 19, 1941.

1942

269. Book Review: "Strange New World."
Australian Museum Mag., 7: 422, March 16, 1942.
270. Report on Molluscan Content of Heron Island Reef Boring Samples.
Report Great Barrier Reef Committee. 5, Appendix 2: 120-122, April 30, 1942.
271. Guide to the Land Shells of New South Wales. Part 4.
Australian Naturalist. 11: 33-40, text figs. 9-11, June, 1942.
272. Description of a Libyan Desert Land Shell.
Rec. Australian Museum, 21: 126, July 8, 1942.
273. Book Review: "Australian Insects. An Introductory Handbook, by K. C. McKeown."
Proc. Roy. Zoo. Soc. New South Wales, 1941-42: 33-34, September 25, 1942.

1943

274. Plain Dwellers and Mound Builders, The *Pedionomus* Puzzle. (T.I. and G. P. Whitley.)
Emu, 42: 246-249, April 1, 1943.
275. Guide to the Land Shells of New South Wales. Part 5.
Australian Naturalist, 11: 61-69, text figs. 1-4, April 2, 1943.
276. The *Ctiloceras* Problem.
Australian Zoologist, 10: 166, April 30, 1943.
277. A Basic List of the Fresh Water Mollusca of Australia.
Australian Zoologist. 10: 188-230, April 30, 1943.
278. A New *Amphidromus* from Burma.
Nautilus, 57: 16, pl. 6, fig. 5, July, 1943.
279. Guide to the Freshwater Shells of New South Wales. Part 1.
Australian Naturalist, 11: 85-95, text figs. 1-3, November, 1943.

1944

280. The "*Gundlachia*" Puzzle.
Australian Zoologist, 10: 290, May 10, 1944.
281. Australian Pearly Nautilus.
Australian Zoologist, 10: 294-298, 2 text figs., May 10, 1944.
282. The Land Mollusca of Lord Howe Island.
Australian Zoologist, 10: 299-334, pls. 17-20, May 10, 1944.
283. Guide to the Freshwater Shells of New South Wales. Class Gastropoda. Part 2.
Australian Naturalist, 11: 113-127, text figs. 4-8, August, 1944.
284. Winter-breeding Sea-Birds.
Proc. Roy. Zoo. Soc. New South Wales, 1943-44; 19-20, August 31, 1944.
285. More About New Guinea Land Shells.
Proc. Roy. Zoo. Soc. New South Wales. 1943-44: 30, August 31, 1944.

1945

286. The Land Mollusca of Norfolk Island.
Australian Zoologist, 11: 46-71, pls. 2-5, June 11, 1945.
287. Jules Verreaux.
Australian Zoologist, 11: 71-72, June 11, 1945.
288. Harry Burrell. (Obituary Notice.)
Proc. Roy. Zoo. Soc. New South Wales. 1944-45: 11, August 31, 1945.
289. Obituary. Mr. A. F. Basset Hull.
Wild Life (Melbourne), 7: 377-378, December, 1945.

1946

290. A New Australian Parrot.
Emu, 46: 1-2, pl. 1, July, 1946.
291. Royal Zoological Society of New South Wales. Sixty-sixth Annual Report.
Proc. Roy. Zoo. Soc. New South Wales. 1945-46: 1-3, October 30, 1946.
292. Sidney W. Jackson. (Obituary Notice.)
Proc. Roy. Zoo. Soc. New South Wales. 1945-46: 16, October 30, 1946.
293. The Mathewsian Library at Canberra.
Proc. Roy. Zoo. Soc. New South Wales. 1945-46: 28, October 30, 1946.

1947

294. Book Review: "Gliders of the Gum Trees."
Proc. Roy. Zoo. Soc. New South Wales. 1946-47: 5, September, 1947.
295. The Scientific Name of the Dingo.
Proc. Roy. Zoo. Soc. New South Wales. 1946-47: 35-36, September, 1947.

1948

296. A Check List of the Birds of Paradise and Bower Birds.
Australian Zoologist, 11: 161-189, February 11, 1948.
297. "Love's Meinie."
Australian Zoologist, 11: 204-206, February 11, 1948.
298. Bullock's Museum.
Australian Zoologist, 11: 233-237, pls. 16-18, text fig., February 11, 1948.
299. H.M.S. "Endeavour Bark."
Australian Museum Mag., 9: 291-293, cover, frontispiece, 1 text fig., December 31, 1948.

1949

300. Western Australian Molluscs.
Proc. Roy. Zoo. Soc. New South Wales. 1947-48: 18-20, "January" (=February 14), 1949.

1950

301. The Marine Mollusca of New Caledonia.
Journ. de Conchyl., 90: 52-55, January 15, 1950.
302. Birds of Paradise and Bower Birds.
Georgian House, Melbourne, pp. I-XII, 1-239, pls. 1-33, orig. illustrs. on cover, folding map, May 8, 1950.

303. Gregory M. Mathews (1876-1949). (Obituary Notice.)
Proc. Roy. Zoo. Soc. New South Wales. 1948-49: 16-20, portrait, May 29, 1950.

1951

304. Moas.
Proc. Roy. Zoo. Soc. New South Wales. 1949-50: 69-70, April 2 1951,
305. Gould and Audubon.
Proc. Roy. Zoo. Soc. New South Wales. 1949-50: 70, April 2, 1951.
306. Book Review: "Australian Shells."
Proc. Roy. Zoo. Soc. New South Wales. 1949-50: 73-74, April 2, 1951.
307. The Humming Bird.
Australian Zoologist, 11: 314-315, July 31, 1951.
308. Again Gould. An Amazing Discovery.
Australian Zoologist, 11: 316-317, July 31, 1951.
309. Audubon in Australia.
Australian Zoologist, 11: 318-321, July 31, 1951.
310. Western Australian Bird Books.
Australian Zoologist, 11: 321, July 31, 1951.
311. The Naturalist's Library. An Essay in Bibliography.
Australian Zoologist, 11: 322-332, pls. 33 & 34, text fig., July 31, 1951.
312. Recent Palaeontology.
Australian Zoologist, 11: 347-350, July 31, 1951.
313. Birds of Paradise.
Australian Junior Encyclopaedia, Georgian House, Melbourne, Vol. 2: 808-809, pl. between pp. 812 & 813, August, 1951.
314. Australian Shells. (J. Allan, T.I. and B. C. Cotton.)
Australian Junior Encyclopaedia, Georgian House, Melbourne, Vol. 2: 875-897, pl., 38 text figs., August, 1951. (Gastropods, The Volutes, Cone Shells, Trumpet Shells, Helmet Shells, Cowries, Collectors' Favourite, The Wonder Cowry, Chitons or Loricates, Freshwater Shells, Land Shells, Desert Snails, The Midgets and The Slugs by T.I.)

1952

315. Sea Birds of Sydney Harbour. Part 1.
Port of Sydney, 4: 24-27, 5 text figs., July, 1952.
316. Sea Birds of Sydney Harbour. Part 2.
Port of Sydney, 4: 50-54, 7 text figs., October, 1952. (Nos. 315 and 316 reprinted in 4 parts in *The Waratah* (Official Organ of the Girl Guides Assoc. of New South Wales), 33, No. 10: 6-7, 5 text figs., April, 1953; *Ibid,* 33, No. 11: 4-5, text fig., May, 1953; *Ibid,* 33, No. 12: 10-11, text fig., June, 1953; *Ibid,* 34, No. 3: 6-8, 5 text figs., September, 1953.)

1954

317. Cuttle Fish "Bones" Again.
Australian Zoologist, 12: 63-82, pls. 4 & 5, March 24, 1954.

1955

318. Bellingshausen in Australia.
Proc. Roy. Zoo. Soc. New South Wales, 1953-54: 34-36, March 4, 1955.
319. Bill Moult in Prions.
Proc. Roy. Zoo. Soc. New South Wales. 1953-54: 37, March 4, 1955.
320. On *Sepia cultrata* Hoyle.
Proc. Roy. Zoo. Soc. New South Wales, 1953-54: 78-79, March 4, 1955.
321. Rissoid Sectional Names.
Proc. Roy. Zoo. Soc. New South Wales, 1953-54: 81, March 4, 1955.
322. James Stuart—Ornithologist.
Australian Zoologist, 12: 127-128, pls. 7-9, 1 text fig., July 18, 1955.
323. Froriep and Lamarck.
Australian Zoologist. 12: 175, July 18, 1955.

1956

324. Broinowski's Birds and Mammals of Australia.
Proc. Roy. Zoo. Soc. New South Wales. 1954-55: 14-16, April 10, 1956.

325. A Northern Australian Volute.
Proc. Roy. Zoo. Soc. New South Wales, 1954-55: 76-77, fig. 1, April 10, 1956.

326. History of New South Wales Shells. Part 1: Cook and His Associates.
Proc. Roy. Zoo. Soc. New South Wales, 1954-55: 81-83, 1 fig., April 10, 1956.

LIST OF NAMES

In the following list, all the new generic, subgeneric, specific and subspecific names proposed by Iredale (including those in collaboration with other authors) are arranged in strict alphabetical order and, in the cases of similar specific names, in alphabetical order of the genera to which they were assigned. No distinction is made between those names proposed for full genera and those proposed for subgenera; specific names and subspecific names may be separated by the binominal or trinominal combinations indicated. In each case, the generic name following a species name, and the generic and specific names following a subspecific name, are those under which they were originally proposed.

The first number following each name is that of the paper in this list, in which the name was first proposed. The second is the number of the page in that paper where it first occurs. In the several cases where two page numbers are given, the earlier represents its first introduction, while the latter may give additional information such as a description or type species.

Preoccupied names, listed elsewhere, are indicated in this list.

The authors have tried as far as possible to avoid errors, but would appreciate information on any which may occur.

aberrans, Innesoconcha, 282: 326.
abitens, Tasmadelos nelsonensis, 237: 118.
abjecta, Paralaoma, 282: 311.
Abranda, 116: 182 & 212.
abstans, Pleuroxia, 246: 56.
Acanthozostera, 138: 263.
accessa, Setaliris, 169: 388.
acervus, Triellsiphon, 261: 439.
Acritopaphia, 207: 280.
acroporicola, Coralichlamys, 244: 356.
actaviva, Oblimopa macgillivrayi, 244: 242.
Acuticylindra, 160: 287.
Adamnestia, 207: 333.
addenda, Lophorina superba, 296: 162.
addenda, Notoplax speciosa, 128: 91.
addenda, Palmatina, 286: 50.
addita, Anadara, 244: 280.
addita, Dominamaria, 268: 58.
addita, Hedleyoconcha, 282: 317.
addita, Trisidos tortuosa, 244: 272.
adelaideana, Microcucullaea, 163: 159.
adelaideana, Prothyasira, 169: 393.
adhaesa, Solitosepia plangon, 137: 238.
adjacens, Acanthosepion ellipticum, 137: 239.
adjacens, Mabellarca dautzenbergi, 244: 265.
adjuncta, Letitia, 268: 78.
adjuncta, Limborelia innesi, 282: 302.
adjunctus, Ratifusus, 163: 183.
adjunctus, Velesunio balonnensis, 196: 59.
aegrifer, Simlimnea, 283: 119.
aenigma, Acanthochiton, 128: 87.
aetha, Semelartemis, 171: 76.
Aethocola, 53: 465.
Afrocominella, 70: 28 & 34.
agnitum, Phalium, 143: 332.
agripeta, Modiolus, 244: 412.
ahena, Paralaoma, 286: 54.
aladdin, Navicula, 244: 292.
Alathyria, 196: 63.
albani, Pedinogyra, 225: 16.
albidus, Favorinus, 99: 197 & 205.
albisoror, Parviperna, 244: 323.
alea, Frustropa, 286: 58.
Aleatelix, 268: 86.
alexanderi, Heteroprion desolatus, 80: 42.
aliena, Sanhaliotis varia, 160: 270.
aliena Scapharca, 244: 282.
Alienitor, 225: 6.
allanae, Coralastele, 171: 76.
Allanassa, 160: 289.
allani, Pedinogyra, 225: 16.
Allenella, 282: 311. (Preoccupied name.)
alleni, Alathyria jacksoni, 277: 89.
alleni, Galadistes, 275: 62.

* Originally described as *Lyria deliciosa howensis* in 1937, this taxon was later (1940) redescribed (by oversight) as a new full species.

* Also written as T. [mccoyi] interpres, p. 272.

* In publishing some MacGillivray papers, Iredale introduced this manuscript name for a genus of bats.

Ichthyological Notes

By GILBERT P. WHITLEY, F.R.Z.S.

(Contribution from the Australian Museum.)

(Figs. 1-7.)

Order SELACHII.

COOPERODON, gen. nov.

Cooperella Gunnell, Journ. Paleont. vii, 1933, p. 291. Orthotype, *C. typicalis* Gunnell. Preoccupied by *Cooperella* Carpenter, Rept. Brit. Ass. Adv. Sci. 1864 (1865), pp. 611 & 639, a genus of Mollusca.

More than sixteen years ago I (Whitley, Austr. Nat. x, 1940, p. 243) pointed out that *Cooperella* was preoccupied, but it has not been renamed until now, when I propose *Cooperodon* to replace it, with *Cooperodon typicalis* (Gunnell, 1933) as type-species. Contact with Gunnell is no longer possible, according to Wilimovsky (Journ. Paleont. xxviii, 1954, p. 693) who brought in *Gunnellodus* for *Idiacanthus* Gunnell, preocc.

Family MACQUARIIDAE.

Genus PERCALATES Ramsay & Ogilby, 1887.

PERCALATES COLONORUM NOVEMACULEATUS (Steindachner).

(Fig. 1.)

Dules novemaculeatus Steindachner, Sitzb. Akad. Wiss. Wien liii, 1866, p. 428, pl. ii, fig. 1. Port Jackson.

The Eastern Freshwater Perch or Australian Bass is here illustrated from a photograph of a specimen from the Woy Woy district in Mr. Eric Worrell's aquarium. This form is found in eastern New South Wales and the Snowy River waters of Victoria.

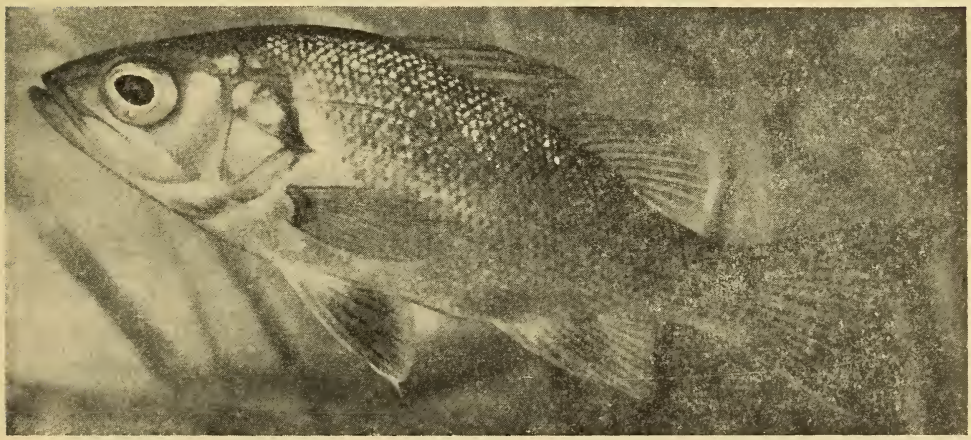

Fig. 1: Australian Bass from the Woy Woy district, New South Wales.
Photo, Eric Worrell.

Family PRENIDAE.

Genus PRENES Gistel, 1848.

PRENES ORNATUS (Cuv. & Val.).

(Figure 2.)

? *Chaetodon argus* Linne, Syst. Nat., ed. 12, 1766. p. 464. India.
? *Chaetodon pairatalis* Buchanan, Fish. Ganges, 1822, pp. 122 & 372, pl. xiv, fig. 41. Ganges.
Scatophagus ornatus Cuvier & Valenciennes, Hist. Nat. Poiss. vii, April 1831, p. 143, pl. clxxx. Amboina.
Scatophagus argus Gunther, Ann. Mag. Nat. Hist. (3) xx, 1867, p. 59 (Cape York & Sydney). *Id.* Castelnau, Proc. Linn. Soc. N. S. Wales ii, 1878, p. 234, and of later Australian authors, also as *Ephippus argus.*
Scatophagus tetracanthus Macleay, Proc. Linn. Soc. N. S. Wales ii, 1878, p. 353 and Descr. Cat. Austr. Fish. i, 1881, p. 96 (Port Darwin). Not *Chaetodon tetracanthus* Lacepede, Hist. Nat. Poiss. iv, 1802, p. 726, vernac. in vol. iii, 1802, pl. xxv, fig. 2. No loc., an African species.
? *Scatophagus multifasciatus* var. *altermans* Castelnau, Proc. Linn. Soc. N. S. Wales iii, 1878, p. 47. Norman River, Queensland.
Scatophagus quadranus De Vis, Proc. Linn. Soc. N. S. Wales ix, 1884, p. 455. [Cardwell] Queensland. Spelt *S .quadratus* by authors.
Scatophagus rubifrons Stoye, Tropical Fish for the Home, 1932, pl. clxv, from a trade name in aquarium journals for a fish supposedly from the East Indies, *fide* Myers, Proc. Biol. Soc. Wash. xlix, 1936, p. 84. United with *ornatus* by Fraser-Brunner, Aquarist, viii, 1938, p. 72.
Scatophagus argus var. *rubrifrons* Innes, Exotic Aquar. Fish., 1935, p. 427, coloured figs. East Indies.
Desmoprenes tetracanthus Whitley, Austr. Zool. ix, 1940, p. 424 (Northern Territory, *ex* Macleay) and xi, 1945, p. 41 (North-west Australia). Not *Chaetodon tetracanthus* Lacepede.
Prenes quadranus Whitley, Proc. Roy. Zool. Soc. N. S. Wales 1954-55 (1956), p. 41.

This little "Scat" of the Brisbane River, a favourite with aquarists, has not been satisfactorily classified because of the uncertainty of specific limits in the genus *Prenes* or *Scatophagus.* It seems to be *ornatus* but whether this is the young of *argus* Linne (which seems doubtful) or not is uncertain. I therefore offer a description and figure of "aquarium-size" specimens under the above tentative identification rather than bestow a new name at this stage.

D xi, 16; A. iv, 15; P. 17; C. 16.

Head (11 mm.) 2.4, depth (16) 1.6 in standard length (26).

Eye (4.5) equals interorbital, 2.4 in head. General facies as figured.

Preorbital and the narrow suborbital meeting at a shallow notch.

Rudiments of the suprascapular spine and its knot are present, but other larval head-bones have disappeared. Gill- membranes united across isthmus in a free fold. Body compressed. Scales minute. Lateral line complete. Dermal part of pelvis fairly broad, tapering to near isthmus.

A procumbent dorsal spine; erect dorsal spines heteracanth, the third and fourth longest (6 mm.) nearly one-third body-depth. Posterior margins of soft dorsal and anal subvertical. Pectoral and caudal rounded.

Colour in alcohol mostly dark brown- except for the pectoral, caudal and soft dorsal and anal fins which are yellow or transparent, and some yellow or cream areas [? red in life] on the front of the head, and on the body below the front and rear dorsal spines and above the anal spines. Two dark brown oblique, separate bars on interorbital; an ocular band over each eye meets its fellow dorsally. Other dark markings tend to form rows of dark brown to blackish spots, as figured, with obscure outlines and faint creamy interspaces. Spinous dorsal and anal fins and soft ventral fins mostly blackish.

Described and figured from a specimen slightly over 1¼ inches (33 mm.) in total length. Austr. Mus. Regd. No. IB.82.

Loc.—Brisbane, Queensland, Mr. A. K. Carter, (1939).

Variation.—Two other Brisbane specimens (IB.79), 24 and 28 mm. long, are similar, but the body-markings tend to form five vertical bars down body and caudal peduncle, apart from the bands down the head. D. xi, 17; P. 16. Mouth barely reaching below eye.

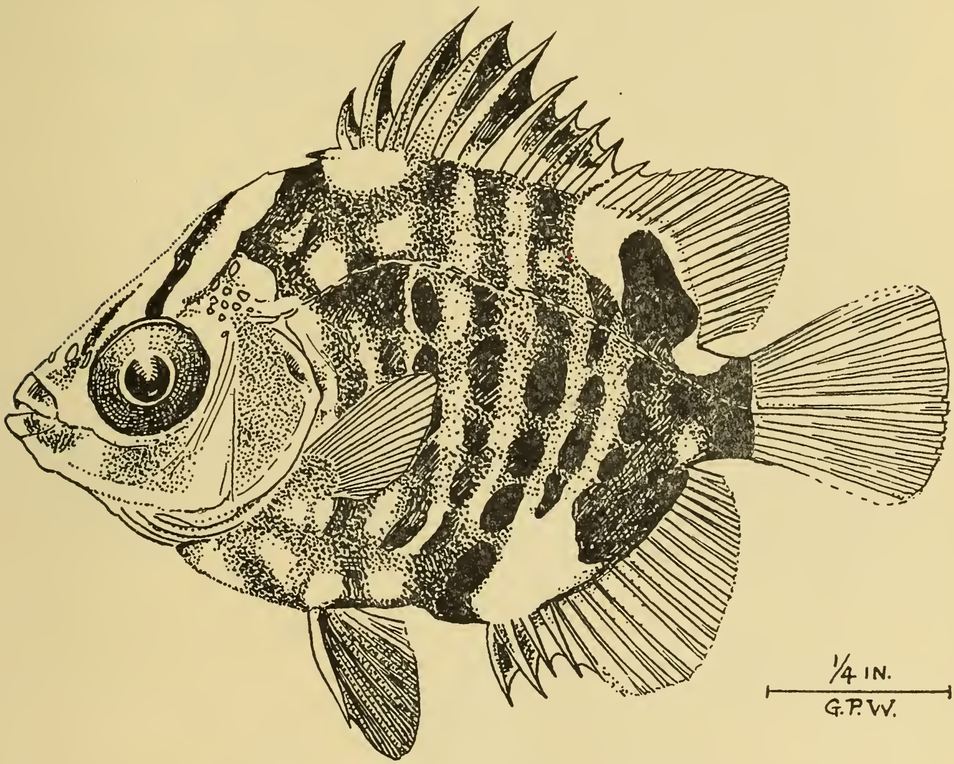

Fig. 2: Small Scat, *Prenes ornatus*, from Brisbane River, Queensland.

Another (IB.83), 40 mm. long, also from Brisbane, has dark brown spots on the sides over a light brown ground-colour, but the cream areas descending from the front and back dorsal spines and ascending over the anal spines still persist.

Three specimens from Townsville (IB.3501), 37 to 47 mm. long, have 6 to 8 transverse rows of spots.

The juvenile coloration is still present in a 51 mm. specimen (IB.535) from Grafton, N. S. Wales, but at 80 mm. the sides are spotted as in the Indian *argus* (IA.7970 from Noosa River, Queensland).

My largest specimen of the figured form, 69 mm. long (IA.5898), is from Groote Eylandt, Northern Territory.

This "large" specimen has procumbent spine concealed, D. xi, 16; A. iv, 14; P. 18; head (21 mm.) 2.6 in standard length (56); depth (37) less than 2 in total length; eye (6) less than interorbital (8); mouth not reaching eye. Pectoral short and rounded, caudal rounded. Chains of light-centred spots extend from back to belly in about eleven transverse rows. There are still traces of the light areas on the nape, below the front and back of the spinous dorsal, over caudal peduncle and above anal fin. Suprascapula covered with scales. Fourth dorsal spine longest, 14.5 mm.

This form grows to at least 2¾ inches in length, or 5 inches if it be the Silver Scat of the Brisbane River mentioned by Jensen (Monthly J. Aquar. Soc. N. S. Wales, iv, Aug. 1954, p. 5). It evidently ranges from Indonesia and the Gulf of Carpentaria, down the eastern coast of Queensland to New South Wales, rarely as far south as Sydney.

The form here figured from Brisbane River differs from the Tholichthys stage I figured from Port Denison (Rec. Aust. Mus. xvi, 1928, p. 217, pl. xviii, fig. 2) in having caudal rounded, scales more numerous and in fin-formulae. I there listed references to other figures of young "*Scatophagus*," most of which show the smaller larval and Tholichthys stages. To that list I now add:—

Blanco & Villadolid (Philip. J. Fisher. i, 1951, p. 80, fig. 19) who illustrate a 7.5 mm. juvenile *argus* from Luzon, and

Giltay (Mem. Mus. Roy. H. N. Belg. v, 3, 1933, p. 69, fig. 20), a Tholichthys from Triton Bay, New Guinea.

There are, however, a few illustrations of forms comparable with my Queensland ones in aquarium literature (notably Innes, 1935). I have not seen Stoye's 1932 figure quoted by Myers, 1936. Weber's figure (Siboga Exped. Monogr. lvii, 1913, pl. x, fig. 5) of a 32 mm. juvenile shows large spots like adult *argus* and is evidently of a different species from my 33 mm. one.

Thanks to Mr. J. Henry, Curator of the Macleay Museum, University of Sydney, I have been able to examine Macleay's specimens which were the basis of his Darwin record of "*Scatophagus tetracanthus*," a species nowadays known only from African waters. These fishes are conspecific with the figured Brisbane Scat. There are ten of them, fairly evenly graded from 32 to 48 mm. in total length. Dark vertical stripes extend down the sides almost to the exclusion of spots, even in the smallest .

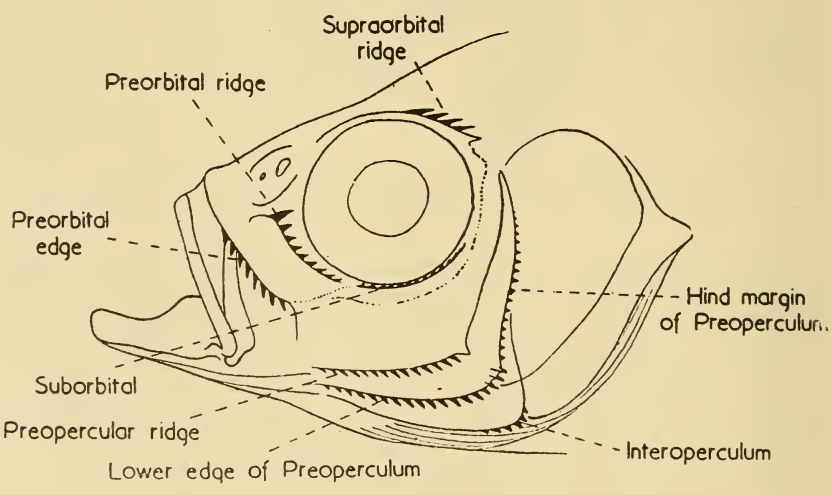

Fig. 3: Head of a Chanda Perch, showing ridges and edges of bones upon which denticulations of taxonomic importance may occur.

After Fraser-Brunner.

Family CHANDIDAE.

(Figures 3-6.)

The Chanda Perches, Percelles, Silver Spray, Doodies or Glassfishes are small, almost transparent perch-like fishes, found commonly in schools in fresh and salt water. They have been recently reviewed by Fraser-Brunner (Bull. Raffles Mus. xxv, 1954, pp. 185-213, figs. 1-4), from whose paper I have copied figure 3 which shows some of the characters used in classifying the species. They are useful as destroyers of mosquito-larvae and, in India, eat the tiny crustacean (Cyclops) which is the carrier of guinea-worm disease. Foreign species are well-known aquarium fishes, but Australia has a good variety of species from which the aquarist can choose.

KEY TO THE FRESHWATER CHANDIDAE OF AUSTRALIA.

A. Scales in 20 to 30 transverse rows. Two rows of cheek-scales. Lateral line developed, incomplete or obsolete.

B. Gill-rakers slender, 13 or more on lower limb of first gill-arch. Mucous pores on head inconspicuous. Body not banded.

C. Supraorbital ridge smooth, ending in a spine (rarely 2 spines). Length usually less than 3 inches.

D. Suborbital denticulate.

E. Hind margin of preoperculum entire.

F. Preopercular ridge entire, except for 2 spines at angle. G/R. 18-20. Soft dorsal and anal rays 8-10.

Austrochanda macleayi

FF. Preopercular ridge denticulate. G/R. 24-26. Soft dorsal and anal rays 7-8.

Austrochanda pallida

EE. Hind margin of preoperculum denticulate.

G. Preopercular ridge scarcely denticulate. Second dorsal spine not longer than base of the spinous fin. G/R. 18.

Blandowskiella agassizi

GG. Preopercular ridge strongly dentate. Second dorsal spine much longer than base of its spinous fin.

H. Soft dorsal and anal rays 7-8. G/R. 18. Colour plain.

Blandowskiella agrammus

HH. Soft dorsal and anal rays 9-10. G/R. 20. Each scale dark-margined, forming network; fins blackish.

Blandowskiella reticulata

DD. Suborbital entire. Murray R. system.

Blandowskiella castelnaui

CC. Supraorbital dentate posteriorly. Attains 4 inches in length.

Priopidichthys marianus

BB. Gill-rakers reduced stumps, 6 on lower limb. Mucous pores on head conspicuous. Lateral line obsolete. Body banded.

Denariusa bandata

AA. Scales 40 or more. More than 2 rows of cheek-scales. Lateral line continuous.

Acanthoperca gulliveri

BLANDOWSKIELLA RETICULATA (Weber).

(Fig. 4.)

Ambassis interrupta var *reticulatus* (sic) Weber, Nova Guinea, ix, 1913, pp. 574, 605 and 609 (Merauke and Lorentz R., N. Guinea).

Ambassis reticulatus Regan, Trans. Zool. Soc. Lond. xx, 6, 1914, p. 276 (Setakwa R., N. Guinea).

Id. Weber & de Beaufort, Fish. Indo-Austr. Archip. v, 1929, pp. 401 & 414, fig. 98, as *reticulata*.

Id. Nichols, Amer. Mus. Novit. 1433, 1949, p. 2 (Archer R. Q.).

Id. Fraser-Brunner, Bull. Raffles Mus. xxv, 1954, pp. 194 & 200. (Setakwa R., New Guinea).

Id. Whitley, Proc. Roy. Zool. Soc. N. S. Wales 1954-55 (1956), p. 41.

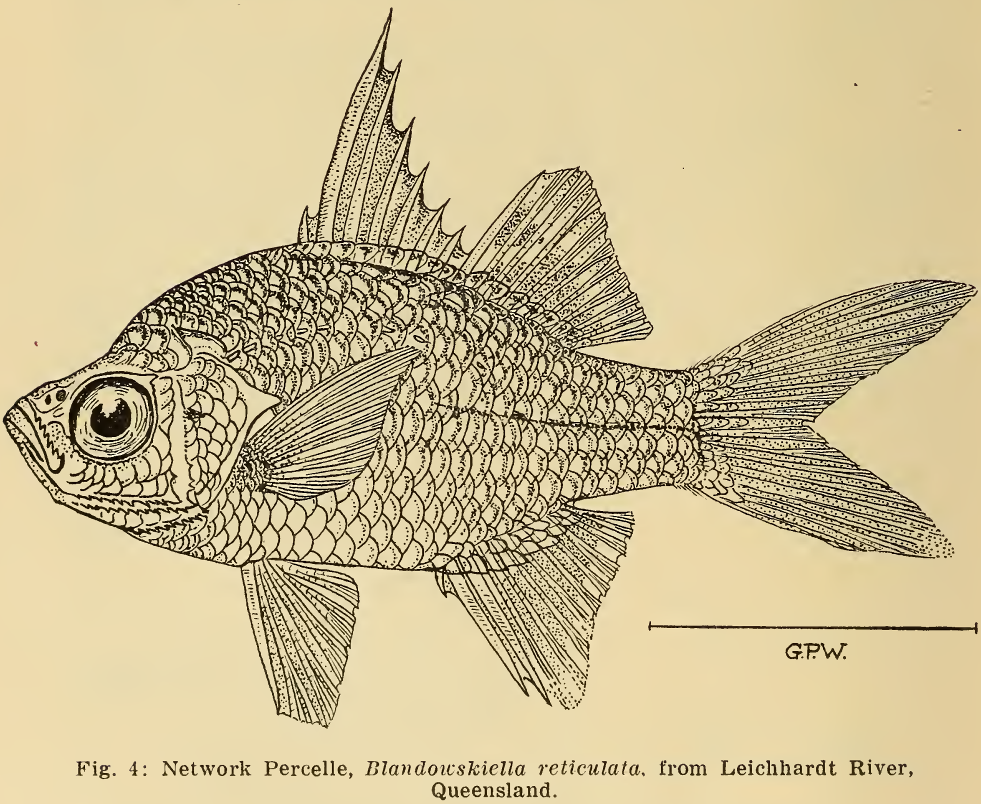

Fig. 4: Network Percelle, *Blandowskiella reticulata*, from Leichhardt River, Queensland.

Here figured from a specimen, 53 mm. in standard length, from the Leichhardt River, Gulf of Carpentaria, Queensland, collected in August 1928 by Dr. William Macgillivray (Austr. Mus. Regd. No. IA.3710). It has D. vii/i, 10; A. iii, 9; P. 14. Sc. 24. Tr. 3/1/10. Pred. 13. L. Lat. interrupted. G/R. 20.

Last dorsal membrane not *very* low on spine of second dorsal fin.

Denticulation of head and coloration as figured.

BLANDOWSKIELLA AGRAMMUS (Gunther).

(Fig. 5.)

Ambassis agrammus Gunther, Ann. Mag. Nat. Hist. (3) xx, 1867, p. 57. Cape York, Queensland. Types in British Museum.
Id. Schmeltz, Mus. Godef. Cat. vii, 1879, p. 38 (Bowen, Q.).
Id. Macleay, Proc. Linn. Soc. N.S.W. v, 1881, p. 338 and Desc. Cat. Austr. Fish. i, 1881, p. 38.
Id. Ramsay & Ogilby, Proc. Linn. Soc. N.S.W. (2), i, 1886, p. 8 (south-east coast of New Guinea).
Id. Weber & Beaufort, Fish. Indo-Austr. Archip. v, 1929, p. 411.
Id. Fraser-Brunner, Bull. Raffles Mus. xxv, 1954, pp. 194 & 200 (lectotype, 42 mm. standard length, selected).
Priopis agrammus Jordan & Seale, Bull. U.S. Fish. Comm. xxv, 1905 (1906), p. 255.
Id. McCulloch & Whitley, Mem. Qld. Mus. viii, 1925, p. 147.
Id. Whitley, Proc. Roy. Zool. Soc. N. S. Wales 1954-55 (1956), p. 41.

Fig. 5: Chanda Perch, *Blandowskiella agrammus*, from Townsville, Queensland.

Here figured from a specimen, from the Waterworks dam at Townsville, Queensland, 42 mm. in standard length (thus the same length as the lectotype selected by Fraser Brunner, 1954). It agrees with Gunther's description and has D. vii, i, 8, A. iii, 8; P. 12. Sc. 27. Tr. 16. Predors. 14. This species is very close to *reticulata*, but has plainer coloration, ventrals and anal fins infuscated, more scales round caudal peduncle, fewer finrays and gill-rakers.

BLANDOWSKIELLA AGASSIZI (Steindachner).

(Fig. 6.)

Here figured from the lectotype of *Pseudambassis nigripinnis* De Vis (Proc. Linn. Soc. N.S.W. ix, 1884, p. 393), a specimen nearly 2 inches long, from the Brisbane River, Queensland (Austr. Mus. Reg. No. I.396).

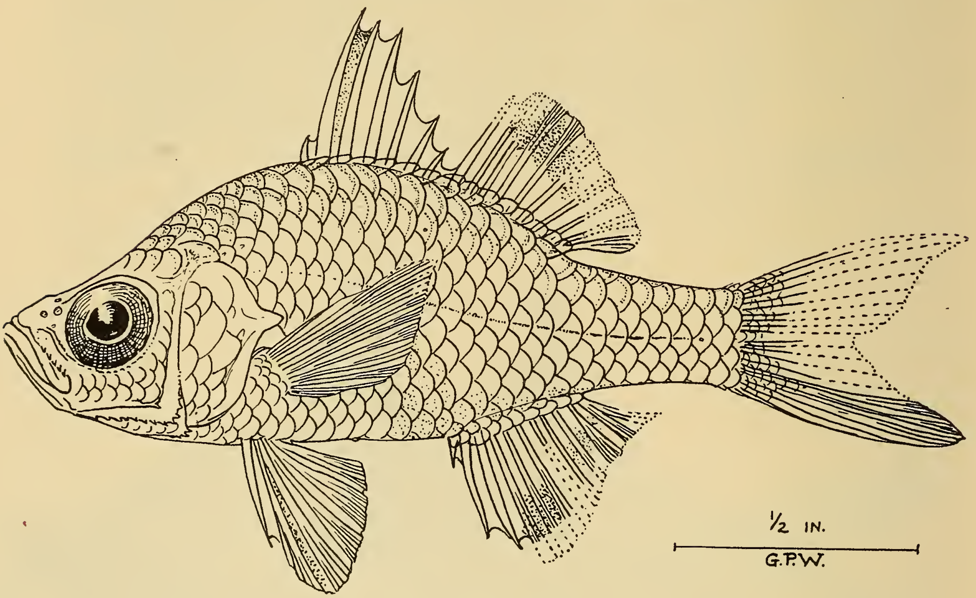

Fig. 6: Olive Perchlet, *Blandowskiella agassizi.* Lectotype of *Pseudambassis nigripinnis* De Vis from Brisbane River, Queensland. Fins restored where dotted.

It has D. vii, i, 8; A. iii, 8; P. i, 10. Sc. 24. L. lat obsolescent. Tr. 12. Predors. 9. The dark markings have faded after seventy years or more in alcohol.

References and synonymy have been given by Whitley, Proc. Roy. Zool. Soc. N. S. Wales, 1953-54 (1955), p. 47, figs. 3-4, but the queried synonyms in that account may be regarded as separate species, following Fraser-Brunner (Bull. Raffles Mus. xxv, 1954, p. 194).

Family BODIANIDAE.

Genus CHOERODON Bleeker, 1845.

CHOERODON TRANSVERSALIS, sp. nov.

(Fig. 7.)

D. xiii/7; A. iii, 10; P. 2, 14; C. 12-main rays. L. lat. 28/29. Tr. 3/1/9. Predorsal scales 6.

Head (112 mm.) 2.8; depth (119) 2.6 in standard length (315). Eye (16) 6.7, preorbital (42) 2.6, interorbital (30) 3.7, snout (47) 2.3, postorbital (61) 1.8, pectoral (85) 1.3, and length of caudal (55) 2 in head.

Head about as high as long. Preorbital very high. Interorbital convex. Eyes small. Nostrils small, below eye-level. Behind the eye, two upright rows of scales are imbricate and increase below to up to 8 rows of cheek-scales which are not imbricate on lower cheeks. A few scales on nape, a single row on interoperculum, and large ones on operculum; rest of head naked with some pimple-like pores. Cleft of upper lip reaching below hinder half of eye; lower lip deep. In front of the lower jaw is a pair of strong, blue, slightly curved, erect tusks; outside these fits a pair of more curved and more compressed, vertical (not flaring) canines from upper jaw. These are followed by a small lateral tusk in the lower and another in the upper jaw on each side. Other teeth fused into a lateral ridge. Posterior canines well developed. Preopercular edge very minutely serrated in places. Gill-membranes broadly united across isthmus.

Body deep, robust; scales with about 30 basal radii. Lateral line continuous, its tubes arborescent, except for a few simpler posterior ones. Predorsal scales begin on level with preopercular edge. Dorsal, anal, and caudal fins slightly sheathed by scales; auxiliary scales contribute towards the dorsal and anal sheaths.

Dorsal spines slender, stiff, pungent, the first (19 mm.) longer than eye; others increase in length posteriorly, the last 22 mm. Membranes incised and produced beyond the spines like pennants. Soft dorsal lobe rather pointed, longest ray 51 mm. First anal spine more than half length of others, third longest, 26 mm. Longest anal ray (54 mm.) reaches farther back than soft dorsal does. Pectorals broadly rounded, second branched ray extending beyond others, but shorter than head. Ventrals not quite reaching anal, pointed, asymmetrical; left, 66 mm., right, 68 mm. Caudal rounded.

Colour-description written 24 hours after the death of the fish by Messrs. T. C. Marshall and E. M. Grant: "General colour olive yellow. Head dull orange, suffused with yellow ochre. Each scale of the body with a vertical blue stripe. Spinous dorsal blue terminally, flame-colour subterminally, followed by strokes of blue and flame. Pectoral rays greenish, membranes smoky. Ventral rays blue, membranes bright orange. Anal blue with numerous elongate orange markings. Caudal dark blue with some traces of orange. Teeth pale blue."

The collector's colour-notes were provisional, as he hoped to secure more specimens: "Basal body coloration peacock blue to green above, shading to creamy white ventrally. Transverse irregular bands, about six in number,

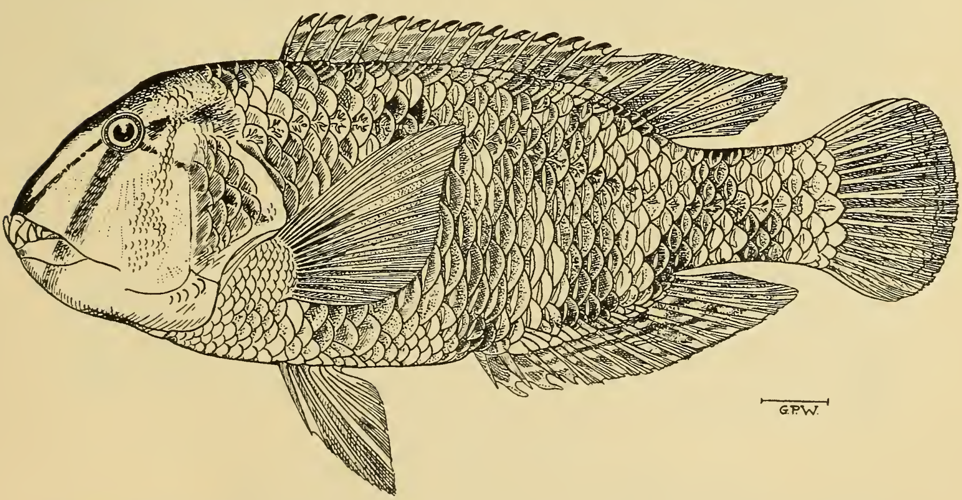

Fig. 7: Blue-toothed Tuskfish, *Choerodon transversalis*. Holotype from Heron Island, Queensland.

on body; colour pale brown, flecked with green. The head is similarly banded. A broad transverse band, the width of the orbit, runs across the nape, and continues below the cheek to fuse diffusely with that on the other side of the head. There are two narrower transverse bands across the lower orbital and nasal regions, and a narrow band running across the lower anterior cheek-region, from the sub-anterior orbit to posterior maxillary." Collected by E. M. Grant, April 1954.

The colours of the specimen have turned to brown in formalin and the evanescent patterns have almost vanished, but there are traces of several dark transverse bars, as figured here. A kodachrome transparency of the fish, kindly lent me by the Dept. of Zoology, University of Queensland, showed the following colours: Broad, anastomosing slate-grey to brownish-grey bands descend from back down head and body over a green background of various tones. Most scales behind pectoral with a vertical blue streak. Very bright green under chin to yellowish on cheek. Fins (folded) mostly dark slate-grey with some blue marks and with the body-bands apparently continuing on to them. Pectorals brownish with grey basal area and green and brown base. Pupil dark grey, iris pale green surrounded by blue ring.

Described and figured from the unique holotype, a specimen 14½ inches or 370 mm. in total length. Australian Museum Regd. No. IB.3527; collector's No. 13.

Loc.—Heron Island, Great Barrier Reef, Queensland; 4 April, 1954. Presented by Mr. David Woodland, Dept. of Zoology, University of Queensland. Collected by Mr. E. M. Grant.

The erect canines, banded coloration and proportions separate this new species from all its congeners.

Choerodon balerensis Herre (Philip. Journ. Sci. lxxviii, 1949, p. 149), from the Philippines, is cross-banded, but in a different fashion and with brilliant orange and blue colouring; it has 8 predorsal scales and different proportions, but differs markedly in having no posterior canine, the soft dorsal equal to the spinous in height. *C. balerensis* has D. xii, 8; A. iii, 9; caudal 3.5 in head; eye 3.8 in head and little less than interorbital, according to Herre.

The genotype of *Choerodon*, *Labrus macrodontus* Lacepede, 1802 = *anchorago* (Bloch, 1791), has longer, more curved, lateral mandibular canines and different colour-pattern. In *C. cyanodus* (Richardson, 1843), as in *C. olivaceus* [= *albigena*] (De Vis, 1885), these canines flare out more. All other species are quite different: a list of Australian species was given by McCulloch (Austr. Mus. Mem. v, 1929, pp. 318-321), since which I have recorded some synonyms and described *C. paynei* Whitley, 1945, from Western Australia.

Family CREEDIIDAE.

Genus SQUAMICREEDIA Rendahl, 1921.

SQUAMICREEDIA OBTUSA Rendahl.

Squamicreedia obtusa Rendahl, K. Svenska Vet. Akad. Handl., lxi, 9, Feb. 14, 1921, p. 20, figs. 4-6. Cape Jaubert, Western Australia.
Id. Schultz, Journ. Wash. Acad. Sci. xxxi, 1941, p. 271.

The range of this fish may be extended to include the Northern Territory and Queensland. The Australian Museum has one (Regd. No. IA.7851) dredged on rope tangles off Charles Point, Northern Territory, in June 1938 by Mr. Melbourne Ward. Mr. R. Slack Smith obtained two from a coral clump on the reef flat at Heron Island, Queensland, on 12th January 1956, and noted the colours as "off-white with 4 reddish brown bars across anal." (Univ. of Queensland No. G.52; Austr. Mus. IB.3546).

Family GOBIIDAE.

Genus GLOSSOGOBIUS Gill, 1862.

GLOSSOGOBIUS SUPPOSITUS (Sauvage, 1880).

Eleotris obscurus Castelnau, Proc. Zool. Acclim. Soc. Vict. ii, 1873, p. 134. Fremantle, Western Australia. Name preoccupied.

Gobius suppositus Sauvage, Bull. Soc. Philom. (7) iv, 1880, p. 41. Swan River, Western Australia.

Eleotris castelnaui Macleay, Proc. Linn. Soc. N. S. Wales v, 1881, p. 620. Swan River.
New name for *Eleotris obscura* (sic) Castelnau, preocc. by *E. obscura* Temminck & Schlegel, Faun. Japon., Poiss., 1845, p. 149.

Glossogobius vomer Whitley, Rec. Austr. Mus. xvii, 1929, p. 135, pl. xxxii, fig. 1. Swan River.

Eleotris obscurus Castelnau, preocc. = *E. Castelnaui* Macleay is obviously a new and hitherto unsuspected synonym of *Glossogobius suppositus*.

Family BLENNIIDAE.

Genus NORFOLKIA Fowler, 1953.

NORFOLKIA SQUAMICEPS (McCulloch & Waite).

Gillias squamiceps McCulloch & Waite, Trans. Roy. Soc. S. Austr. xl, 1916, p. 449, pl. xli, fig. 1 and Waite, ibid., p. 454. Lord Howe and Norfolk Islands.

Norfolkia lairdi Fowler, Trans. Roy. Soc. N. Zeal. lxxxi, 1953, p. 264, fig. 12. Norfolk Island.

Two specimens, up to $1\frac{7}{8}$ inches long, from Heron Island, Queensland, constitute a new record for Australia. One is in the Dept. of Zoology, University of Queensland (No. E.34) and the other in the Australian Museum (No. IB.3544). The life-colours were noted as "grey and white [barred], with red-tipped mouth."

Norfolkia lairdi is a new synonym of *squamiceps*.

Family CLINIDAE.

Genus CLINUS Cuvier, 1816, s.l.

CLINUS PUELLARUM Scott.

Clinus marmoratus Klunzinger, Arch. Naturg. xxxviii, 1, 1872, p. 33. Port Phillip, Victoria. Types in Nat. Sammlung, Stuttgart, seen. *Id.* Klunzinger, Sitzb. Akad. Wiss. Wien lxxx, 1 ,1879, p. 392. *Id.* Macleay, Proc. Linn. Soc. N. S. Wales ix, 1884, p. 37. *Id.* Lucas, Proc. Roy. Soc. Vict. (2) ii, 1890, p. 29. *Id.* Whitley, Austr. Zool. x, 1941, p. 38, fig. 25 (type). Name preocc. by *Clinus marmoratus* Castelnau, Mem. Poiss. Afr. austr., 1861, p. 52, from Table Bay, South Africa.

Clinus puellarum Scott, Proc. Roy Soc. Tas. lxxxix, 1955, p. 139, pl. i, fig. 1. Low Head, Tasmania.

I find that *Clinus marmoratus* is preoccupied but does not require a new name as it is evidently *C. puellarum*, as above. The species is found on both sides of Bass Strait.

Family DIODONTIDAE.

Genus CHILOMYCTERUS Barneville, 1846.

CHILOMYCTERUS ATRINGA (Linne).

Add to synonymy: *Diodon muricatus* Humphries, Museum Calonnianum, 1797, No. 1313.

An Extraordinary Bilateral Gynandromorph Butterfly

By L. COURTNEY HAINES.

(Plate xxxi.)

On the 27th December, 1948, Mr. F. Hole, of Burradoo, N.S.W., captured in his garden a strange specimen of the Common Brown Butterfly, *Heteronympha merope merope* Fabricius, 1775, which he showed to Roderick Dobson Esq., well-known British naturalist, who, at that time, was residing in Burradoo.

Mr. Dobson was impressed by the specimen, observing it to be a rare hermaphrodite; and on his next visit to Sydney brought the unset specimen along to me.

Instantly, I recognised it as being a very rare and most striking bilateral gynandromorph, made all the more outstanding by the remarkable difference in the sexes of *Heteronympha merope merope*. Fortunately the specimen was in near perfect condition.

The upper left fore-wing was of a normal male pattern, as was the left hind-wing, except for a small oval freak ocellus on the right of the normal hind-wing ocellus.

The undersides of the left wings were normal male, both in markings and in colour.

The right wings' upper surfaces were completely female, as were the undersides.

As the male *Heteronympha merope merope* is somewhat smaller than the female, it was interesting to note that this feature was also produced, though to a lesser extent, in this remarkable hermaphrodite.

A number of other hermaphrodites have been captured from time to time by entomologists. The following gynandromorphous specimens are mentioned by the late Dr. G. A. Waterhouse in the *Proc. Linn. Soc. N.S.W.*, for Sept. 25, 1912.

New Guinea Birdwing. *Papilio (Troides) priamus poseidon* Doubleday. 1847.

Orchard Swallowtail. *Papilio aegeus aegeus* Don. 1805.

Big Greasy. *Eurycus cressida cressida* Fab 1775.

Caper White. *Anaphaeis (Belenois) java teutonia* Fab. 1775.

Queensland Two-brand Crow. *Euploea sylvester sylvester* Fab. 1793.

Meadow Argus. *Precis (Junonia) villida calybe* Godart. 1819.

EXPLANATION OF PLATE XXXI.

The acompanying photograph depicts the male and female *Heteronympha merope merope*, figs. 1 and 3, whilst fig. 2 illustrates the gynandromorphous specimen.

New South Wales Mussels

A Taxonomic Review of the Family Mytilidae from the Peronian Zoogeographical Province

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(Figs. 1-53.)

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INTRODUCTION.

This is one of a series of papers, a number of which have already appeared, in which single families of molluscs from the Peronian Zoogeographical Province are reviewed taxonomically as a whole. The object is to bring the widely scattered references into one paper, and to illustrate and discuss all the species and subspecies and their relationship one with another. The description of new species or genera is secondary, though this inevitably has been found necessary to a greater or less extent.

The mussels as a whole play an important part in the marine ecology of the Australian coast, particularly of the foreshore, and their place in the intertidal zonation has been studied by Bennett and Pope (1953). Though their spawning habits have not been specially studied, it is obvious from their gregarious habit, and by inference from the known spawning habits of other pelecypods, that they must be extremely prolific. The littoral species are therefore well fitted to take advantage of any means of migration, and as inhabitants of the intertidal zone they are also well adapted to withstand considerable ranges in temperature. As a result many species so placed have a range throughout more than one zoogeographical province, though there is generally a greater local concentration to make a species more characteristic of one province than another. The range on the whole is wider than in many other families of mollusca. The wider range may also be accounted for by antiquity. The family goes far back in geological history, though the true phylogenetics of fossil forms are imperfectly understood. In Australia some forms have been described from the Permian; then there is a great time-gap to the Cretaceous, the next period from which extensive marine deposits are known. Many mussels have been found in the Australian Cretaceous, but have never been worked out, and much of the material is in poor condition. In the Australian Tertiary there are some links between fossils and species now living on the continental shelf, but less between fossils and recent littoral forms. This can be understood, as the bulk of the Tertiary deposits are from deeper water, and fossils from the littoral zone can be expected only from restricted areas on the border of the Tertiary Sea. These may yet be found, probably from the vicinity of the lower Darling River and parts of the Murray River Valley.

The family Mytilidae is fairly well defined, though some modern conchologists advocate a division into two famliies, Mytilidae and Modiolidae. The division is based largely on the hinge, Mytilidae having hinge teeth while the Modiolidae are edentulous. This character alone hardly seems sufficient, for when teeth are present they are small and rarely functional, appearing more as a development and modification of crenulations on the dorsal margin. Only in *Austromytilus* do they appear immediately below the umbos on what is approximately a true hinge plate, but even here they are irregular in size and number and tend to become obsolete on maturity. There is no resemblance to the definite pattern and interlocking of the hinges of most of the higher families of pelecypods, nor even to that of the more primitive taxodonts. In the description of species which follows, the term "teeth" is used where they are functional, that is interlocking with those of the opposite valve; otherwise the term "pseudo-teeth" is used.

Hedley (1917) listed 18 species of Mytilidae from the Peronian Province. Subsequently Iredale in various papers rejected one species, renamed others and added a new record. In this paper 22 species are discussed and figured, some further revision of nomenclature has been undertaken, necessitating the proposal of one generic and 5 new specific names, and the addition of 2 new records from the Province. Original descriptions have been amplified, taxonomic comparison has been made, and some new data added on the distribution of the various species.

All types, paratypes and specimens illustrated have been presented to the Australian Museum, Sydney.

The following is now the complete list of Peronion species.

Mytilus planulatus Lamarck.
Austromytilus rostratus (Dunker).
Septifer australis, sp. nov.
Trichomya hirsuta (Lamarck).
Musculus cumingianus (Reeve).
Musculus ulmus Iredale.
Musculus alganus, sp. nov.
Musculus varicosus (Gould).
Trichomusculus barbatus (Reeve).
Trichomusculus splendidus (Dunker).
Modiolus peronianus, sp. nov.
Modiolus cottoni, sp. nov.
Modiolus agripeta Iredale.
Modiolus victoriae Pritchard & Gatliff.
Modiolus delinificus Iredale.
Modiolus pulex (Lamarck).
Amygdalum beddomei Iredale.
Amygdalum lineum (Hedley).
Amygdalum glaberrimum (Dunker).
Fluviolanatus amarus sp. nov.
Exosiperna relata Iredale.
Solamen rex Iredale.

DESCRIPTION OF SPECIES.

Genus MYTILUS Linne.

Syst. Nat., ed. 10, 1758, p. 704. Type species *Mytilus edulis* Linne.

Mytilus is now restricted to mussels with a few small hinge teeth on a thickened marginal extension anterior to the umbos. The teeth are functional, interlocking with those of the opposite valve. The shell is wedge-shaped, very inequilateral, the umbos anteriorly terminal and acute, sculpture smooth or finely concentric, periostracum smooth, byssus strong, ligament linear, set in a marginal groove.

Mytilis planulatus Lamarck.
(Figs. 1-3.)

Mytilus planulatus Lamarck, 1819, Anim. sans Vert., 6, p. 125.

The type locality is Western Australia, and the species ranges throughout southern Australia to the east coast. In New South Wales it is one of the commonest species, forming dense, gregarious colonies on piles and rocks in the outer harbours just below the limit of low tide level. The form is variable, Western Australian specimens being generally broader than those from the east, though among the latter are many individuals which are just as broad. The colour varies from deep brown to nearly black, with a strong violet tinge particularly noticeable on worn specimens. The interior is white, except at the margins. The small teeth are variable in number, generally 3 in each valve, but there may be 5 or 6. They are best seen in young specimens, and in many mature shells they are quite obsolete. The specimen illustrated is from North Harbour, Port Jackson, its height from the umbo to the extreme posterior-ventral margin 59 mm., the depth of the conjoined valves 23 mm.

Genus AUSTROMYTILUS, gen. nov.

Type-species *Mytilus rostratus* Dunker.

A genus of the Mytilidae characterised by a few, prominent nodular hinge-teeth set on a plate immediately below the umbo, a black, smooth periostracum, radial sculpture, a semi-internal ligament set in a groove behind the umbo. The number of teeth is variable, even in the one species, but the general formula is 2 in the left valve and one in the right. The form of the shell is very inequilateral, and the umbos are terminal and rostrate. The adductor muscles are unequal, the posterior large, rounded ventrally and elongated dorsally, the anterior small, round and deeply excavated just below the hinge plate. The habit is gregarious, individuals adhering by a hirsute byssus protruding from between the valves just below the umbo.

By its shell characters *Austromytilus* is related to the true *Mytilus*, but differs by its radial sculpture, and by the large irregular teeth below the umbo. In *Mytilus* the teeth are small and set on an anterior extension of the margin. In *Brachyodontes*, to which the type has been referred, there are no cardinal teeth, but a row of small pseudo-teeth on the margin above the ligamental groove posterior to the umbo. The southern and western species *M. erosus* (Lamarck) has a hinge much nearer to this type.

Austromytilus rostratus (Dunker).

(Figs. 4, 5.)

Mytilus rostratus Dunker, 1857, Proc. Zool. Soc. Lond., 1856, p. 538; Reeve, Conch. Icon., 1857, 10, pl. 5, fig. 15.

The type locality is Tasmania, and the species is very common in communal masses in the intertidal zone throughout southern Australia. In the east it has invaded the Peronian Province and is found in occasional patches as far north as Jervis Bay, but is never common. The specimen figured is from Narooma, its height 33 mm. and depth of conjoined valves 15 mm.

In the past there has been some doubt as to whether it was a variation of *Mytilus erosus* Lamarck, but good figures by May (1923) and Cotton and Godfrey (1938) make the differences clear. The only other possible doubt was whether Lamarck's original *erosus* was not really the rostrate form, as his quite inadequate description indeed suggested. The type of *erosus* is in the Paris Museum and has never been figured, so drawings of the two species were sent to Paris for comparison. Fortunately this showed that the interpretations by later Australian authors were correct, and the identification of the two species can be considered as satisfactorily settled.

A. rosratus is variable in shape and when in dense colonies is often deformed, and the upper portion of both valves much eroded, but when growing singly it is generally wider and constant. The teeth are stronger in young shells, and in very old individuals they may be fused together or often nearly obsolete. They are irregular in form. Generally there are 2 in the left valve and 1 in the right, but the formula may vary as 1-0, 2-1, 3-2, 2-3 and even 4-3. These teeth are true teeth, interlocking with those of the opposite valve. The colour of eroded specimens is generally purple, but when uneroded is nearly black.

Genus SEPTIFER Recluz.

Septifer Recluz, 1848, Rev. Zool., p. 275. Type species *Mytilus bilocularis* Linne.

The shell is trigonal and very inequilateral, the umbos terminal, the sculpture of radial ribs on the posterior portion. The main generic character is, however, the subumbonal shelf in which is excavated an impression for the insertion of the anterior muscle. The distribution of the genus is given as from Mauritius to Australia. It is generally associated with coral reefs, and most of the described species are tropical. Iredale records two species from Queensland, doubtfully referred to *S. bilocularis* and *S. excisa* Wiegmann. Again from New Zealand Powell* records from the stomach of a fish a single valve which he compares with *S. bilocularis*, and also remarks that similar valves are not uncommon in a dredging from 10-30 metres off the Kermadecs. A species occasionally found in New South Wales has been variously determined as *bilocularis* and *S. kraussi* Kust, and it is here named as new.

The genus is also found in the Victorian Tertiary, and it is probable that the New South Wales and New Zealand forms have more relationship with the fossil than with living species.

Septifer australis, sp. nov.

(Figs. 6, 7.)

Shell small, solid, trigonal, narrow anteriorly, expanded posteriorly, very inequilateral, the umbo large and terminal with a small, round prodissoconch. Dorsal margin straight, ventral margin sinuate, posterior margin rounded. Colour white flecked with brown. Sculpture of concentric growth furrows, crossed on the posterior portion by numerous, well defined, radiating ridges. Hinge line long and straight, with a wide, strong ligamental grooved plate behind the umbo. The margin above this and also the anterior margin are crenulate. Below the umbo is a wide, definite plate, deeply excavated for the anterior adductor muscle. Above this on the left valve are two small, deep impressions. Posterior adductor scar very faintly impressed. Height from umbo obliquely to posterior-ventral margin 5.4 mm., depth of a single valve approximately 1.6 mm.; the corresponding measurements of the paratype 6.4 mm. and approximately 2.4 mm.

Locality.—14 fms. off Long Reef, holotype and 1 paratype.

Remarks.—This is probably the species previously recorded from New South Wales as *S. bilocularis* Linne, the type of which came from Mauritius. It differs, however, radically in shape and sculpture from that species, and also from the Victorian Tertiary fossil *S. fenestratus* Tate.

Genus TRICHOMYA Ihering.

Trichomya Ihering, 1900, Proc. Mal. Soc. Lond., 4, p. 87, Type-species *Mytilus hirsutus* Lamarck.

The nomenclature was reviewed by Iredale (1924). Later (1939) he proposed a further genus *Dentimodiolus* with a new Queensland species *sculptus* as type. From Iredale's description of the hinge of *Dentimodiolus* there seems very little difference between *Trichomya* and *Dentimodiolus*. It reads: "ligament set upon a shallow shelf, above which the margin is strongly numerously toothed; teeth as round knobs, not interlocking with opposite series; the pseudo-teeth continuing all along the upper margin, but disappearing ventrally, stronger at the anterior end where they may act as true teeth." This description applies equally well to *hirsutus*, the type of *Trichomya*, except that in *hirsutus* there is individual variation in the hinge. For instance, in some specimens the anterior marginal crenulations below the umbo are faint, in others the uppermost 2 or 3 are quite large and rounded and simulate true teeth. Cotton and Godfrey (1938) placed the three species *rostratus*, *erosus* and *hirsutus* all under *Brachyodontes*, but here they are considered as generically separate, not only from *Brachyodontes* but from each other. An obvious conchological difference apart from the hinge between *hirsutus* and the other two is that it possesses a hirsute periostracum, the hairs of which are forked as in *Trichomusculus*.

Another character noticed by Iredale (1924) suggests relationship between *Trichomya* and *Trichomusculus* and *Musculus*: this is the sculpture. Though the sculpture of *Trichomya hirsuta* is primarily radial and at first sight appears to cover the whole shell equally, close examination shows that in the sinus on the ventral margin at the anterior end it becomes very faint or even quite obsolete, reappearing again just below the umbos.

* Rec. Auck. Mus., 1954, 4, p. 235.

Trichomya hirsuta (Lamarck).

(Figs. 8-10.)

Mytilus hirsutus Lamarck, 1819, Anim. sans vert., 6, p. 120.

The type locality is doubtful, but may be South Australia. Fortunately it is a well defined species and its identity is well established. In New South Wales it is very abundant in the bays where it grows in gregarious masses and forms a well defined band in the lower part of the littoral zone. It prefers a truly marine environment, and in the upper reaches of Port Jackson and in the river estuaries it is generally replaced by *Modiolus pulex*. Owing to crowding the form is often distorted, and it varies accordingly much in shape. The masses of individuals bound together by the hirsute periostracum provide shelter for many other organisms and constitute a distinct ecological unit. It can be readily recognised by its form, brown coloration and pearly interior. The specimen illustrated came from Port Jackson; its height from umbo to extreme posterior ventral extremity is 59 mm. and depth of conjoined valves 32 mm. It has also been recorded from Tasmania and Victoria, where it is rare, and from South Australia where it is quite common. It is also common in large colonies in southern Queensland, and specimens from Hervey Bay within the Solanderian Province cannot be separated from those from New South Wales.

Genus MUSCULUS Bolten.

Musculus Bolten, 1798, Mus. Bolt., p. 156. Type species *Musculus discors* Linne.

Iredale (1924 & 1936) has outlined the nomenclature of this genus, which may be accepted for a group of Australian shells with smooth periostraca, edentulous hinges, marginal ligaments and discrepant, threefold sculpture, radial sculpture occurring at both the anterior and posterior ends with a central area smooth except for faint concentric growth lines. A further subdivision by Iredale (1924) placed those species with otherwise similar characters but with hirsute periostraca in a new genus *Trichomusculus*.

Cotton and Godfrey (1938) have not accepted *Trichomusculus*, but in their key to the South Australian species of *Musculus* use the nature of the periostracum as a primary subdivision.

Living species of both these groups seem to be direct descendants of Tertiary fossils from southern Australia. For instance *Musculus cumingianus* greatly resembles *Modiolaria corioensis* Tate from the Miocene of Corio Bay, Victoria, and *Trichomusculus barbatus* is close to *Modiolaria semigranosa* Tate from the Adelaide bore.

Musculus cumingianus (Reeve).

(Fig. 11.)

Modiola cumingianus Reeve, 1857, Conch. Icon., 10, pl. 9, fig. 50.

The validity of this name is still in doubt, depending on whether it is a distinct species from the South Australian *M. nanus* Dunker. If not the latter name has a year's priority. The type locality of *cumingianus* is Moreton Bay, Queensland, and the species ranges right down the New South Wales coast, generally attached to ascidians or sponges. The specimen figured came from Long Reef, near Sydney; its length is 24 mm., height 15 mm. and depth of conjoined valves 13.5 mm. An important character for specific determination is the number and disposition of the radial ribs. In the New South Wales specimens the anterior ribs are always the most prominent; they are narrow and well raised with wide, flat channels between, and number 7-8, of which the 3-4 commencing on the umbo stand out, while the others at the extreme anterior end are faint. The posterior ribs are less defined and number approximately from 20-24. The colour is generally a rich red brown. The South Australian *nanus* Dunker and the New Zealand *impactus* Hermann, if not identical, are both very close to this. The species *cuneatus* Gould, which appears on Hedley's Check List (1917), was described from False Bay, Cape of Good Hope, and has among other differences a much greater number of radiating ribs than any Australian species. It has already been rejected from the New South Wales list by Iredale (1936).

Musculus ulmus Iredale.

(Fig. 12.)

Musculus ulmus Iredale, 1936, p. 271, pl. 21, fig. 10.

Small specimens from Port Jackson, which might be taken as immature *cumingianus* were separated chiefly by the greater number of radiating ribs at the anterior end, 15 being counted on the type. The colour generally is green, the same as in some immature specimens of *cumingianus*, but apart from the number of ribs, *ulmus* is even more inequilateral, the umbos overhanging the anterior margin. The specimen figured is from Port Jackson, its length 11 mm., height 6 mm. and depth of conjoined valves 6 mm.

Musculus alganus, sp. nov.

(Figs. 13, 14.)

Shell small, oval in contour, widening at the posterior end, the ventral margin sulcate beneath the umbos, very inequilateral, the umbos tumid and overhanging the anterior end. Colour white to pale yellow, variegated with irregular brown patches. Periostracum thin with a minute granular texture. Sculpture distinctive, 3 or not more than 4 short, radial ribs at the extreme anterior end, the median region smooth except for concentric growth lines, the posterior region with very faint, distant radial threads, often hardly discernible. Hinge edentulous, ligament short, marginal, set in a very narrow submarginal groove. Length 4 mm., depth of conjoined valves 1.9 mm.

Habitat.—Living on algae in rock pools, Yamba, holotype and 1 paratype; also in similar habitat at Point Halliday, common. A series in the Australian Museum from Port Jackson is slightly larger than the type.

Remarks.—It was thought that this might be the juvenile of one of the other species, but the distinctive shape and sculpture and also the uniform size and colouring of series from several localities led to the conclusion that it is quite different. It is not uncommon on the outer beaches, but wave rolled specimens are hard to recognise, and can easily be confused with *M. varicosus*.

Musculus varicosus (Gould).

(Fig. 15.)

Modiola varicosa Gould, Proc. Boston Soc. Nat. Hist., 1861, 8, p. 37.

Though no figure was originally published there is fortunately no doubt as to the identity of the species, as the type-locality is Sydney. It is common on the beaches both within Port Jackson and on the neighbouring coast and also in dredgings from a sandy bottom, but is rarely seen with both valves conjoined. It is readily recognised by the wedge-shaped contour, and by its very narrow anterior end. The colour is variegated, a white to yellow ground with irregular lines, often zigzag, and patches of deep chocolate. It is small, the specimen figured from Port Hacking being about the maximum size. Its length is 13.5 mm. and the depth of the single valve approximately 3.5 mm. The ligament is very weak, the submarginal groove barely discernible on the dorsal margin of the very thin shell.

Genus TRICHOMUSCULUS Iredale.

Trichomusculus Iredale, 1924, Proc. Linn. Soc. N. S. Wales, 49, p. 196. Type-species *Lithodomus barbatus* Reeve.

Hinge and sculpture similar to *Musculus*, but with a hirsute periostracum on the posterior half. It may be noted that the hairs of the periostracum are branched.

Trichomusculus barbatus (Reeve).
(Figs. 16-18).

Lithodomus barbatus Reeve, 1858, Conch. Icon., 10, pl. 5, fig. 27.

The type-locality is given as Port Jackson, 6 fms., in mud. It is a small, well defined species, common on the rocky foreshores of Port Jackson and on the neighbouring coast. It has also been recorded from Tasmania and South Australia. The specimen figured is from North Harbour, Port Jackson; its height obliquely from the umbo to the extreme posterio-ventral margin is 7.5 mm., the depth of the conjoined valves 4.5 mm. Apart from its form it can be readily recognised by the dense, hirsute periostracum covering the posterior portion of the shell and projecting behind in a beard-like appendage. The hairs of the periostracum are long, and often much branched.

Trichomusculus splendidus (Dunker).
(Figs. 19-21.)

Volsella splendida Dunker, 1857, Proc. Zool. Soc. Lond., 1856, p. 365.
Lithodomus splendidus Reeve, 1858, Conch. Icon., 10, pl. 5, fig. 21.

The identity of this species is not yet certain. The type-locality was given by Dunker as California, though it has not since been recognised from there. Reeve figured it as from Sydney. Hedley (1901) provided another figure of the interior only of the local shell. In view of the uncertainty and of the inadequacy of Dunker's original description his name might well be rejected as indeterminable, but it has been difficult to obtain satisfactory material for adequate description, and for this reason no change is proposed in the present nomenclature. Apparently it is rather a rare shell. The specimen illustrated has been identified from Hedley's figure, and came from Kurnell, Botany Bay. Its length is 15 mm., height 6.5 mm. and the depth of the single valve approximately 4 mm. Other specimens came from Huskisson and from the beaches at the mouth of the Clarence River, but the periostracum is so dense, often covering the whole shell, that both the form and sculpture are obscured and identification is difficult. Compared with *barbatus* the form of the shell is more elongated, the dorsal and ventral margins are nearly parallel, and the umbo is more terminal, quite overhanging the anterior end. The interior anterior margin below the umbo is often deeply crenulated, simulating a row of teeth.

Genus MODIOLUS Lamarck.

Modiolus Lamarck, 1799, Mem. Soc. Nat. Hist. Paris, p. 87. Type-species *Mytilus modiolus* Linne.

The main characteristics of this genus are the very inequilateral, oblique shell, narrow anteriorly but expanding posteriorly, the nearly terminal umbos and the thin, edentulous hingeline. The ligament is internal, set in a long groove excavated in the margin behind the umbos. The sculpture consists of fine growth-lines only, and there is often a hirsute periostracum. Iredale (1939) suggests that when the animals are critically examined the genus may have to be divided into more than one. Superficially he recognises two sections, those with a long hingeline and weak slender ligament and those with a short hingeline and strong ligament. He also notes that members of the former group are mud living and unattached by a byssus, and are also not hirsute, while the latter are attached to rocks, etc., by a byssus and are very hirsute. The division is, however, not as clear cut as this, for at least one species attached by a byssus, *Modiolus pulex*, has a smooth and not a hirsute periostracum.

Modiolus peronianus, sp. nov.
(Figs. 22-24.)

Shell of medium size, stout, very oblique, narrow at the anterior end, dorsal margin arched, about half the total length, posterior end elongated and expanded, angled at its junction with the hinge, ventral margin sinuate, umbos large and prominent, close to the anterior margin which is slightly auriculate.

Colour deep red-brown to almost black, interior purple, worn beach specimens often red. Sculpture of closely spaced, strong, concentric growth-ridges. Periostracum hirsute, covering most of the shell, the hairs not bifurcate but generally bearing short hooks. Hingeline long, arched, edentulous, the ligament internal, behind the umbos, strong, set in a well defined submarginal groove. Adductor muscle scars shallow and not clearly defined. Height from umbo to extreme posterio-ventral margin 57 mm., depth of conjoined valves 28 mm.

Locality.—Gunnamatta Bay, Port Hacking, on sand flats at low tide; holotype and 1 paratype.

Remarks.—This is one of the species previously called *M. australis* Gray, and later identified by Hedley with the New Zealand species *M. areolatus* Gould. *M. australis* was proposed as long ago as 1826, and appeared in all check-lists up to 1923, having at one time or another been applied to several different species. Hedley (1923) finally pointed out that Gray's description was confined to a few remarks about a single worn and unlocalised valve, and decided to discard it as unintelligible. Unfortunately in its place he proposed to use *M. areolatus*, a well defined New Zealand species which very doubtfully occurs in Australia at all. Since then *areolatus* has been applied to more than one Australian species, and the confusion has been perpetuated. For instance, Cotton and Godfrey (1938) used it for a South Australian species, but at the same time stated: "We are not altogether satisfied with the species name *areolatus*," and noted also that Tate wrote of the same species: "*M. australis* Gray, this is also *albicosta* var. *spatula* Lamarck."

Of the Australian species, *peronianus* approaches closest to the New Zealand *areolatus*, but is only half the size, and differs slightly in shape, being even narrower anteriorly and more elongate posteriorly. It is felt that by giving a new name to this Peronian species its identity will be established and future confusion avoided.

Modiolus cottoni, sp. nov.

(Figs. 25-28.)

Shell large, thin, very oblique, very narrow at the anterior end, expanded posteriorly, dorsal margin nearly straight, angled with the posterior margin which is regularly curved, ventral margin sulcate just below the umbo, anterior margin small and auriculate, umbos not large, near the anterior margin. Colour pale yellow brown, one half-grown specimen red, interior pure white. The type has only traces of a periostracum, but if the identification of a group of half grown specimens is correct, it is hirsute, the hairs near the posterior margin being long, thin, flattened and not forked. Hingeline long and nearly straight, edentulous, the ligament internal, thin and weak, set in a very narrow submarginal groove. Adductor muscle scars hardly impressed, the anterior small and close to the umbo, the posterior larger, rather wide, close to the posterior extremity. Depth from umbo to posterior ventral extremity 83 mm., length of hingeline 51 mm., depth of conjoined valves 45 mm.

Locality.—30-50 fms., off Twofold Bay; holotype (Mr. T. A. Garrard).

Remarks.—This appears to be the species known in South Australia as *M. areolatus*, and it cannot be separated from the eastern Tasmanian shell also known by that name. For reasons given when discussing *M. peronianus*, *areolatus* is now discarded for Australian shells. Compared with *M. peronianus* it is a larger, frailer shell with a different contour, even narrower anteriorly, the hingeline is straighter and the ligament much weaker. The colour is also different. For the South Australian species the range in depth is given by Cotton as from below low tide down to 300 fms.

The species is named in honour of Mr. B. C. Cotton whose monumental work in collaboration with Mr. F. K. Godfrey on the South Australian Pelecypoda has been of such assistance to Australian conchologists.

Modiolus agripeta Iredale.

(Figs. 29, 30.)

Modiolus agripeta Iredale, 1939, Gt. Barr. Reef. Exped. Sci. Rept., 5, p. 412, pl. 6, fig. 21.

The type locality is Low Islands, Queensland, where it is gregarious, forming a mat. Several specimens found on the beach at Woolgoolga now add a species to the Peronian fauna, though with other species from this locality it can be looked upon as a migrant from the tropics, its passage assisted by the warm Notonectian Current. The Woolgoolga specimens match the type almost exactly, but owing to their beach-rolled condition most of the very hirsute periostracum has been worn off. The colour is very deep red-brown to chocolate, with a light band extending from the umbo to the ventral margin. The height from the umbo to the ventral margin, the greatest dimension, is 40 mm., the depth of the conjoined valves 25 mm.

Modiolus victoriae Pritchard and Gatliff.

(Figs. 31, 32.)

Modiolus victoriae Pritchard & Gatliff, 1903, Proc. R. Soc. Vict., 16, p. 93, pl. 15, figs. 1, 2; Iredale, 1924, Proc. Linn. Soc. N. S. Wales 49, p. 197.

The type-locality is from 6 fms. off Rhyll, Western Port, Victoria, and Iredale first recorded it from the Peronian Province from shallow water in Twofold Bay. It is obviously a migrant from the Maugean Province, though so far it has not been recorded from Tasmania. The specimen illustrated is from the type-locality, Western Port; its height from the umbo diagonally to the opposite ventral margin is 14 mm., its length 17 mm. and depth of conjoined valves 8 mm. It can readily be distinguished from all other species of *Modiolus* by its much wider anterior end with the dorsal and ventral margins nearly parallel.

Modiolus delinificus Iredale.

(Figs. 33-35.)

Modiolus delinificus Iredale,, 1924, Proc. Linn. Soc. N. S. Wales, 49, p. 196, nom. nov. for *Mytilus albicostus* Lamarck.

The only reason Iredale gives for the rejection of *albicostus* is: "There is a serious doubt as to the validity of this name." Without access to the full literature, and acting on the assumption that Iredale had adequate reasons for his conclusions, *delinificus* is accepted, as the legal term has it, "without prejudice," though it must be noted that Cotton and Godfrey (1938) still retain *albicostus* for the South Australian shell. The type chosen for *delinificus* is that figured by May (1923, pl. 4, fig. 6) and mentioned as common on many ocean beaches in Tasmania. Whatever name is used there can be no doubt of the species referred to. The range is throughout Tasmania and southern Australia as far as Western Australia, and the species seems very constant throughout. In New South Wales it is confined to the extreme south where it is sometimes procured in dredgings. The specimen illustrated was trawled off Brush Island, Bateman's Bay, and this so far is its most northern record. Its height from the umbo to the extreme posterior ventral margin is 70 mm., and the depth of the conjoined valves 33. Another specimen from Twofold Bay is still larger, the corresponding measurements being 84 mm. and 32 mm.

It is easily recognised, the strong ventral sulcus, the broad, inflated posterior ventral carina, and the elongation of the shell in this direction giving it a distinct facies. The colour varies from bright chestnut to deep red-brown, and the umbo and carina are generally white. A series of small shells from 25-30 fms., Twofold Bay, are probably the juveniles of this species, and one of them (fig. 35) is here figured for reference. Its height is 7 mm.

Modiolus pulex Lamarck.

(Figs. 36-38.)

Modiolus pulex, Lamarck, 1819, Anim. sans vert., 6, p. 112.

Perna confusa Angas, 1871, Proc. Zool. Soc., 1871, p. 21, pl. 1, fig. 33.

Though *confusus* has been generally used for the Peronian shell, most recent authors, including Cotton and Godfrey (1938), are satisfied it is a synonym of the southern and western species *pulex*. Hedley in his check-list (1919) used *confusus*, and May (1923) admitted both species, *pulex* for those living on the outer foreshores, and *confusus* for those in the estuaries. In their work on the ecology of Victoria Bennet and Pope (1953) recognise *pulex* as occupying a narrow, well defined band in the upper littoral zone on the outer rocks, and where conditions are favourable, as in western Victoria and South Australia, it occurs in dense masses matted together by the hairy byssus. Individuals are on the whole smaller and rather narrower than those from the estuaries, and in this form are characteristic of the Maugean cool-temperate Province. In New South Wales the species is largely confined to the heads of the bays and to the river estuaries, and in the latter habitat is found well away from the sea in water that is often only brackish. In Port Jackson in the narrow upper reaches of the long inlets such as Lane Cove it is found in communal masses adhering to piles and rocks, where it replaces *Trichomya hirsutus*, found in similar situations nearer the open sea. Fallen logs in the mangroves are another favourite habitat. New South Wales specimens approximate very closely both in form and size to those from South Australia, particularly those living under pure marine conditions as at Shark Island in Port Jackson. The range in New South Wales is wide, from the extreme north coast to the Victorian border, whence it ranges to Bass Strait.

The type locality of *pulex* is King George's Sound, Western Australia, that of *confusus*, Queenscliff Lagoon, just north of Port Jackson. The opinion is here expressed, confirming that of Godfrey and Cotton, that both are the one species, and that slight differences between estuarine and marine forms are not constant, being due to different conditions and are not even racial.

In New South Wales there is considerable variation even in the one location. The length of mature individuals varies from about 15 mm. to a maximum of 25 mm. (Shark Island, Port Jackson), and the colour varies from a deep red-brown to a more common quite black. The shape also varies, and some specimens have the ventral margin deeply sulcate (fig. 36), while others have this margin nearly straight (fig. 38). Fig. 36 shows one from Queenscliff Lagoon; its height from the umbo diagonally to the extreme posterio-ventral margin is 17 mm., the depth of the conjoined valves 8 mm. Fig. 38 is from mangrove swamps at Huskisson, its corresponding measurements 16 mm. and 7.5 mm. respectively.

Genus AMYGDALUM Muhlfeldt.

Amygdalum Muhlfeldt, 1811, Ges. Nat. Fr. Berlin Mag., 5 p. 69. Type species *Mytilus arborescens* Chemnitz, syn. *Amygdalum dentriticum* Muhlfeldt.

Shell like *Modiolus*, very inequilateral with terminal umbos, but narrow and more elongated, the conjoined valves more or less cylindrical, the surface smooth, the texture very thin and translucent. The ligament is very narrow and weak, the hinge edentulous. It often forms a nest from its long byssal threads. *Amygdalum* has been generally neglected by most writers who placed the type species under *Modiolus*, but the name was revived by Iredale (1924).

Amygdalum beddomei Iredale.

(Figs. 39-41.)

Amygdalum beddomei Iredale, 1924, Proc. Linn. Soc. N. S. Wales 49, p. 197, pl. 35, fig. 21.

This is the species previously known to local conchologists as *Modiolus arborescens*, the type of which is said to have come from the island of St. Domingo. The rather involved nomenclature has been reviewed by Iredale, and apparently there are several species, the Western Australian form being different, while still another occurs in the Moluccas. Specimens from Tasmania cannot be distinguished from those from New South Wales, and South Australian specimens are also similar, though that figured by Cotton and Godfrey (1938) is slightly broader at the anterior end. The specimen here figured is from 30-35 fms. off Crookhaven; its height from the umbo to the extreme posterior ventral margin is 34 mm., the depth of the conjoined valves 9 mm.

It is an inhabitant of the continental shelf, though specimens have been found in Quarantine Bay, Port Jackson, at a depth of 8 fms. This seems to be its most northerly record. It can be easily recognised, not only by the form, but by the brown variegated markings on the posterior end.

Some small, colourless shells up to 5 mm. in length have been collected from various localities on the continental shelf which are probably the young of this species, though they are relatively broader in proportion to their length. One of these from 20-25 fms. off Crookhaven (fig. 41) is here figured for comparison.

Amygdalum lineum (Hedley).

(Figs. 42, 43 (after Hedley).)

Modiolus lineus Hedley, 1906, Rec. Aust. Mus., 6, p. 300, pl. 56, figs. 23-25.

The type-locality is 80 fms. off Narrabeen, and the species has also been recorded from deep water in Tasmania and South Australia. The dimensions given by Hedley are length 5.75 mm., height 2.5 mm., depth of single valve, 9 mm.

The systematic position of this small species is doubtful, as its shape is unlike either *Modiolus* or *Amygdalum*. The smooth, thin and glassy shell and the very weak ligament bring it closer to *Amygdalum* in which it is provisionally included, though further material and study may necessitate a new genus for its reception.

Amygdalum glaberrimum (Dunker).

(Figs. 44, 45.)

Volsella glaberrima Dunker, 1857, Proc. Zool. Soc. Lond., 1856, p. 363.

Modiola glaberrima Reeve, 1857, Conch. Icon. 10, pl. 8, fig. 48.

The type-locality is "Australian seas near the city of Sydney," and its range to date has not been extended far beyond this area. It is in fact difficult to obtain material, as its habitat is apparently among reefs in deeper water where it may live in colonies. The specimen illustrated was dredged in Pittwater, its height from the umbo to the posterior ventral margin 19 mm. This is only about half grown, as specimens in the Australian Museum from Port Jackson are about twice the size, though otherwise identical. It is an easy species to recognise. Compared with *beddomei* it has a different shape, and the fine radial rays at the posterior end are distinctive.

Genus FLUVIOLANATUS Iredale

Fluviolanatus Iredale, 1924, Proc. Linn. Soc. N. S. Wales, 49, p. 196. Type-species, *Modiolarca subtorta* Dunker.

The type has at different times been placed in *Modiolarca*. *Modiolus* and *Musculus*. in any of which it is equally out of place. The main generic characters are the irregular, subquadrangular, inequilateral shell, which is slightly twisted and has a slight posterior gape. The valves also are slightly unequal, the right valve overlapping and clasping the left. The hinge is edentulous, the ligament internal, short, behind the umbo, and set in a narrow submarginal groove. The adductor impressions are faintly impressed, the anterior rather larger and farther from the umbo than in most of the family, the posterior impression very large. The sculpture is confined to irregular growth-lines, and there is no radial sculpture as in *Musculus*. It is an inhabitant of coastal lagoons and brackish water.

Fluviolanatus amarus, sp. nov.
(Figs. 46-49.)

Shell small, nearly rectangular in shape, inequivalved, the right valve slightly larger and clasping the left valve, very inequilateral with a slight median twist, the valves gaping posteriorly, umbos large and flat, terminal but not overhanging. Texture thin and rather chalky, colour yellow, sometimes slightly variegated, but generally hidden by the thin deep yellow-brown periostracum which is roughened at the posterior end. Dorsal margin slightly arched, ventral margin parallel and slightly excavate, anterior margin rounded, posterior margin obliquely truncate. Hingeline arched, thin, edentulous, ligament weak, set in a very narrow submarginal groove. Adductor muscle-scars faintly impressed, the posterior scar very large. Length of type (fig. 46) 12.5 mm., depth of conjoined valves 5.5 mm.

Habitat.—On reedy margins of coastal lagoons of New South Wales, often in water which is nearly fresh. Woolgoolga, holotype and many paratypes; Dee Why Lagoon near Sydney (fig. 48), etc.

Remarks.—This is the species appearing on the New South Wales list as *Musculus subtortus* (Dunker), and recorded from New South Wales by Angas (1867). *Modiolarca subtorta* was described by Dunker in 1857* and figured by Reeve in 1858.† The type-locality is New Holland, north coast, which is almost certainly Port Essington, in the Northern Territory, as this was the only north Australian locality at the time from which Dunker obtained material. Both the description and the figure show this to be quite a different species from *amarus* though evidently they are congeneric. The main difference is in the shape, *subtortus* being narrow anteriorly, whereas *amarus* has the dorsal and ventral margins parallel. This is a constant character even though *amarus* varies slightly its proportions, some specimens being relatively wider. Specimens from New Caledonia which have been labelled *subtortus* are of still another species which is as yet undescribed. These have much the same shape as *amarus* but have radial rays and a radial fold at the posterior end.

Genus EXOSIPERNA Iredale.

Iredale, 1929, Rec. Aust. Mus. 17, p. 166. Type-species, *Arcoperna scapha* Verco.

A genus known only so far from deep water. The shell is small, oval in shape, the umbos terminal, the hinge without true teeth, but with fine crenulations simulating teeth, most prominent on both the post-dorsal and anterior dorsal margins, the ligament weak and obscure, Cotton and Godfrey (1938, p. 120) stating that it appears to be external. The sculpture is both finely radial and concentric, producing a reticulated surface. It is probably related to *Musculus* and *Trichomusculus*, but it has quite a different shape, and the radial sculpture covers the whole of the shell and is not discrepant as in both those genera.

Exosiperna relata Iredale.
(Figs. 50-51.)

Exosiperna relata Iredale, 1929, Rec. Aust. Mus. 17, p. 167.

This is the species included in Hedley's check-list (1917, No. 96) as *Musculus scapha* Verco. Iredale based his species on material in the Australian Museum from 80 fms. off Narrabeen labelled *scapha* and obviously the source of Hedley's record, though it does not appear in the list of species in Hedley's own paper on the mollusca from that locality. The species has not so far been figured and the material is not of the best. The illustration now given is of the specimen in the Australian Museum, No. C.26032; this is presumably the type. It is very close to the South Australian *scapha*, but differs slightly in shape and details of the hinge. Its height is 5.5 mm. and the depth of the single valve approximately 2.5 mm.

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* Proc. Zool. Soc. Lond., 1856 (1857), p. 365.

† Conch. Icon., 1858, 10, pl. 10, fig. 57.

Genus SOLAMEN Iredale.

Solamen Iredale, 1924, Proc. Linn. Soc. N. S. Wales 49, p. 198. Type-species, *Solamen rex* Iredale.

Shell oval, inflated, with large umbos, very thin and fragile, the hinge quite edentulous and without crenulations, the ligament weak, semi-internal, the submarginal ligamental groove very narrow and barely discernible. Sculpture of very fine, closely packed radial threads.

Solamen rex Iredale.
(Figs. 52-53.)

Solamen rex Iredale, 1924, Proc. Linn. Soc. N. S. Wales 49, p. 198, pl. 33, fig. 15, pl. 35, fig. 2.

This is probably the species recorded by Hedley* as *Arcoperna recens* Tate from 8 fms., Port Stephens, where it was procured alive encased in a nodule of hard mud. In his check-list (1917, No. 95) Hedley placed it under *Musculus*. The type of *rex* came from Twofold Bay, and the specimen illustrated is of a still larger specimen in the Australian Museum from 55 fms., off Green Cape. Its height is 29 mm. and depth of conjoined valves 24 mm. It is very close to the Tasmanian and South Australian *recens*, but differs slightly in shape.

REFERENCES.

Bennett, I. and Pope, E. C., 1953. "Intertidal Zonation of Exposed Rocky Shore of Victoria," *Aust. Jour. Mar. Fr. Res.*, Vol. 4, No. 1, 105-159.

Cotton, B. C. and Godfrey, F. K., 1938. "The Molluscs of South Australia," Part 1, Pelecypoda, *Govt. Printer, Adelaide.*

Hedley, C., 1901. "Studies of Australian Mollusca, No. 5," *Proc. Linn. Soc. N.S.W.*, 26 (4).

Hedley, C, 1917. A Check List of the Marine Fauna (Mollusca) of N.S.W. *Suppl. to Jour. Roy. Soc. N.S.W.*, 51.

Hedley, C., 1923. *Proc. Linn. Soc. N.S.W.*, 18.

Iredale, T., 1924. "Results from Roy Bell's Molluscan Collections," *Proc. Linn. Soc. N.S.W.*, 49 (3), 179-278.

Iredale, T., 1929. "Mollusca from Continental Shelf of Eastern Australia, No. 2," *Rec. Aust. Mus.*, 17, 157-189.

Iredale, T., 1936. "Australian Molluscan Notes No. 2," *Rec. Aust. Mus.*, 19 (5), 267-239.

Iredale, T., 1939. Great Barrier Reef Exped. Sci. Reps., 5 (6), Mollusca, Part 1. *British Mus.*, 210-425.

Jukes-Brown, A. J., 1905. "Review of the Genera of Family Mytilidae," *Proc. Malac. Soc. Lond.*, 6, 211-224.

May, W. L., 1923. Illustrated Index of Tasmanian Shells, *Govt. Printer, Hobart.*

* Proc. Linn. Soc. N.S.W., 1900, 25, p. 496.


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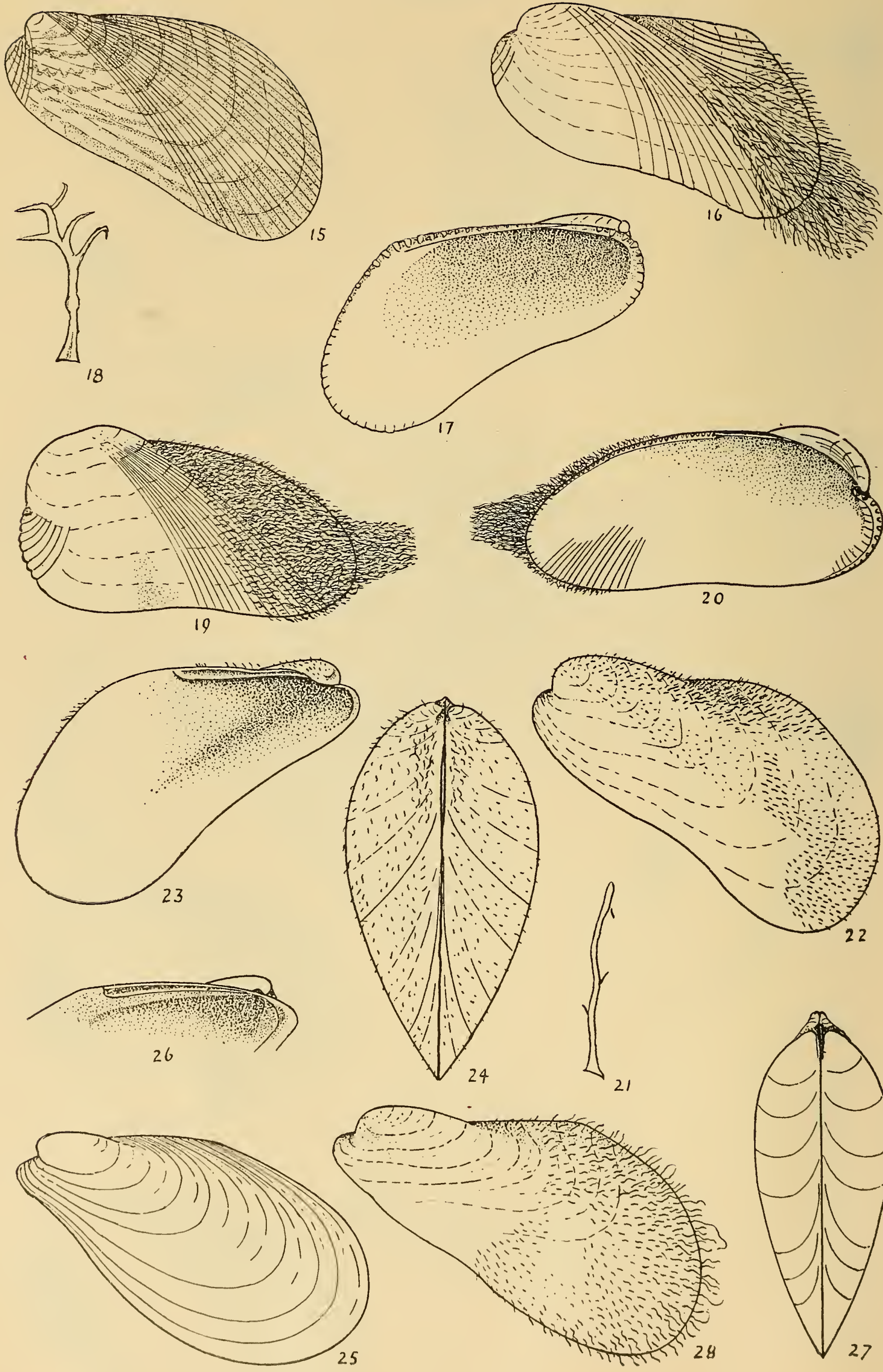
EXPLANATION OF FIGURES.

Fig.

1. *Mytilus planulatus* Lamarck, left valve.
2. *Mytilus planulatus* Lamarck, interior.
3. *Mytilus planulatus* Lamarck, hinge.
4. *Austromytilus rostratus* (Dunker), left valve.
5. *Austromytilus rostratus* (Dunker) interior.
6. *Septifer australis*, sp. nov., holotype, left valve.
7. *Septifer australis*, sp. nov., interior.
8. *Trichomya hirsuta* (Lamarck), left valve.
9. *Trichomya hirsuta* (Lamarck), interior.
10. *Trichomya hirsuta* (Lamarck), hair magnified.
11. *Musculus cumingianus* (Reeve), left valve,
12. *Musculus ulmus* Iredale, left valve.
13. *Musculus alganus*, sp. nov., holotype, left valve.
14. *Musculus alganus*, sp. nov., conjoined valves.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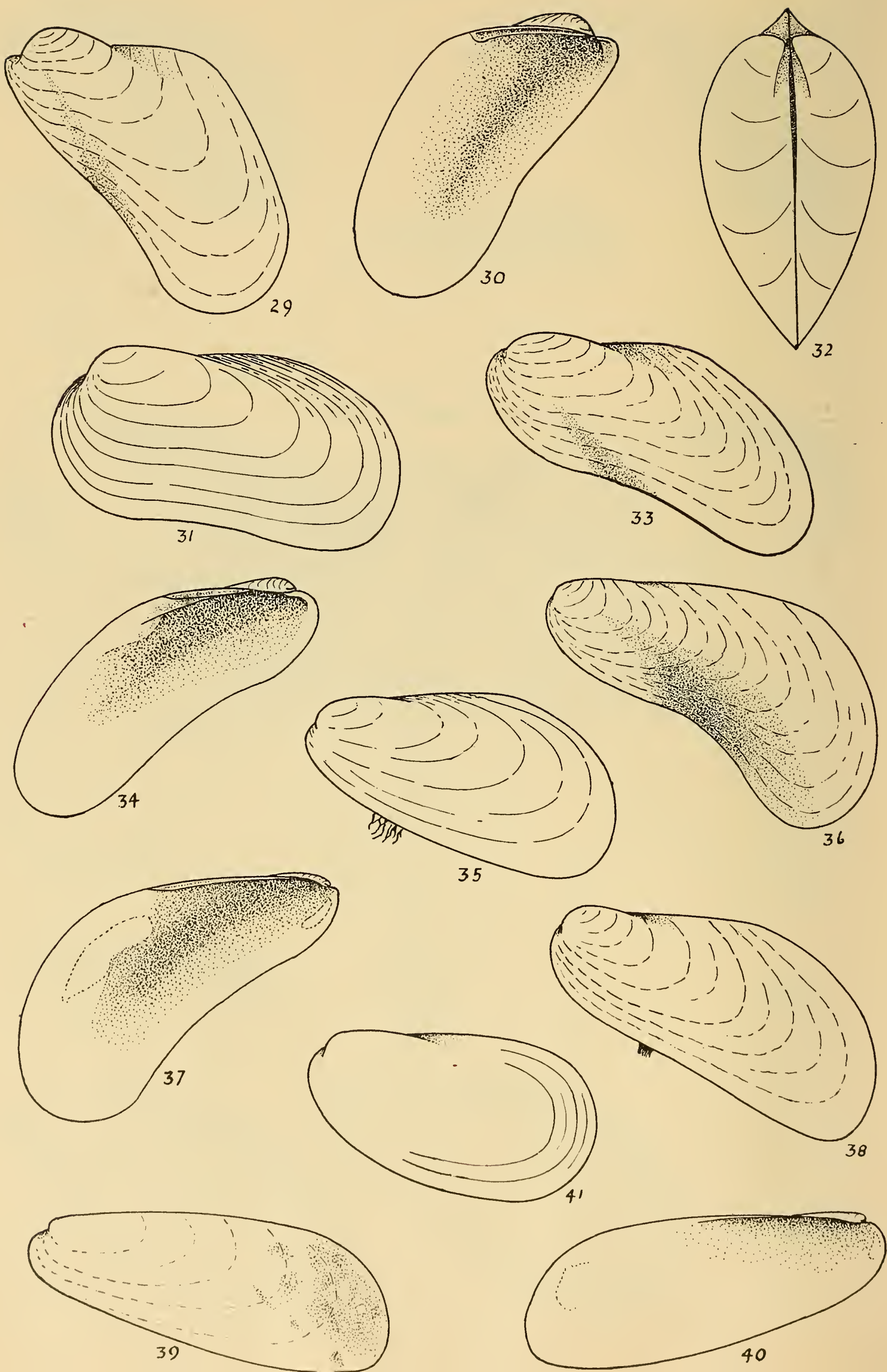
EXPLANATION OF FIGURES.

Fig.

15. *Musculus varicosus* (Gould), left valve.
16. *Trichomusculus barbatus* (Reeve), left valve.
17. *Trichomusculus barbatus* (Reeve), interior.
18. *Trichomusculus barbatus* (Reeve), hair magnified.
19. *Trichomusculus splendidus* (Dunker), left valve.
20. *Trichomusculus splendidus* (Dunker), interior.
21. *Trichomusculus splendidus* (Dunker), hair magnified.
22. *Modiolus peronianus*, sp. nov., holotype, left valve.
23. *Modiolus peronianus*, sp. nov., interior.
24. *Modiolus peronianus*, sp. nov., conjoined valves.
25. *Modiolus cottoni*, sp. nov., holotype, left valve.
26. *Modiolus cottoni*, sp. nov., hinge.
27. *Modiolus cottoni*, sp. nov., conjoined valves.
28. *Modiolus cottoni*, sp. nov., juvenile with periostracum.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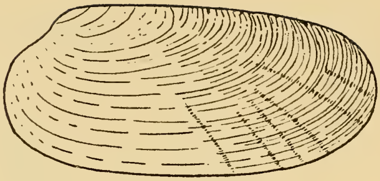
EXPLANATION OF FIGURES.

Fig.

29. *Modiolus agripeta* Iredale, left valve.
30. *Modiolus agripeta* Iredale, interior.
31. *Modiolus victoriae* Pritchard & Gatliff, left valve.
32. *Modiolus victoriae* Pritchard & Gatliff, conjoined valves.
33. *Modiolus deliniificus* Iredale, left valve.
34. *Modiolus delinificus* Iredale, interior.
35. *Modiolus delinificus* (?) Iredale, juvenile.
36. *Modiolus pulex* (Lamarck), left valve.
37. *Modiolus pulex* (Lamarck), interior.
38. *Modiolus pulex* (Lamarck), another specimen.
39. *Amygdalum beddomei* Iredale, left valve.
30. *Amygdalum beddomei* Iredale, interior.
41. *Amygdalum beddomei* Iredale, juvenile.



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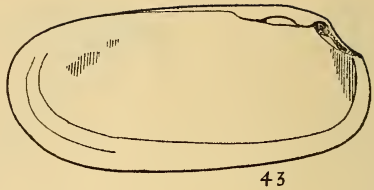

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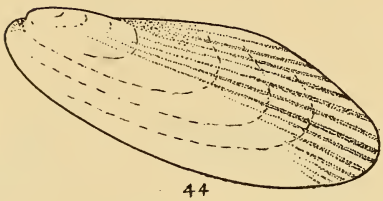

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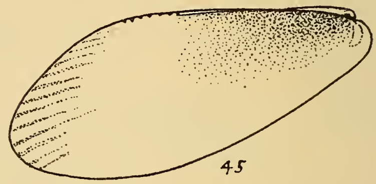

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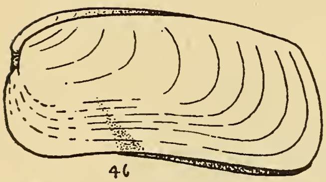

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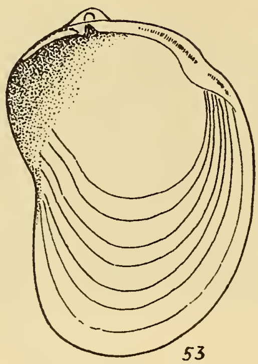

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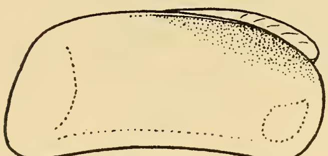

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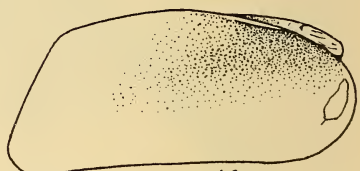

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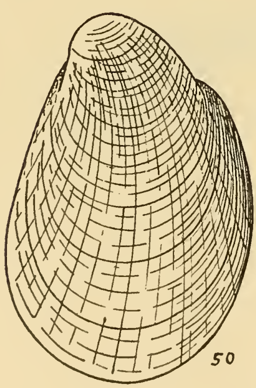

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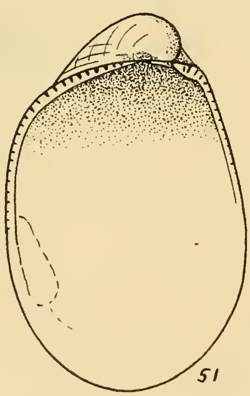

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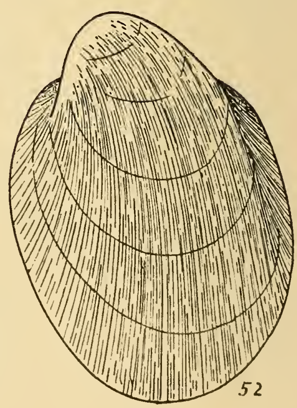


52

EXPLANATION OF FIGURES.

Fig.

42. *Amygdalum lineum* (Hedley), after Hedley, left valve.
43. *Amygdalum lineum* (Hedley), after Hedley, interior.
44. *Amygdalum glaberrimum* (Dunker), left valve.
45. *Amygdalum glaberrimum* (Dunker), interior.
46. *Fluviolanatus amarus*, sp. nov., holotype, left valve.
47 *Fluviolanatus amarus*, sp. nov., holotype, interior.
48 *Fluviolantus amarus*, sp. nov., another specimen.
49. *Fluviolanatus amarus*, sp. nov., another specimen, interior.
50. *Exosiperna relata* Iredale, left valve.
51. *Exosiperna relata* Iredale, interior.
52. *Solamen rex* Iredale, left valve.
53. *Solamen rex* Iredale, interior.

The Nymphs of *Synlestes tropicus* Tillyard, *Chorismagrion risi* Morton, *Oristicta filicicola* Tillyard and *Lestoidea conjuncta* Tillyard: With Description of the Female of the Latter and Further Notes on the Male

By Lt.-Col. F. C. FRASER, I.M.S., Retd.

(Figs. 1-4.)

Systematists working on the Order ODONATA are continually confronted with problems regarding the correct placing of aberrant species, towards which, a knowledge of the nymphs would be of great assistance. This is especially true in regard to archaic forms such as *Hemiphlebia*, *Chorismagrion* and *Lestoidea*, the two former of which may be correctly described as living fossils. The nymph of *Hemiphlebia mirabilis* Selys was discovered and described by Tillyard in 1927 at Alexandra, Victoria, and a study of its wing-tracheation revolutionised our ideas on this subject. Tillyard, in a letter to Mr. Morton, dated December 2nd, 1927, writes: "I am not sure that this nymph does not deal a deadly blow to the whole Comstock-Needham concept of wing-tracheation preceding veins. If the tracheae follow the veins in the cases mentioned (intercalated veins), why should not the *original* trachea have followed the *original* veins? This would explain the puzzle of the incomplete and irregular tracheation of the Trichoptera as against the complete and regular tracheation of the Lepidoptera, which are surely a more highly specialised Order? It would also explain the condition of the tracheation in Mayfly nymphs."

It has now been the good fortune of my colleague Mr. R. Dobson to discover the nymphs of *Chorismagrion risi* Morton and *Lestoidea conjuncta* Tillyard; the first in considerable numbers, the latter from a single exuviae with the newly emerged imago perched on it, so that there could be no doubt about the identification; Mr. Dobson took this nymph some years ago but in the absence of the imago was unable to identify it. On the same short expedition, he took also nymphs of *Synlestes tropicus* Tillyard and *Oristicta filicicola* Tillyard, both of which were hitherto unknown.

Our sole knowledge of the nymph of *Chorismagrion* until now, was contained in a letter which I received from Dr. Tillyard some years ago, and as this has never been published, I reproduce it in full: "You will be glad to learn that the search for the larva of *Chorismagrion* has at last been crowned with success. While using part of the Royal Society grant, for a visit to the Pre-Cambrian and Cambrian beds at Mt. Isa, N.W. Queensland, I spent ten days on the Atherton Tableland. It rained solidly the whole time, but I got on the original locality of Dr. Mjoberg at Dinner Creek, near Tully Falls, and dredged the creek for two miles in the dense jungle in bitterly cold rain squalls. I thought I had nine *Chorismagrion* larvae as a result, but on dissection I find that eight belong to the primitive *Synlestes albicauda* Tillyard and only one, about one-third grown, belongs to *Chorismagrion*. Unfortunately this larva had only one gill left, and this, by some unfortunate chance, was thrown out while being cleared for mounting. However, I have a sketch of it, and as it is exactly like the gill of *S. albicauda*, except for a broad band of brown on it, the loss does not matter much. The gizzard and mask are definitely Synlestine, but slightly more primitive, and the antennae have not got that specialised lengthening of the first segment. It is a relief to secure this important larva and to know that my placing of this genus so close to *Synlestes* is justified. I hope to send a paper for publication on the larvae of Australian Synlestidae to Ent. Soc. London before long."

Tillyard did not survive long enough to write this paper for all that was found among his correspondence was the capitation of the proposed paper, and a reference to the London Society elicited the reply that no such paper had been received. It may be said now that from an examination of Mr. Dobson's material, it is certain that Tillyard had the correct nymph and that the genus is, as he thought, very closely related to the *Synlestes*.

Dr. Tillyard's knowledge of *Lestoidea conjuncta* Till., was limited to the holotype male, now in the British Museum (Natural History); he did not know the female or the nymph but from the venation, he thought that the genus linked up the Lestidae with the Protoneuridae. He was not so fortunate in his conjectures about this queer species, for Mr. Dobson's nymph clearly shows that it is unrelated closely to either of these families but related to the more advanced Amphipterygidae.

Of the Isostictinae, Tillyard figured but did not describe nymphs of *Neosticta canescens* Tillyard and *Isosticta simplex* Martin, but the figures were too small and without much detail; the latter appears to be very similar to that of *Oristicta filicicola* Tillyard, described in this paper.

Finally, Tillyard stated in a letter that the only Synlestine which had been described was the nymph of *Synlestes weyersi* Selys, but all that I have been able to trace of such a description is the small figure of the nymph given in his "Biology of Dragonflies" and the figure of the labium, so that for purposes of comparison with *Chorismagrion*, I have had to employ the nymph of *Synlestes tropicus* discovered by Mr. Dobson.

DESCRIPTION OF NYMPHS.

1. *Synlestes tropicus* Tillyard, 1917 (fig. 1).

Total length 21 mm. Caudal gills 5 mm. Labial mask 3.5 mm. Hind-femora 5.5 mm.

Head broader than deep with the frons projecting, broadly truncate; antennae very long, with short scape but elongate pedicel about three times the length of scape, 3rd segment nearly twice the length of pedicel, remaining segments of distalia shortening progressively; bases of pedicel and 3rd segment blackish. Vertex marked with black and only the median ocellus distinct, the lateral ill-defined; occiput bulging, rounded or globular, traversed by a blackish stripe and black posteriorly. Labial mask kite-shaped, entirely without setae, lateral lobes robust, with moderately long movable hook and two stout teeth at apex, the inner one the longer, strongly curved; inner border finely dentate. Medial lobe with irregular border, its central portion projecting truncately and deeply and finely cleft and with its border finely dentate. Prothorax rectangular, the shoulders squared, broadly black anteriorly, from which two stripes run backwards and are continued very sinuously on to the dorsum of synthorax. Wing-pads extending nearly to the apical end of segment 4 of abdomen and with a broad oblique sooty black band traversing their breadth about the middle. Legs long and slim, strongly ridged and very minutely spined; femora with two black rings and the distal end blackish; tibiae with two black rings, one subbasal, the other subapical. Abdomen long and tapered, rounded, pale with black markings, two parallel stripes on middorsum enclosing oval pale spots, and two subdorsal stripes, the innermost of which is interrupted before the end of each segment and dilates apically. Caudal gills paddle-shaped, very obtuse at apices, the median somewhat shorter than the lateral ones. All are held vertically (not horizontally as in *Austrolestes*) and closely opposed; a broad black band extends from near the base but falls short of the conspicuously pale apex.

Habitat: Mervyn Creek, Kuranda, N. Queensland, 5.X.55, collected by R. Dobson.

2. *Chorismagrion risi* Morton, 1914 (fig. 2).

Total length 17 mm. Caudal gills 2.75 mm. Labial mask 2.5 mm. Hind-femora 4 mm. Abdomen about 10 mm.

Head wider than deep, frons rounded, the labium just showing from beneath the head as viewed dorsally; antennae very long, scape short, pedicel nearly four times as long, 3rd segment about one-third shorter than pedicel, remaining segments progressively shorter; segments 3 to 5 black except at apices. Vertex marbled with brownish grey, the ocelli outlined in this colour; occiput shallowly concave, bulging and globular behind eyes where it is finely spined. Labial mask kite-shaped, deep black in colour except the lobes; lateral lobes with a long robust movable hook and terminating in two stout teeth, the innermost the longer and acuminate at apex; medial lobe projecting as two rounded lobes separated by a deep but closed fissure, the free border finely dentate; no setae present on any part of labium. Prothorax oval, marked with a parallel pair of short longitudinal middorsal stripes of black, as well as its sides. Thorax bulky, blackish except on middorsum and medial borders (fig. 2). Legs rather long and slender, ridged but without armature save some bordering minute spines. Coxae, base and apex of femora as well as two medial rings black, tibiae with two black rings. Abdomen cylindrical, tapering, pale on dorsum and blackish beneath and with a narrow blackish band extending along each side from end to end. Caudal gills broadly oval, shorter than in *Synlestes* and rather obtusely pointed at apices, the dorsal gill hardly shorter than the lateral; all gills black except a conspicuously pale yellowish apex. The gills are held vertically and closely opposed as in *Synlestes.*

Habitat: Mervyn Creek, Kuranda, N. Queensland, 3.X.55, collected by R. Dobson. Several nymphs and exuviae.

3. *Oristicta filicicola* Tillyard, 1913 (fig. 3).

Total length 16 mm. Caudal gills 5.0-5.5 mm. Labial mask 3 mm. Hind femora 3.5 mm.

Head pentagonal, slightly wider than deep; eyes dark, prominent; antennae rather long, scape and pedicel of even length, both short, 3rd segment nearly three times longer than the pedicel, 4th segment slimmer but at least as long as the 3rd, remaining segments of distalia progressively smaller, 3rd and 4th segments with a medial black band, less marked on the segments of distalia. Face and vertex grey, enclosing the paler ocelli and a short stripe running medially from the labrum; occiput dark at centre and sides, with the pale longitudinal stripe of the vertex running posteriorly on to the prothorax and base of synthorax; the sides of prothorax irregular and with an obtuse tubercle at their middle. Thorax robust but short, the bases of wing-pads invading it medially. Wing-pads pea-pod shaped, narrow, elongate and parallel, the bases striped longitudinally and the subbasal portions sharply defined paler. Legs rather long, slim, only minutely spined along the ridges, all femora and tibiae with three black rings. Abdomen cylindrical, tapering to end, blackish above and beneath but the segmental apical borders and a narrow middorsal line pale; apical borders of segments coarsely hairy. Caudal gills markedly elongated and flattened, held vertically and closely opposed, constricted at base, the sides parallel, constricted again at the node which is situated at the junctions of the middle and apical thirds, the apical portion leaf-like, shaped like the head of a spear and fringed throughout along the sides with long, closely-set hairs. Labial mask kite-shaped, closely resembling the Platycnemidine type, lateral lobes with short movable hook and two robust teeth at apex, the outermost the longer and sharply curved, 5 long setae on each lobe; middle lobe produced, cone-like but without cleft, bordered with fine dentations, 4 setae in a straight line at base of the lobe as in genus *Platycnemis* (Platycnemididae).

Habitat: Tully, N. Queensland, 9.X.55, 2 nymphs and 2 exuviae examined, collected by R. Dobson. The shape and formation of the labial mask suggests that the Isostictinae are related to the Platycnemididae, which hitherto, have been unknown from Australian limits, although well represented in the neighbouring continent of New Guinea.

4. *Lestoidea conjuncta* Tillyard, 1913 (fig. 4).

Total length 15 mm. Caudal gills 2.5 mm. Labial mask 3 mm. Hind femora 4 mm.

Head subtrapezoidal, wider than deep, the frons and labrum forming a rather flat convexity, the latter fringed with short vibrissae, the labium projecting squarely from beneath it. Antennae with elongate scape and a pedicel twice as long (the rest of the segments have been lost). To the outer side of the base of the antennae and on the outer parts of the occiput is a field of small stout spines. Prothorax and thorax bulky as compared with the very short abdomen, both coated with similar spines as seen on the head, especially on the shoulders. Wingpads large and flattened, extending nearly to the apical border of segment 5 of abdomen. Legs moderately long, markedly depressed, the femora with a row of small spines on the medial border. Abdomen depressed, very short, and tapered but slightly towards the anal end. Caudal gills saccoid in character, triquetral in section with the inner surface flattened, the outer rounded; dorsal gill but slightly shorter than the lateral, all terminating in a long tail-like spine which is thickly coated with long coarse hairs. Labial mask Gomphine-like, flattened and squared, lateral lobes robust, with moderately long movable hook and two robust apical teeth, the outer acuminate, the inner truncate, the inner border of the lobe finely dentate, the outer with a tuft of long hairs at its base, without any setae; middle lobe produced, deeply emarginate at its centre where is a fine short cleft; its borders finely dentate; no setae present at its base.

Habitat: Mervyn Creek, Kuranda, N. Queensland, 3.X.55. A single exuviae taken along with the freshly emerged imago by R. Dobson. This is a short stout nymph of a uniform dark brown colouring without perceptible markings. Its shape, the fringed labrum, the Gomphine-like labial mask and the saccoid gills all agree with the same characters in the Amphipterygidae, so that it is evident that *Lestoidea* is a more recent type than the Lestidae or the Protoneuridae, an annectent of which Tillyard thought the genus to be. The shape of the discoidal cell, the elongate pterostigma, the straight nature of the accessory intercalaries and the advanced recession of the veins IRiii and Riv+v are all compatible with *Lestoidea* being a reduced type of Amphipterygine. Tillyard described *L. conjuncta* from the holotype male which was a discoloured specimen; Lieftinck afterwards described another male but this also was largely defective in its colouring; the female has never been described. Lastly some inaccuracies also occurred regarding the venational details and measurements of the imago, which may now be corrected.

Lestoidea conjuncta Tillyard.

Male. Abdomen 28-29 mm. Hindwing 21 mm.

The anal vein, which Tillyard said was entirely absent, is present in all specimens although vestigial in character, sometimes as a small chitinous triangle at the lower end of the cubital vein (Ac) but much more usually as a distinct small triangular cell at this point.

Head: labium brownish yellow, labrum pale creamy glossy white with a black anterior border; anteclypeus black, genae and a narrow stripe crossing the postclypeus pale creamy yellow, frons and rest of head mat black but with a small point of yellow on the outer side of the ocellar space each side. Prothorax entirely dull ochreous, posterior lobe as described by myself (1953). Thorax ochreous or a warm light orange brown marked with black as follows: a moderately narrow middorsal stripe, a small point on the upper end of the humeral suture, a large duplicated (dumb-bell-shaped) spot above the middle coxae, a rather diffuse stripe on the postero-lateral suture, sometimes deficient above, and a similar diffuse stripe on the lower border of metepimeron. Beneath paler ochreous with a sharply defined linear spot of black on each side of pectus. Legs blackish brown or black on extensor surfaces, pale on the flexor. Abdomen black, segment 1 pale yellowish save for a black dorsal triangular marking with its apex directed apically, segment 2 with parallel subdorsal longitudinal yellow stripes not extending to either end of segment, segments 3 to 5 or 6 with small paired basal spots of white. Anal appendages black, as described by Lieftinck (1951).

Female. Abdomen 26 mm. Hindwing 22 mm.

Coloured and marked similarly to the male but the lateral thoracic stripes perhaps better defined and more complete. In some specimens the ground colour of the thorax, especially laterally, is a beautiful lilaceous blue; this does not appear to be due to age but a true variation. Anal appendages black, shortly conical. Ovipositor robust, extending slightly beyond end of abdomen. (Postnodal veins in both sexes vary from 14 to 16 in the forewings, and 11 to 13, usually 12 in the hind.)

BIBLIOGRAPHY.

1913. Tillyard, *Proc. Linn. Soc. N.S.W.*, 37: 408, 428, pl. 46, figs. 1-2, pl. 47, fig. 1.

1914. Morton, *Trans. Ent. Soc. London*, 1914, 1: 169-172, pl. 9.

1917. Tillyard, *Biology of Dragonflies*. 279, 293, 294, fig. 154.

1919. Munz, *Mem. Amer. Ent. Soc.*, 3: 17, 41, 45, fig. 45.

1923. Kennedy, *Bull. Mus. Comp. Zool. Harvard*, 67: 307.

1926. Tillyard, *Insects of Australia and New Zealand*, 78.

1938. Tillyard & Fraser, *Australian Zool.*, 9: 153, 157, fig. 19.

1951. Lieftinck, *Amer. Mus. Novitates*, No. 1488: 9-16, figs. 5-7.

1953. Fraser, *Ent. mon. Mag.* 89: 227-230, figs. 1 and 2.

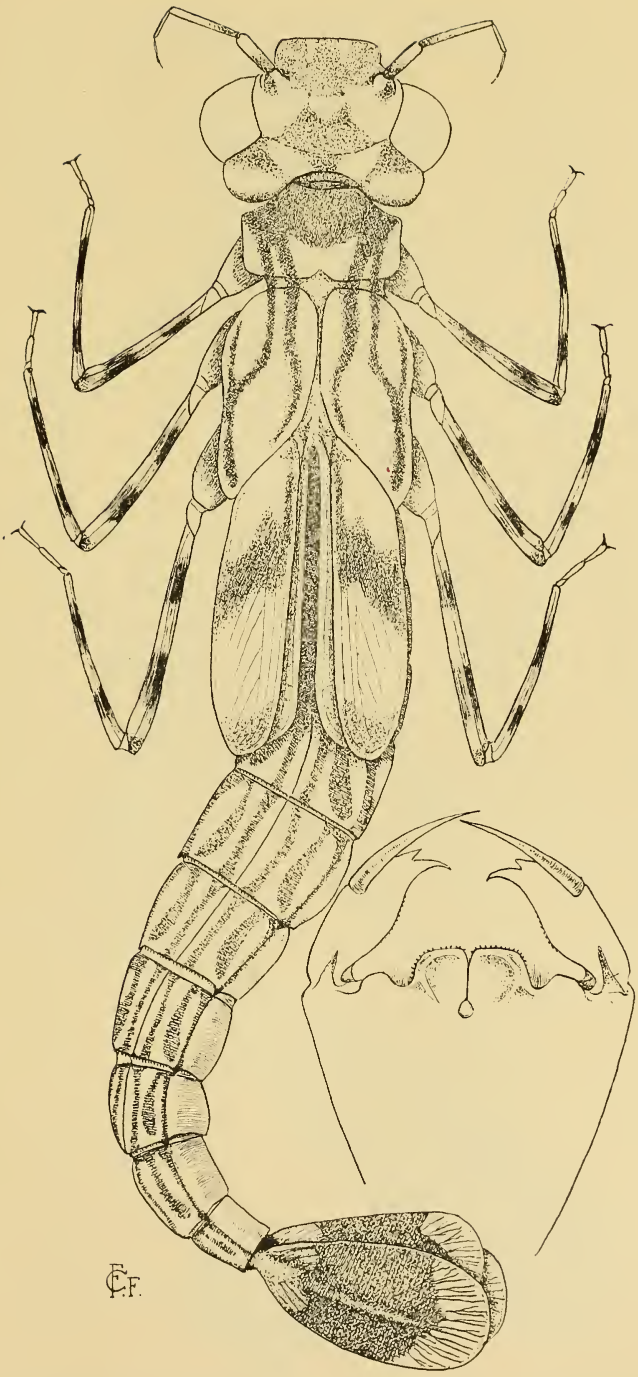


Fig. 1: Adult nymph of *Synlestes tropicus* Tillyard.

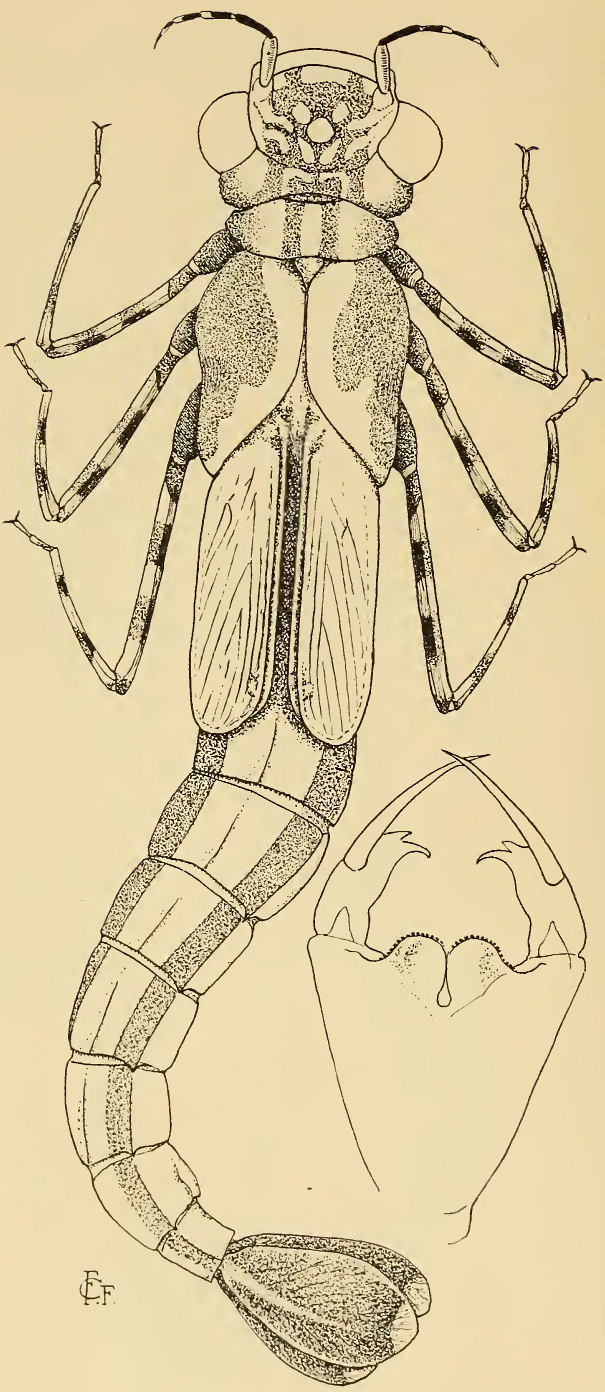


Fig. 2: Adult nymph of *Chorismagrion risi* Morton.

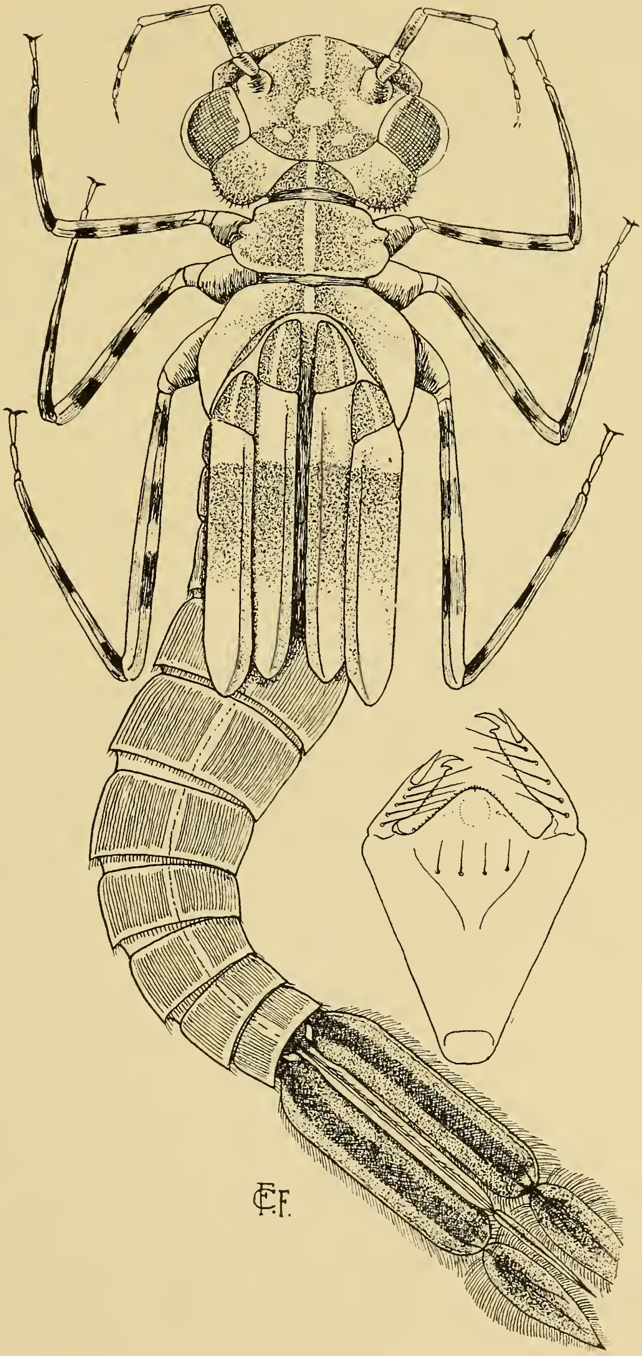


Fig. 3: Adult nymph of *Oristicta filicicola* Tillyard. (The lateral gills are shown rotated outward in order to show the outlines to advantage; ordinarily they are held in close apposition to the dorsal gill.)

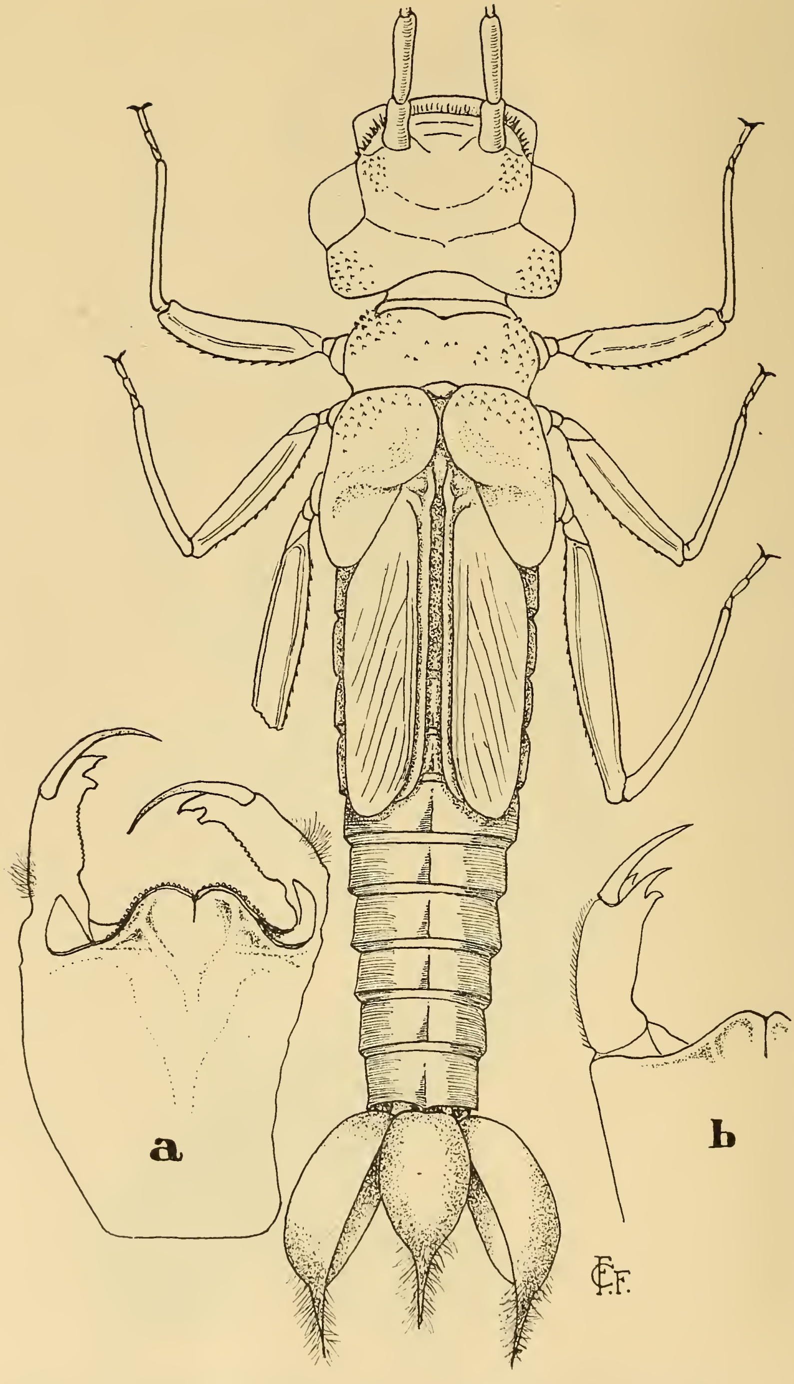


Fig. 4: Adult nymph of *Lestoidea conjuncta* Tillyard.
a. Labial mask of the same species.
b. Labial mask of *Diphlebia lestoides* Selys, 1853, for comparison with the last species.

The Status of *Algoa* (Pisces: Coryphaenidae)

By G. P. WHITLEY.

Castelnau's genus and species *Algoa viridis* (Mem. poiss. Afr. austr., 1861, p. 69) has puzzled subsequent ichthyologists (Gilchrist, Mar. invest. S. Afr. i, 1902, p. 144; Jordan, Gen. Fish. iii, 1919, p. 301 and Classif. Fish. 1923, p. 163; and Barnard, Ann. S. Afr. Mus. xxi, 1925, p. 319). They were misled by Castelnau's placing of his fish with the gadoids, which its characters show it was not. It is evident to me that *A. viridis* was a young dolphin fish, *Coryphaena hippurus Linn.* and Castelnau's names should be added to the synonymy of Linne's species (for other synonyms, see Whitley, Rec. Austr. Mus xx, 1939, p. 270). The generic name is anticipated by *Algoa* Gray, 1840, a *nomen nudum* in mollusca (*fide* Iredale, Proc. Malac. Soc. x, 1913, p. 309). Professor J. L. B. Smith omits "*Algoa*" from his "Sea Fishes of Southern Africa," though his coloured plate of the growth-stages of *Coryphaena* and a comparison of Castelnau's account with small specimens in the Australian Museum settle my identification.

An Interesting Leatherjacket

By G. P. WHITLEY.

Family ALEUTERIDAE.

Genus AMANSES Gray, 1833.

AMANSES SANDWICHIENSIS (Quoy & Gaimard.)

Balistes sandwichiensis Quoy & Gaimard, Voy. Uranie, Zool., 1824, p. 214. Sandwich Islands.

Monacanthus pardalis Ruppell, Neue Wirbelth. Abyssin. (Fische), 1837, p. 57, pl. xv, fig. 3, as *parthalis*. Tor, Red Sea. *Id.* Peters, Monatsb. Akad. Wiss. Berlin 1876 (1877), p. 852 (Mermaid Strait, Western Australia). And of other authors.

Cantherines nasutus Swainson, Nat. Hist. Class. Fish. Amphib. Rept. ii, 1839, p. 327. Based on *Balistes sandwichiensis* Quoy & Gaimard. Hawaii.

Amanses microlepidotus Gray, Descr. Cat. Roy. Coll. Surg. 1859, p. 49. China.

Liomonacanthus pardalis Bleeker, Atlas Ichth. v, 1869, p. 136, pl. ccxxx, fig. 2 and in other papers of his.

Monacanthus microlepidotus Bleeker, Atlas Ichth. v, 1869, p. 136, and other names in synonymy.

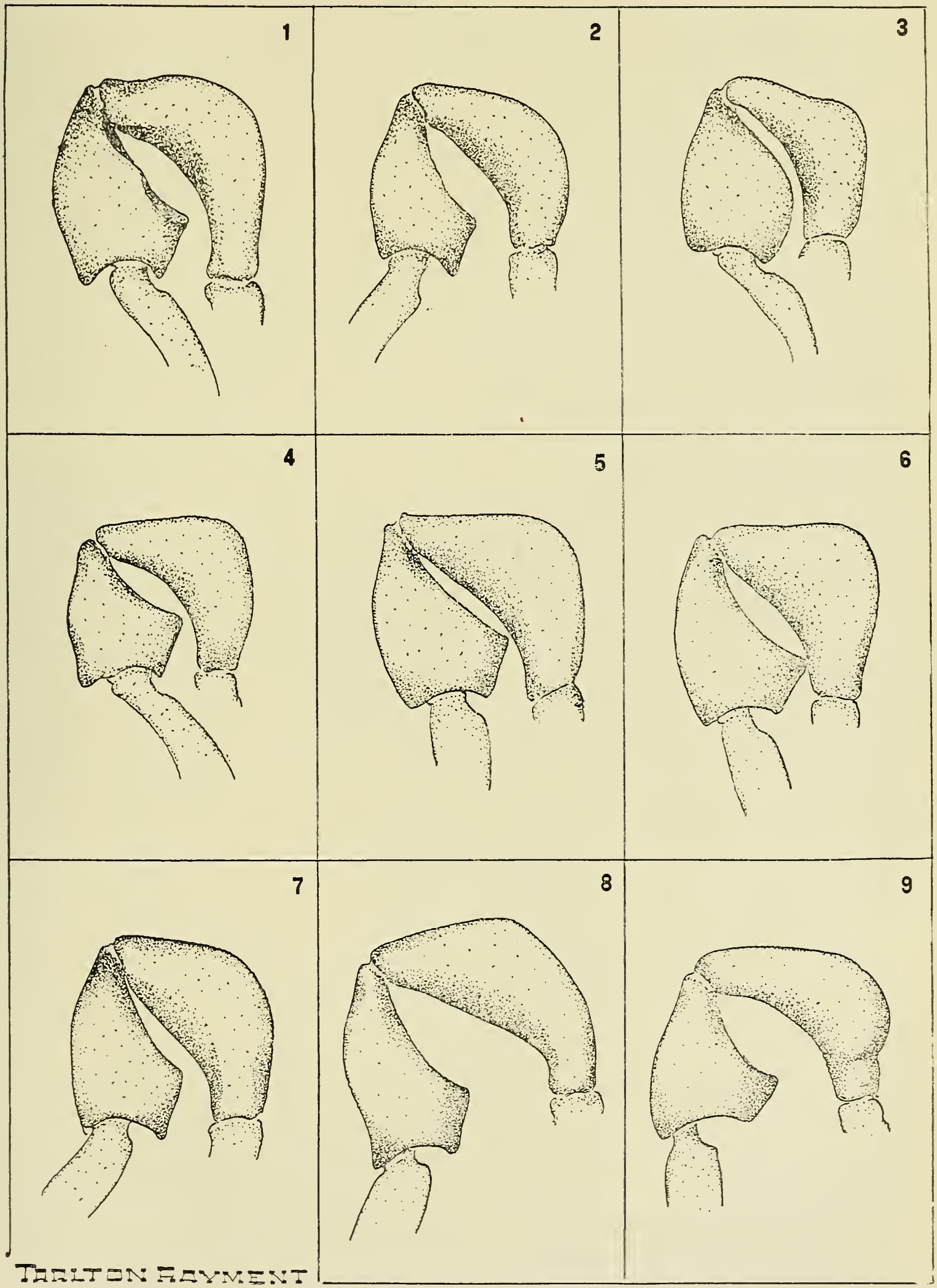
Cantherines carolae Jordan & Evermann, Fish. N. & Mid. Amer. ii, 1898, p. 1713, Ex Jordan & McGregor, MS. "Clarion" (error for Socorro) Island.

Cantherines sandwichiensis and *pardalis* of authors.

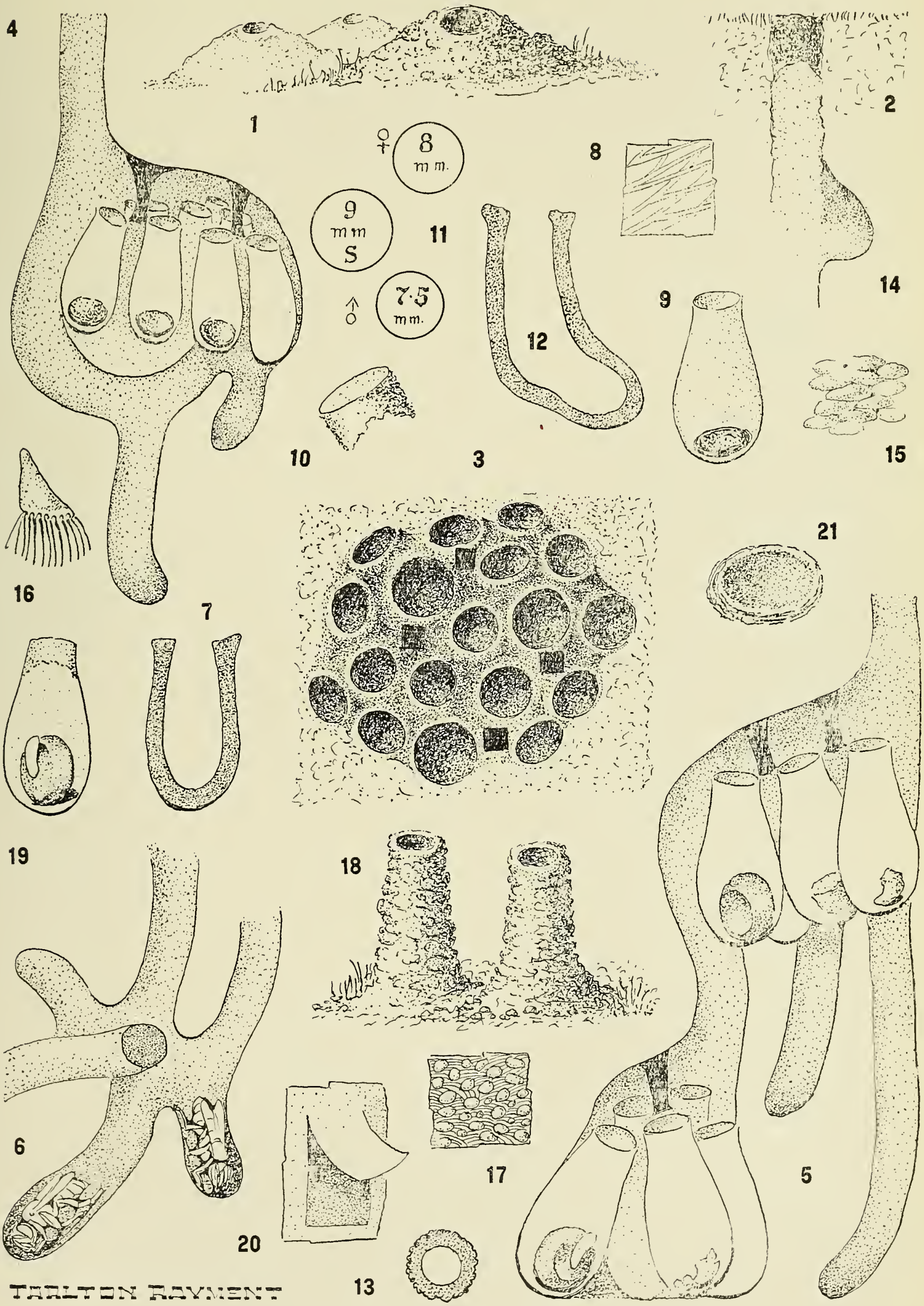
Monacanthus natalensis Gilchrist & Thompson, Ann. S. Afr. Mus. xi, Sept. 7, 1911, p. 48. Natal.

Amanses sandwichiensis Fraser-Brunner, Ann. Mag. Nat. Hist. (11) viii, 1941, p. 186. *Id.* Smith, Sea-Fish. S. Africa 1950, p. 403, pl. 88, fig. 1144 & text-fig. 1144. *Id.* Clark & Gohar, Publ. Mar. Biol. Sta. Al Ghardaqa viii, 1953, p. 43, fig. 9 (after Ruppell).

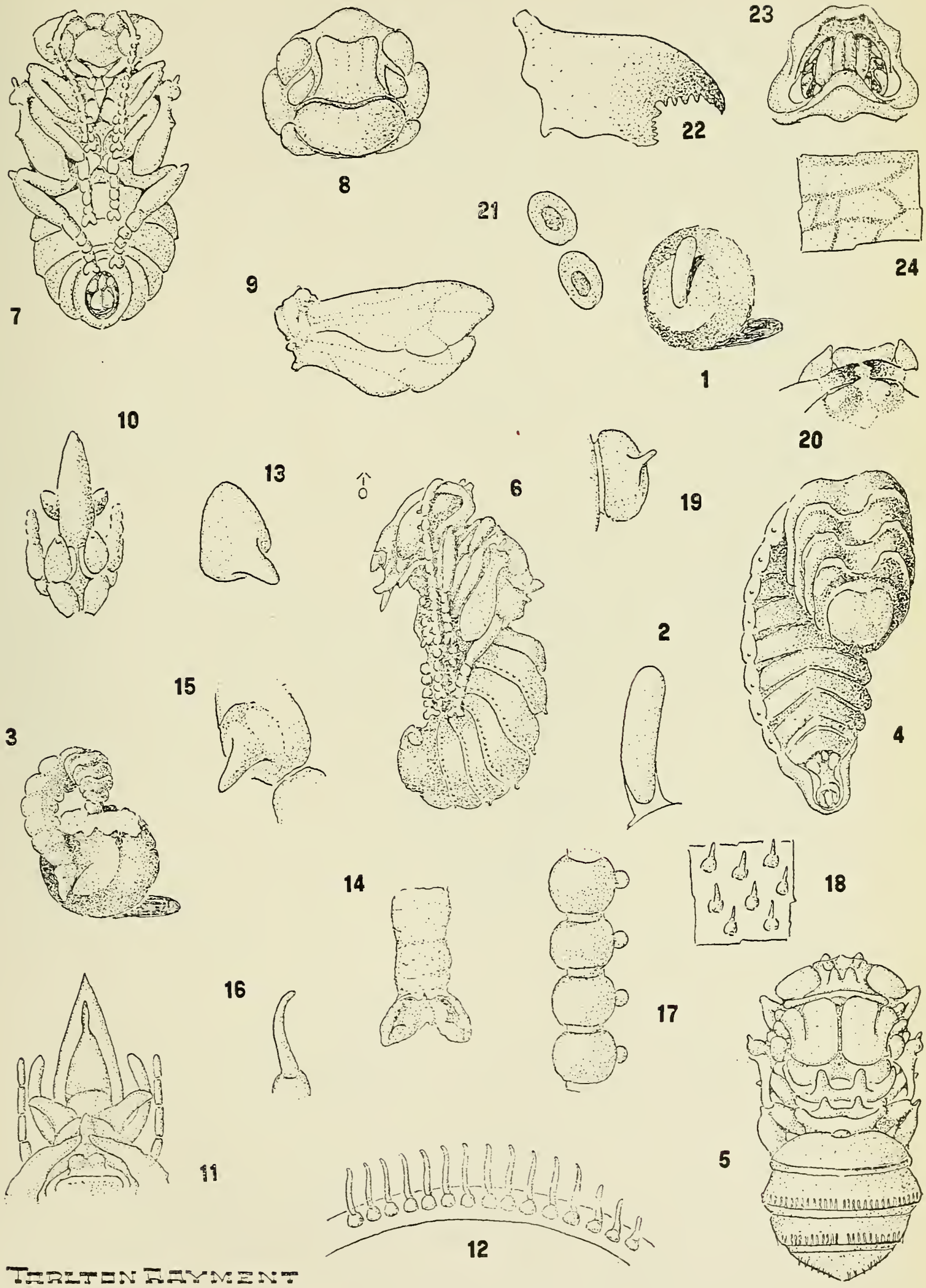
An interesting fish of the leatherjacket family, 89 mm. in standard length or just over 4¼ inches in total length, was picked up on Collaroy Beach near Sydney on 24 June 1956 by Mr. Phillip Colman. It has D. ii/34; A. 30; P. 13-14. Grey with small, round, blue spots over body and oblique bars on head. It is similar to Ruppell's figure of *pardalis*, but the spots are more numerous and there is no brush of setae on the caudal peduncle. The late J. D. Ogilby (unpublished MS. dated 15 March 1912) noted a Moreton Bay, Queensland, specimen. These are new records for eastern Australia (New South Wales and Queensland). The species is said to grow to 15 inches. Herre (1936) said it can change colour with astonishing rapidity; the small caudal fin is usually motionless and only used in swimming when the fish is excited or frightened.



Nomia australica Sm.



Architecture of *Nomia australica* Sm.



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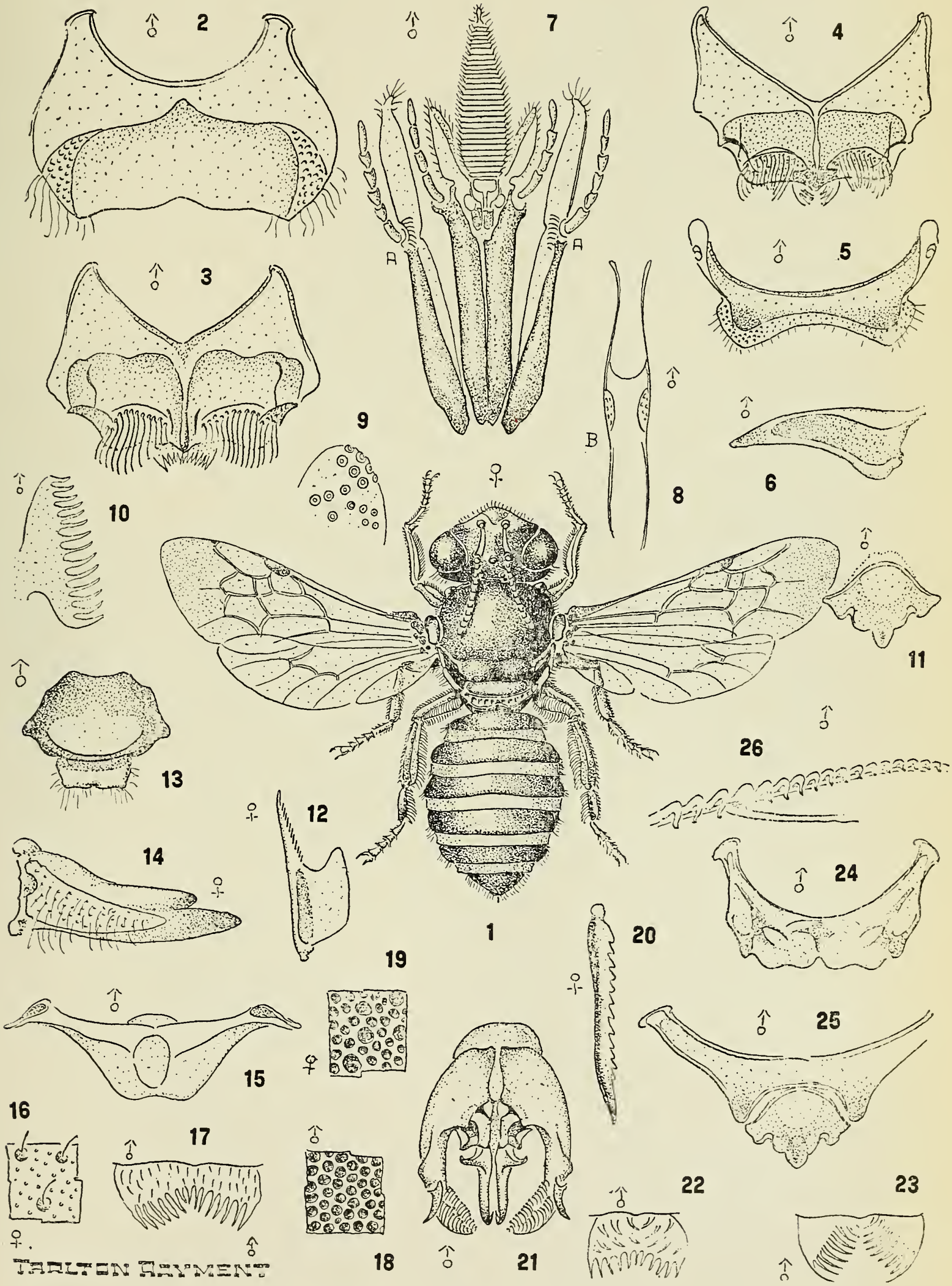
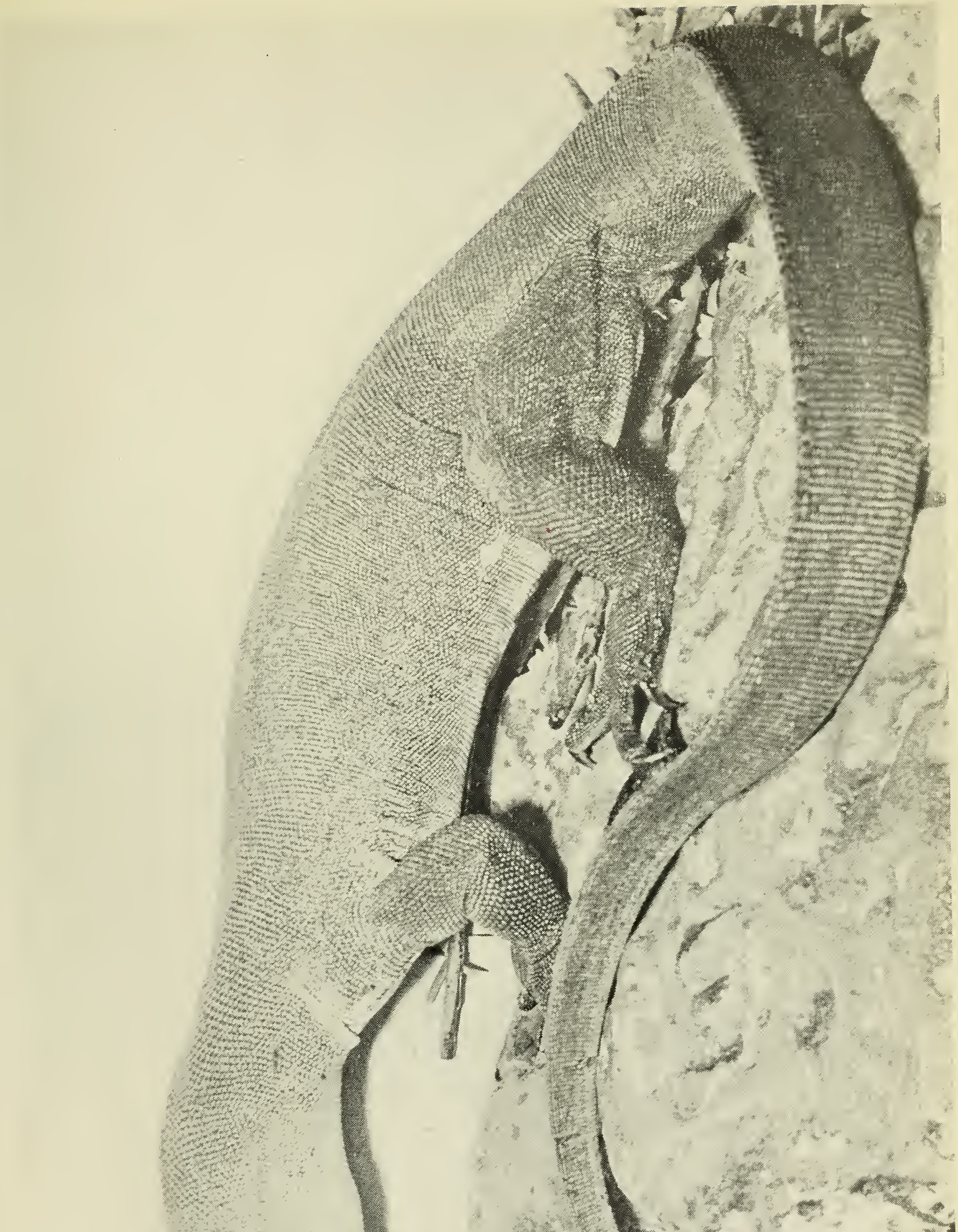
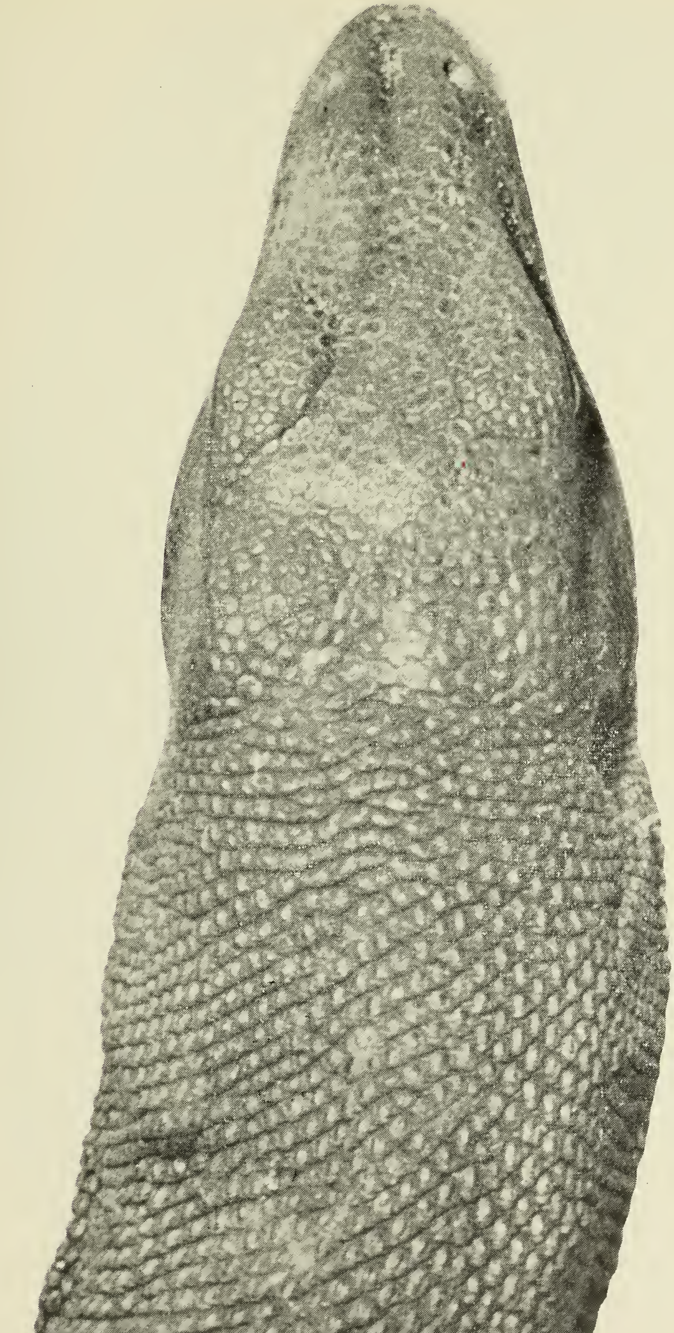


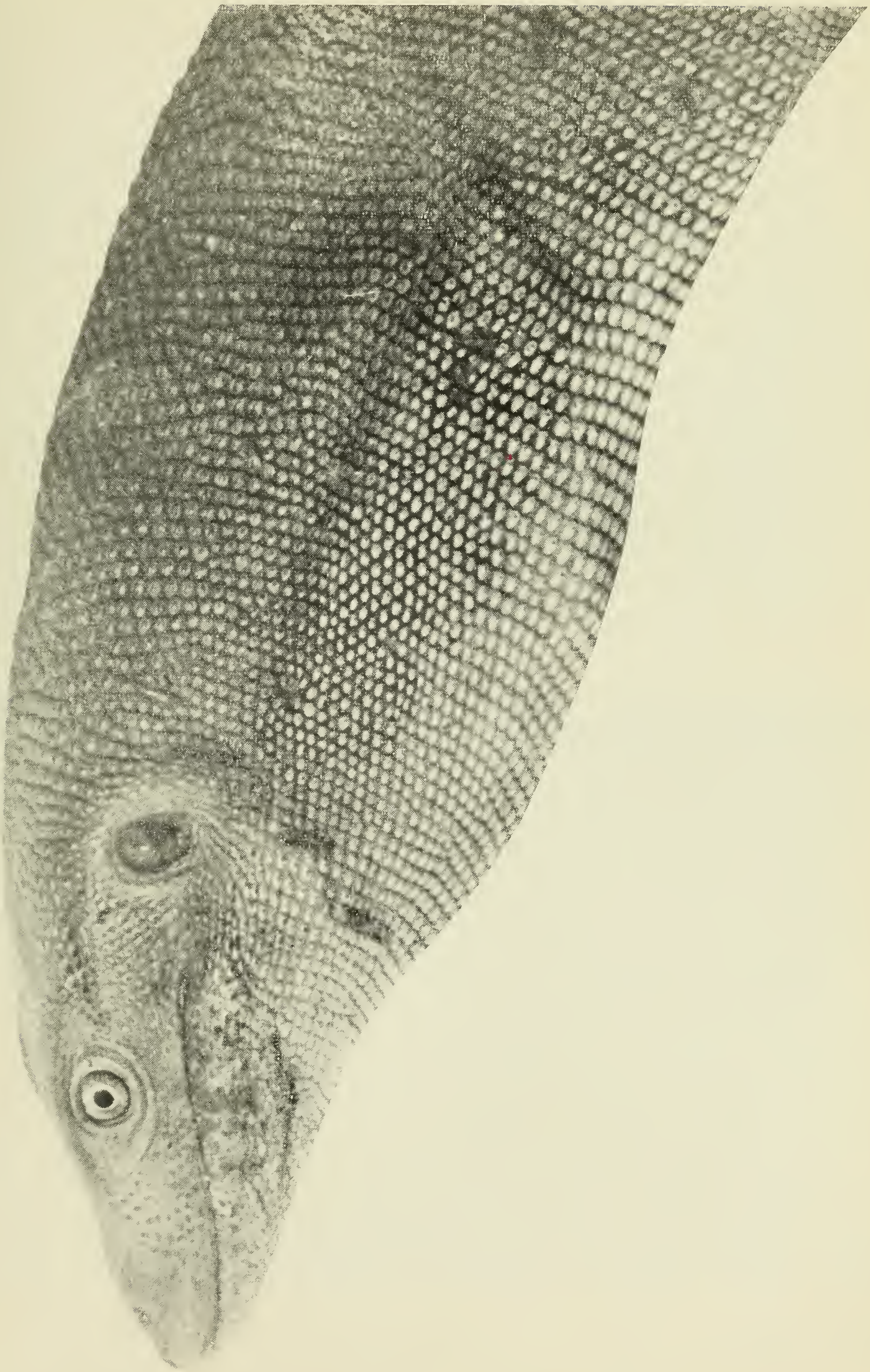
Morphology of *Nomia australica* Sm.



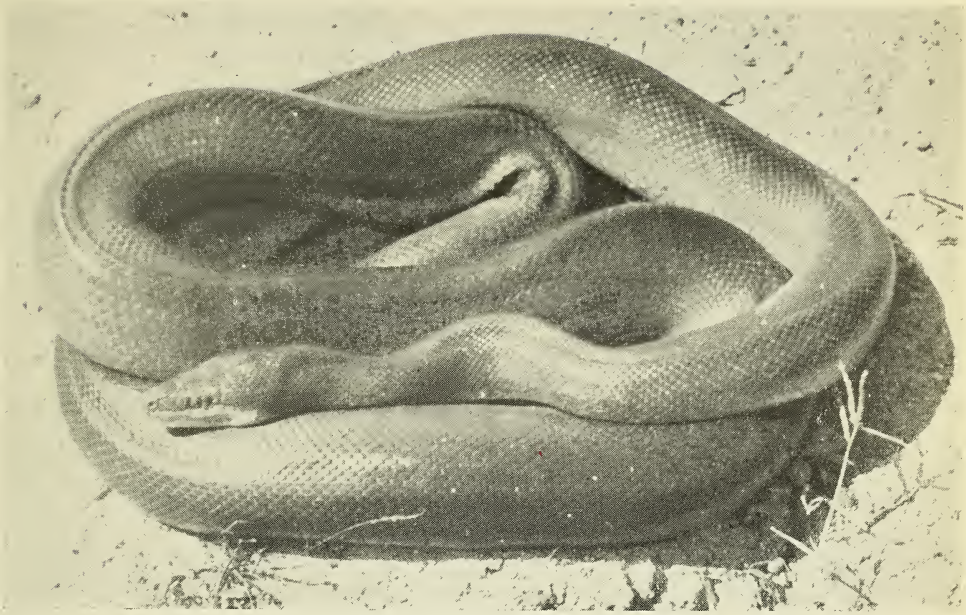
Varanus bulliwallah.



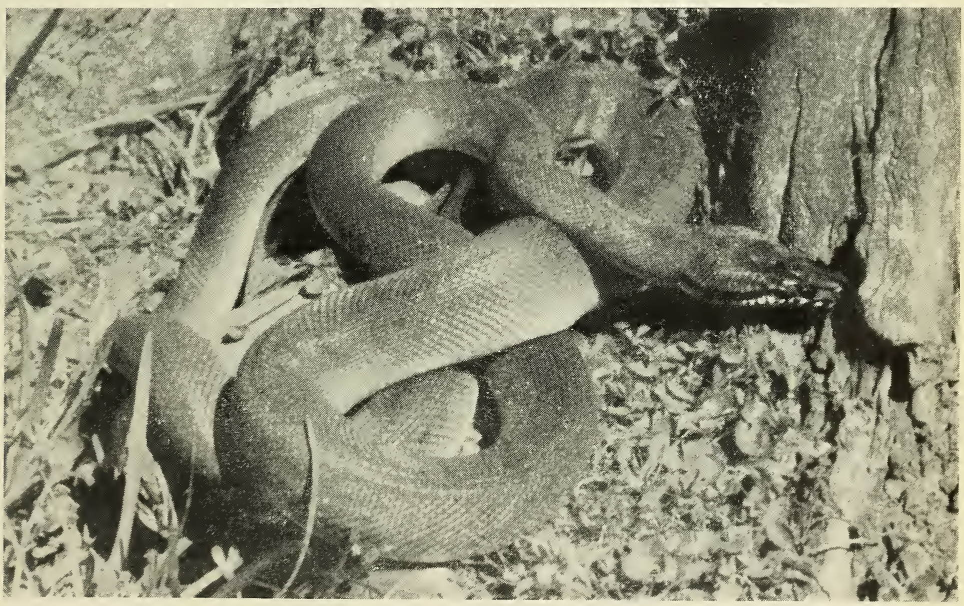
Varanus bulliwallah.



Varanus bulliwallah.



1. Water Python, *Liasis fuscus* Peters.



2. D'Alberti's Python, *Liasis albertisii* Peters & Doria.
Photos--E. Worrell.

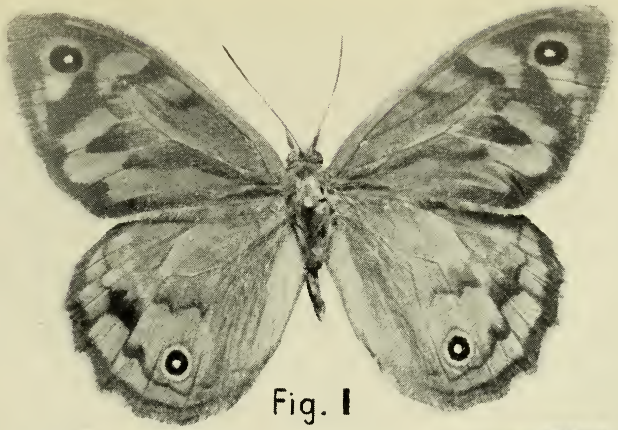


Fig. 1

Fig. 2

Fig. 3

Gynandromorph Butterfly.

Photo—H. Hughes, Australian Museum.

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GILBERT WHITLEY, F.R.Z.S.

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Male Satin Bower Bird at bower.

Block by courtesy of the New South Wales Gould League of Bird Lovers.

THE AUSTRALIAN ZOOLOGIST

Vol. XII Part 4

Bower Building and Display of the Satin Bower-bird

By NORMAN CHAFFER, F.R.Z.S.

(Plates xxxii-xxxv)

The unique habits of the bower-birds of building decorated structures in which they perform strange courting ceremonies have made them world famous. John Gould expressed his gratification in being the first ornithologist to bring their extraordinary habits before the scientific world. Various authors have referred to the habits of the various species , in such terms as "incredible," "amazing," and "world's strangest." It is therefore not surprising that much attention has been devoted to these birds, and numerous accounts of their strange ways have appeared in scientific and popular journals.

Gould stressed (1865, pp. 444-448) the sexual significance of bower building. Later writers expressed the opinion that the sexual motive in bower building and display is now of secondary importance and that the birds' activities have developed into a conspicuously aesthetic pastime; they concede, however, that such activities have in all probability originated on a sexual basis. Recent investigations, especially those by Dr. A. J. Marshall, have indicated that bower building is governed solely by sexual motives. On the evidence available Marshall considers (1954, p. 59) such activities "are expressions of innate behaviour patterns. These are automatically called into operation under the periodical influence of sex hormones." Throughout this paper I have quoted freely from *"Bower-Birds, Their Displays and Breeding Cycles,"* by A. J. Marshall. That recently-published book is recommended to anyone wishing to make a detailed study of the subject, particularly in reference to the factors governing the sexual cycles of the birds.

By virtue of its nearness to the more heavily-populated areas of Eastern Australia, the Satin Bower-bird *(Ptilonorhynchus violaceus)* has received far more attention from observers than the remaining memberst of the family. A consistent and thorough observer, E. Nubling, spent numerous weekends over a period of years from 1920 onwards investigating the intensely interesting habits of these birds in the Royal National Park near Sydney. Other observers who put in much time studying the birds in their native haunts include Marshall and P. A. Gilbert, while the writer has given considerable attention to them for many years. On numerous occasions observers have watched the male displaying before the female at the bower. However, it is surprising that until recently no one had reported the actual mating of the birds at the bower, and some observers believed it did not occur in the vicinity, an opinion once held by Marshall. In 1934, after describing the display of a male before a female at the bower, he stated (1934, pp. 57-61): "There is no evidence, I think, to lead us to believe that coition occurs in the vicinity of the bowers." In 1954 he stated (1954, p. 39): "Although many people have watched the bower performance, coition has never been observed." As narrated later, coition at the bower was observed and photographed by Ellis McNamara at Cordeaux River in 1954. In 1955 and again in 1956 I had the good fortune to witness and photograph the act in a bower in the Royal National Park. It probably occurs with some frequency at the bower, but the timidity of the female usually precludes the observer from witnessing the event.

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The following observations were made over a number of years, with particular reference to those recorded during the last three years. I am indebted to Ellis McNamara for field notes, in addition to those made myself, relating to two bowers near his home at Cordeaux River.

In late summer and in autumn Satin Bower-birds gather into flocks and range through the forest in search of food. Such flocks may be of considerable size, and I estimated one seen on 14th April, 1956, to number about one hundred individuals. Green birds, many of which appeared to be young of the season, comprised the majority of the flock, but several blue males were present. McNamara later informed me that the size of the flock was maintained for about a month, then a big reduction took place. Whilst watching feeding flocks I have noted individuals or small groups indulge in a certain amount of display in the trees. They will sometimes toy with a few leaves or twigs before dropping them. Mr. J. Waterhouse supplied me with some interesting notes on a group of green birds he had under observation at Wentworth Falls on May 9th, 1957. About a dozen of the birds were repeatedly flying to the ground and picking up dead, brown-coloured leaves, with which they strutted about in a form of display. At various intervals the birds flew off to nearby trees with the leaves in their bills. This display continued for upwards of an hour. Waterhouse searched for but could not find any sign of a bower or platform in the vicinity. During the flocking period the pair-bonds are considered to be initiated. I am inclined to believe that some individuals, particularly blue males, do not join the large mobile flocks but form smaller groups of perhaps a score or so birds which do not move far from their springtime territory.

Bower building by the adult male usually begins about July, but considerable variation occurs even in the one locality, and in some cases a bower may be built as early as May. For some time after the construction of the bower the adult male continues to associate with a mixed group of perhaps a dozen individuals, mainly green birds, formed from the breaking up of the main flock.

In the spring green Satin Bower-birds build rudimentary bowers which they decorate with a few display objects. On October 5th, 1931, about twelve birds were noted together at a bower which was composed of a few coarse wattle twigs thrust into the ground and surrounded by a scanty platform of sticks. Nearby there was a platform only, on which green birds, probably of both sexes, were seen playing. Gilbert devoted considerable time to the study of the green Satin Bower-bird in relation to the construction of rudimentary bowers and platforms. He considers that members of both sexes played at these bowers, but he suggests (1940, pp. 209-219) that they are often built by females. The sexes of the birds playing at the bowers cannot accurately be determined, for the young male is indistinguishable from the female in the field. He states that females construct such bowers or platforms immediately prior to and during nidification, and that the female prequently plays alone in the bower. From my own observations I am of the opinion that the construction of the rudimentary bowers or platforms are mainly community efforts and that they are used by a mixed group of the sexes. Gilbert evidently has grounds for stating that the female does build a bower for its own use, and he further states that he has found the nest by following a female from her bower.

Over a period of many years a blue Satin Bower-bird has constructed his bower near the Upper Causeway picnic area in Royal National Park. Here in 1944 and again in 1945 the bower was placed in an unusually open situation, and I was able to obtain colour movie films of the bird's activities. In later years the bower was moved to positions, across the river, unsuitable for photography. During 1955 and 1956 it was again built near the original site but in a position that was heavily shaded. I made many visits to the bower, and some of my observations are recorded herewith. I have no definite evidence to prove that one individual bird was responsible for the construction of the bowers over the period 1944 to 1956. However, this is a distinct possibility, because the bower owner had a habit, not common with the species, of using painting-wads. These were noted in 1944-5 and again in 1955-6. In the intervening years few visits were made to the area.

On August 7th, 1955, a visit was made to the bower, and it was seen to be in good order, with the appearance of having been in use for some time. The bower, rather smaller than usual, was otherwise the normal structure of upright twigs forming two walls about a foot in length and of the same height and spaced some four inches apart. A platform of sticks and grass stems surrounded the bower and display objects were placed thereon, but chiefly on the northern and north-eastern section. Many observers have drawn attention to the discrimination shown by the Satin Bower-bird in the choice of colours of the display objects. Those at the bower under discussion were typical. They consisted of the following blue articles: several tail feathers of the Crimson Rosella, a few *Dianella* flowers, paper, rag, string, china, glass, metal bottle-caps, two cigarette packets, matchbox, portion of hair-comb, and a few other oddments. Next in order of preference were articles of a greenish-yellow colour, and included *Banksia* leaves, flowers of the creeper *Billardiera scandens,* onion peelings, and a few oddments such as pieces of yellowish plastic ware. In addition were brownish snail shells, grey to straw-coloured mantis egg-cases, wasps' nests, and several pieces of an inconspicuous weed-like plant. Experiments were carried out by Marshall (1954, p. 59) and others to test the colour discrimination of the birds, and it was found that preference was almost invariably given to blue. However, in addition to colour, the type of object seems to influence the selection, and I found that blue feathers are preferred to materials of a similar shade, such as paper. At the Upper Causeway picnic area blue paper and other materials are in plentiful supply, but only a small portion of the available supply is taken to the bower. Blue feathers are quickly collected by the bird and added to his store. I once found a bower by dropping a blue feather in view of a male bird, who quickly seized it and flew straight to his bower, which was well hidden by bracken ferns. All bowers in the Royal National Park, and in many other areas, are adorned with the not very conspicuous greenish-yellow flowers of *Billardiera,* and I have seen as many as two hundred at one bower. Greenish-yellow leaves, particularly those of *Banksia serrata,* are found at most bowers, often in considerable numbers. A bright array of the blue feathers of the Crimson Rosella are usually represented amongst the display objects. Objects of other colours, particularly red, are used only if they are associated with a favoured colour. At one bower I noted a small Australian flag, mainly blue but carrying a small Union Jack in the corner, which included an area of bright red. I have placed feathers, coloured other than the shades favoured by the bird, on the bower and have filmed the bird removing them. On another occasion I took blue feathers from the bower and mixed them with various coloured feathers which were placed several feet away. On arrival the bird first picked up feathers of the unwanted colours and dropped them some distance away in the bushes. He then selected some of the blue feathers, which he took to the bower. I once noted (1931, p. 279) an unusual display object at a bower in the form of a wounded bluish centipede. On November 21st, 1955, a large freshly-killed cricket was lying on the platform of the causeway bower, but the bird made no attempt to eat it. Later a small water-dragon, about fifteen inches in length, wandered by during the absence of the male and quickly devoured the insect. When the male returned he uttered a harsh scolding note and attacked the lizard, which beat a hasty retreat.

What influences the bird when choosing certain colours to adorn his bower? The blue eyes and the greenish colouring of the female have been suggested by various authors as the probable reason for such colour preference. Nubling has dealt exhaustively with this idea in the *Australian Zoologist* (1941, p. 95). On the basis of experiments with captive birds, Marshall suggests (1954, p. 190) that the preference may be influenced by the colouration of rival males, particularly by the prominent blue iris and greenish-yellow beak. He states "that may be why blue and greenish-yellow are the predominant colours taken to the display-ground and used there in the aggressive display which . . . is partly a device to keep rival males out and the attached female in." Gilliard considers

(1956, pp. 450-451) that the bower and display objects are "secondary sexual characters" of the male and that they represent a "transfer of the forces of sexual selection from morphological characters to external objects, namely, the bower." He further states: "The adoption of inanimate objects as primary sexual releasers apparently has no parallel among vertebrates, except perhaps among humans."

Another extraordinary habit acquired by the Satin Bower-bird is that of bower painting. A few bowers in the Royal National Park do not appear to be painted, but a coating of paint may be found on the majority. The owner of the Upper Causeway bower was quite accomplished in this regard and was also one of the few individuals noted using painting-wads. During the spring the painting of the bower is of frequent occurrence and may be carried out many times in a single day. However, on some of these occasions the material already applied to the walls of the bower appears only to be freshened up with saliva. The use of a wad of fibrous bark for applying material to the bower walls was first observed in 1929, when G. R. Gannon (1930, pp. 39-41) watched a bird at work. The habit does not appear to be widespread, as painting-wads have been observed at only a few bowers. The use of these wads at the Upper Causeway bower was observed in 1944-5 and also in 1955-6. Observations made on October 31st, 1944, are typical. At 9 a.m. the bird arrived at the bower with a bundle of fibrous bark in its bill, which was dropped at the bower entrance. Selecting a piece from the bundle, the bird entered the bower, where the bark was nibbled gradually into its bill, a minute or so being taken in the process. With an inch of bark still protruding from its bill it commenced painting, pausing occasionally to nibble at the bark. The bark dropped at the entrance to the bower was seen to be partly composed of a crumbly material which would crush readily, and partly of a fibrous inner structure rather resistant to division. The fibrous portion formed the wad used for painting and the crumbly part mixed with saliva constituted the "paint." The wad was held near the top of the bird's bill and was applied to the sticks of the inner walls of the bower with short, jabbing strokes. The sticks also showed evidence of having been painted with charcoal, and a piece of that material was noted at the bower. On September 25th, 1945, charcoal was used by the owner of the bower built in this vicinity, and the bird was noted grinding it in his bill and applying it to the sticks. The preparation of painting wads from fibrous bark was also watched on the same occasion. I have noted the blue berries of *Dianella* used as the paint, and also the blue from laundry blue-bags.

The extraordinary habit of bower painting is considered by Marshall (1954, p. 65) as "probably an extension of, and possibly a substitution for, the courtship-feeding that is practised by so many birds during the sexual season." I have found it is not confined to the adult male, and have watched and photographed a green bird, believed to be a young male, painting a bower during the owner's absence. This bird was attacked and driven away when the blue male returned. On several occasions I have also seen the female going through the actions of painting the walls of the bower while the male displayed to her.

Satin Bower-birds almost always build their bowers with the walls running north and south. Among scores of bowers I have examined, very few have deviated to any extent from this north-south orientation. Likewise, I have found that the Great Bower-bird *(Chlamydera nuchalis)*, an inhabitant of Northern Australia, has the same habit. Such was the case with four bowers I examined near Townsville, and Marshall (1954, p. 94) lists fourteen bowers with an approximate north-south orientation. Marshall suggests (1954, pp. 40-43) a possible explanation for placing the bower in the above manner. He says: "The utility of north-south orientation may be that, very early each morning, when energetic display begins, the male can keep the motionless female in view without staring straight into the rising sun. Likewise she can watch his flashing display without discomfort." This theory may be feasible with the Great Bower-bird, which builds its bower in open country (although usually placed beneath a thicket). It could hardly apply in the case of the Satin Bower-bird, which mostly builds in heavily-wooded and hilly situations where the early-morning sun rarely reaches the bower and where throughout the day it is only illuminated by broken shafts of sunshine."

The following observations, made mainly at the Upper Causeway bower during 1955, have been condensed from my notes; they give an indication of the various activities of the birds at the bower. On September 2nd, 1955, in the early morning, I erected a hide for observation and photography. The male soon appeared and made a number of visits to the bower, sometimes arriving with display objects. On one occasion he brought a piece of crumbly bark, presumably for use in painting. He was later noted nibbling fibrous bark in his bill and wiping it up and down the sticks. During his absence a green bird, presumed to be a male, came to the bower and carried out some of the painting. Later, accompanied by the male, the female alighted on a nearby log and the male commenced displaying. However, the female flew off without going to the bower. Several times the male was noted flying around with six green birds, so it appears that the flocking phase had not then completely terminated.

Again, in the early morning of September 26th, I erected a hide facing the bower. The male made many visits and much painting took place. During a few visits crumbly bark was nibbled in his bill and plastered on the inner walls of the bower, which were later seen to be liberally coated with a greyish desiccated material. The female came to the bower on two occasions accompanied by a second bird, which perched on a log about two feet away. The female entered the bower and the male displayed energetically, but ignored the second green bird on the log. I began to wonder if the bower owner had more than one female in his retinue. The second green bird could have been a young male, and the intentness with which it watched the display gave one the impression that it was receiving a lesson. However, later in the day the female visited the bower twice with another green bird in attendance, but on both occasions the male immediately attacked the second bird. During another visit of the female to the bower three green birds were in the nearby bushes.

Whenever the female visited the bower the male put on a great display, accompanied by many weird sounds and some mimicry of the calls of other birds. On such occasions he was seen to pick up small objects such as plant stems, a leaf, and a dried weed-like plant, all of which were rather dull, straw-coloured, and not at all conspicuous. Observers writing in popular and scientific journals frequently state that the male endeavours to attract the attenion of the female by flashing brightly-coloured objects in his bill. However, I have noted at several bowers that the male, when displaying before the female, almost invariably disregards the numerous bright blue objects lying around and parades with the rather nondescript and dull-coloured articles such as mentioned above. He will often use blue ornaments for display during the absence of the female, and a solitary performance observed on October 24th is typical. The male toyed with blue feathers in front of the bower, and then moved with a "galloping" action to the side, where the feather was dropped. Moving to the front of the bower, he flashed open his wings, wheeled around, and took several paces in the reverse direction, accompanied by wing movements. Moving to the side of the bower, he picked up a snail shell in a slow, deliberate manner, elevated his tail high in the air, and with sudden flicks of the wings wheeled and took several quick paces sideways. He several times pranced completely around the bower with body held high, tail elevated and breast puffed out, ocasionally making sudden side steps with quick opening flicks of the wings.

On November 4th, 1955, I arrived at the bower at 6.30 a.m., and the male was heard giving his display calls. Both he and the female flew away as I approached. The observation hide was again erected. During the following four hours the male made a number of visits to the bower, and was frequently observed in the trees nearby where he could keep a watch on the bower. At times he brought fresh flowers and also painted the bower or tidied the sticks forming the walls.

Late in the morning the female alighted near the bower and then flew into some bushes about eight feet away. The male displayed vigorously, either at the bower or on a nearby log, where he was in full view of the female. He called continuously with many queer sounds. Finally he rushed toward the crouching female and copulation occurred; the female then fluttered her wings for perhaps half a minute. The male continued displaying and calling, with some mimicry, and appeared to be endeavouring to entice the female to the bower. She moved towards him, but evidently deterred by the presence of the hide, flew away.

At 1.45 p.m. the male arrived and carried out various activities in the bower and departed after a short stay. In less than a minute after his departure a rival male alighted at the bower and began tearing it to pieces. He worked in a great hurry, dragging out beakfulls of sticks and scattering them about. Very soon the bower owner returned and fiercely attacked the wrecker, who was quickly routed. Such destruction of bowers or the stealing of ornaments by rival males is of frequent occurrence. The male began to repair the damage to the partly-demolished bower, but after working for about a minute he stopped and began calling and displaying. Presently the female arrived at the bower and the male displayed vigorously, but she stayed only a short time. The male continued to display for about half an hour; probably the female was still in the vicinity, although, from my position in the hide, I could not see her. Later he resumed the repairing of the damaged bower and soon restored it to some semblance of order.

At 4.45 p.m. the male started "churring" and displaying, and presently the female came to the bower. In contrast to the timidity shown on previous visits, she did not, on this occasion, take any notice of the hide or the camera. She played about for a while in front of the bower and then entered it from the back. The male displayed energetically, and with constant vocal efforts which included many strange churring and scolding notes not at all pleasant to the human ear. The calls often mounted in intensity until they finished with a curious sound like a series of gears running together. He sometimes posed, with very little movement, for minutes with his tail elevated, bill pointed to the ground, and body held high on stiff legs. Occasionally the straw-coloured weed-like material was held in his bill while posturing in the above manner, and once a snail shell was used. These actions were varied by stiff prancing with half-galloping, half-hopping movements. Several times he leapt back and forth across the bower entrance in front of the watching female. During this manoeuvre his wings were outflung in a dazzling flash of colour. Various flash photographs were taken of this display and both birds ignored the flash. For most of the time the female stood quietly in the bower in a rather crouched attitude. Occasionally she would rearrange some of the sticks in the bower wall or perform painting actions. Two or three times she backed out of the bower and, picking up a twig, re-entered and placed it in position in the wall. The male was showing signs of great excitement; his eyes bulged, revealing a lilac edging to the blue of the iris, and at times he rushed right around the bower. Suddenly he dashed up, and, quickly mounting the female, copulation occurred. A flash photograph was taken during the brief duration of the act. After the male left her the female stood erect in the bower and rapidly fluttered her wings. He continued to display, although at a reduced tempo, and the female remained quietly in the bower for some time. She then moved to the centre of the bower, where she was seen to be breathing rather heavily. She crouched crosswise in it as though sitting in a nest, and, as the bower walls were spaced only some four inches apart, conditions were rather cramped. Shortly afterwards the male appeared to be attacking her, and he drove her out of the bower several times. After being driven out she would quickly run around and re-enter the bower. I was fortunate in securing a rather dramatic flash photograph where the male is seen striking the female with his claws as she cowers away from him. (See Plate xxxiv, fig. 2.)

The display of the male gradually waned, and he sometimes left the bower for short periods. Eventually the female hopped on to a log behind the bower, and she was seen to be still breathing heavily and appeared somewhat distressed. Suddenly to my great surprise she laid an egg, which dropped two feet to the ground. Shortly afterwards she departed, having been at or around the bower for forty-five minutes. I secured the egg, which luckily received only a small fracture in its fall. The egg was quite normal and of a buff ground colour, spotted and blotched with dark brown and slate-grey.

What caused the male to attack the female after coition? With many species of birds the threat display directed towards a rival is very little different from the courting display. This was notably demonstrated in observations I made during 1956 on the Golden Bower-bird, when the two displays were, to all appearances, the same. Marshall quotes Hingston as saying (1954, p. 63): "The gestures made before the female is exactly the same gestures as that made before a rival in battle," and that "Courtship behaviour is hostile behaviour." Marshall says (1954, p. 94) "the 'fierce' intensity of the blue male at the bower and the 'threatening' attitudes that he adopts there make it apear that in this species display is basically closely allied to the general threat complex which the bird has developed as part of the protection of its bower, display things, and its territory." There is not the close liaison between male and female bower-birds as exists between the sexes of many other species in which the male frequently shares the task of nest building, brooding of the eggs, and care of the young. In the bower-birds the male leaves the whole of these activities to the female. The defence of his territory, i.e., the bower surroundings, is strongly developed in the Satin Bower-bird, and, his sexual instincts having been gratified, he may have possibly then regarded the female as a trespasser on his domain. It may be, in the instance where the female laid the egg at the bower, that the male was aware of the imminence of ovulation and was endeavouring to drive the female to her nest. However, this seems unlikely, as he normally appears to take no interest in nesting activites. The laying of the egg at the bower may indicate that a nest was not built or not completed at the time, or that external conditions such as food supply were not conducive to breeding. Her attitude in crouching crosswise in the bower suggests that that structure was being used as a substitute for a nest.

Copulation at a bower was again witnessed and photographed on November 23rd of the following year (1956). The female came to the bower for a short period late in the morning, and the usual display of the male took place. At 2 p.m. the male began displaying, sometimes at the bower but mainly on a nearby log. Presently I sighted the female perched in the bushes ten feet behind the bower. For perhaps ten minutes the male displayed energtically and with constant vocal efforts. Suddenly he ceased displaying and dashed up to the female, and copulation took place. After a vigorous beating of her wings she remained quietly in the bushes for a minute or two, while the male resumed his displaying. She then moved forward and entered the bower, and the male intensified his display. After a few minutes the male rushed towards her and copulation again occurred. The accompanying photograph was secured on this occasion (Plate xxxv, fig. 1). As before, the female vigorously fluttered her wings following coition, and then shortly departed.

Ellis McNamara supplied me with the following details of the birds' activities on September 28th, 1954, when he witnessed copulation at the bower. The male arrived and painted the bower for some minutes. He then hopped into a nearby tree, where he called frequently for half an hour. The female flew up and went direct to the bower. She moved through the runway, wheeled, re-entered the bower, and passing through it wheeled again and took up a position facing south between the walls. The male dropped down at the rear (southern end), where he displayed with great vigour, often leaping across the bower entrance with flashing wings in front of the watching female. Sometimes display objects were held in his bill. After several minutes of this display the female crouched in the bower and the male intensified his performance. Circling quickly to the front he entered the bower and copulation took place. The female then stood erect and beat her wings so rapidly that the bower was partly demolished. She then moved some five feet from the bower and again rapidly beat her wings. A few minutes later she re-entered the bower, ran through it, and departed. About twenty minutes later the male returned and repaired the damage caused to the bower by the female.

The prolonged courting period and delay in the insemination of the female is rather difficult to account for. The pair-bond is probably formed during the autumn flocking period. The female visits the bower of the male in the early spring, yet some months pass before she will permit coition. The presence of the bower and the display therein evidently serve to retain the interest of the female and so ensure that fertilisation occurs when conditions are most favourable. The display at the bower is probably necessary for mutual stimulation leading up to the sexual synchronisation of the pair. Marshall states (1954, p. 64) that the male is physically capable of reproduction for quite a long period before insemination occurs. He believes that one of the chief factors that govern the willingness of the female to permit coition is the advent of a plentiful supply of protein food, in the form of insects, which is necessary for the feeding of the young.

Nests are usually completed and eggs laid between October and December, and the young hatch out at a time when the forest is teeming with insects, such as cicadas, which are much relished as an item of food. One nest I had under observation was built in a Turpentine tree twenty-five feet from the ground. It was vacated by the young bird before the end of November, so it was evidently built early in October. I saw the northern sub-species of the Satin Bower-bird *(P. v. minor)* building her nest in mid-October, 1956, on the Atherton Tableland at an elevation of about 3,500 feet above sea-level. The nest of twigs was only six feet from the ground.

The male continues to frequent the bower after the female is busily engaged in incubation and the rearing of the young and she has ceased to visit the bower. Although sexual motives are undoubtedly responsible for the building of the bower, one has only to watch the male at his various activities to reach the conclusion that his actions are not solely instinctive and automatic and that he derives considerable enjoyment from such activities. His play at the bower after the female has left strengthens this conclusion. However, his visits are much less frequent as summer advances and fewer display objects are brought to the bower. In late summer the bower is usualy neglected and allowed to fall into disrepair, although it may be rebuilt and tended for short periods during the autumn. In one instance one or more green birds were maintaining, in mid-April, a bower previously used by a blue male.

The instinctive urge to build a bower is sometimes carried to extremes, and some birds undertake an orgy of bower building, resulting in abnormal structures.

For some years a normal bower has been maintained in the one general area near McNamara's home at Cordeaux River. When first constructed early in the spring of 1954 it was the usual two-walled structure. When I visited it on October 4th a third parallel wall had been added, and also a fourth wall at right angles to the other three. Figure 1 illustrates the layout of the bower. McNamara informed me that "A" and "B" represented the original walls, then "C" was constructed and was continued in a semicircle around to the proximity of the northern end of "A." The walls of "A" and "C" were separated by a runway a few inches wide. Finally the rather flimsy wall "D" was built, and wall "C"shrunk to the size shown on the diagram. Display objects included more than one hundred blue tail feathers of the Crimson Rosella. Other blue objects were glass, wool, china, and a handkerchief. Numbers of yellow leaves and the greenish-yellow *Billardiera* flowers were present, and also a few snail shells and puff-ball fungi. The various display objects were grouped mainly in two positions, one on the north-eastern end of the platform adjacent to the walls "B" and "D" and the other on the south-eastern end near the entrance to the runway between "A" and "C." At the beginning of summer numerous cicadas emerged from the earth, and on December 22nd more than one hundred of their nymphal cases were noted on the bower platform. McNamara informed me that the bower was regularly, if not frequently, attended during the autumn.

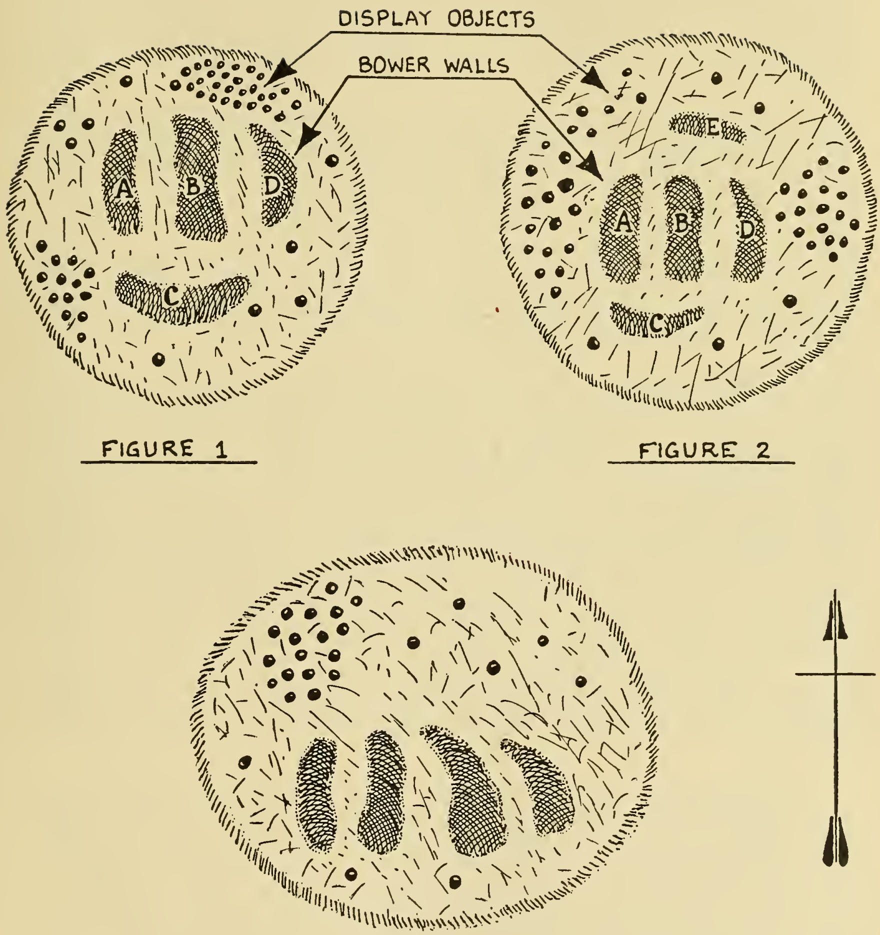

FIGURE 3

PLAN OF ABNORMAL BOWERS

Evidently the owner did not permanently join any autumn flock. During the winter the bower was allowed to fall into disrepair.

On August 12th, 1955, I was again in the area, and found the bird in possession of a substantial bower well decorated with display objects. It was similar in layout to that built last year shown in Figure 1. On September 2nd a new and rather flimsy cross wall "E" had been added at the northern end of "B" and "D." As with last year's bower, the display objects were mainly grouped in two areas, one at the eastern and the other at the western side of the bower. The plan of this bower is shown in Figure 2 and the display objects are indicated by spots.

With J. Waterhouse I again visited the bower on October 1st and found that it had reverted to the normal two-walled structure. McNamara informed me that the five-walled bower was destroyed about two weeks prior to our visit, probably by a rival bird. On October 3rd Waterhouse spent a few hours in a hide photographing the bower owner. While the blue male was absent he watched a green bird, evidently a young male, proceed to wreck the structure. It departed hurriedly when a flash was fired. The blue male arrived later and began rebuilding the partly-wrecked bower. The wrecking of a rival's bower is usually carried out by a blue male, and I have not previously heard of a green bird performing such a deed. During a brief visit I made on November 4th I found the bower in ruins and all display objects removed.

I was again in the area on December 4th and 5th, when McNamara pointed out a new bower which the bird had built about forty yards away from the previous structure. He found it in mid-October, when the bird was also using the old bower. The new bower was substantially built and decorated with numerous display objects, including many blue parrots' feathers. As with previous bowers built by this bird, it was abnormal in that a rather scanty cross wall was constructed near the northern end of the two main walls. Surrounding the bower was a thickly-matted circular platform of sticks. On examining the old site I was surprised to find a partly-constructed bower. McNamara stated that no sign of it was in evidence on the previous day. On the following day the bird was observed busily at work on the new bower, which was then almost completed but held no display objects. On December 17th all the display objects had been transferred to the bower erected a week ago, and the second bower was now deserted and falling into disrepair. During visits on December 26th, January 15th, and April 14th, 1956, the two bowers were in good order but no fresh flowers or other display objects had been added. On the latter date McNamara informed me that the bowers were being visited and kept in order by green birds only.

An abnormal bower was found on the banks of the Hacking River in the Royal National Park on September 25th, 1944. The structure consisted of three walls running in the usual north-south direction. On October 14th a further wall had been added, and it then conformed to the plan shown on Figure 3. See also Plate xxxv, fig. 2. The following year, on August 4th, the bower was seen to be a three-walled structure, but on November 23rd it had reverted to a normal two-walled bower. In 1946 an inspection was made on September 12th, when a normal two-walled bower was in use.

ACKNOWLEDGEMENTS.

I wish to thank the New South Wales Gould League of Bird Lovers for the donation of the colour plate accompanying this paper. Both the colour block and the printing were provided by the Gould League free of charge.

I also wish to thank Messrs. K. A. Hindwood and R. Gannon for various suggestions and for the revision of the paper.

SUMMARY.

The courtship and display of the Satin Bower-bird are considered to be of outstanding interest. The life history of the bird is traced, with special reference to the writer's personal observations of the building of bowers, acquisition of display objects of certain colours, bower-painting, including the use of painting-wads, and display. An attempt is made to demonstrate the sexual significance of bower-building and display. Despite many years of research by competent observers, no definite evidence of mating at the bower had been recorded until recent years, when copulation at the bower was observed and photographed by E. McNamara in 1954 and by the writer in 1955 and 1956. Detailed accounts are given of courtship displays of the male in the presence of the female. The aggressive display directed against a rival is shown to be very similar to the courtship display. Evidence is brought forward to show that the urge to build bowers is sometimes carried to extremes, resulting in abnormal structures.

BIBLIOGRAPHY.

Chaffer, N. (1931).—"The Satin Birds of National Park." *The Emu,* Vol. 30.

Gannon, G. R. (1930).—"Observations on the Satin Bower-bird with Regard to the Material Used by It in Painting Its Bower." *The Emu,* Vol. 30.

Gilbert, P. A. (1940).—"The 'Green' Satin Bower-bird." *The Emu,* Vol. 39.

Gilliard, E. T. (1956).—"Bower Ornamentation versus Plumage Characteristics in Bower-birds." *The Auk,* Vol. 73.

Gould, J. (1865).—*Handbook to the Birds of Australia.*

Marshall, A. J. (1934).—"Notes on the Satin Bower-bird in South-eastern Queensland." *The Emu,* Vol. 34.

Marshall, A. J. (1954).—*Bower Birds, Their Displays and Breeding Cycles.*

Nubling, E. (1941).—"A Contribution to the Biology of the Satin Bower-bird." *The Australian Zoologist,* Vol. 10.

Incubation of New Guinea Taipan Eggs

By K. R. Slater.

(Department of Agriculture, Stock and Fisheries, Port Moresby, Papua)

(Plate xxxvi)

A captive 6-foot specimen of *Oxyuranus scutellatus canni* Slater laid fourteen eggs on 19th July, 1957. One of these was obviously infertile and was discarded. Thirteen eggs were placed in a desiccator as described below, and began to hatch after ninety-one days. Another badly-injured, gravid female was destroyed, and upon examination it was found to contain eighteen eggs. This snake was approximately 8 feet in length.

For incubation of the 13 eggs, a 10-inch Schiebler desiccator was used and was filled with water to just below the perforated porcelain plate. Three microscope slides evenly placed around the lip of the desiccator permitted a small air space when the lid was placed in position. After the eggs were located on the perforated plate, the apparatus was left within a laboratory against an asbestos cement wall. This wall was externally exposed to the sun's rays throughout the day, thus maintaining the temperature near the desiccator at about 32 degrees Centigrade. Condensation inside the lid indicated the high level of relative humidity provided by the water, but at times the moisture absorption rate of the eggs reduced condensation to a negligible amount.

At the time of laying, the ovoid eggs measured 70 mm. long by 35 mm. in diameter and were adhered to one another. During the period of incubation, depressions developed in the egg cases, and these remained until hatching commenced. Observations of the hatching process permitted recordings of the following stages:—

Friday, 18th October, 1957:

3.00 p.m.—One egg slit and baby snake's snout protruding (91 days after laying).

Saturday, 19th:

9.00 a.m.—One snake free of egg and two other eggs slit.

7.00 p.m.—One snake free of egg, one snake partly free, and four others eggs slit.

Sunday, 20th:

8.30 a.m.—One snake free of egg, one snake partly free, and six other eggs slit, with snouts protruding from three of these.

12.20 p.m.—Two snakes free of eggs, one snake partly free, and seven other eggs slit.

Monday, 21st:

9.00 a.m.—Eight snakes free of eggs, one partly free, and three other eggs slit.

Tuesday, 22nd:

8.30 a.m.—Eleven snakes free of eggs, one partly free.

3.00 p.m.—Twelve snakes free of eggs. (As the thirteenth egg showed no sign of hatching at this stage it was opened with a scalpel. The embryo within was lifeless, yet its advanced stage of development indicated that death had not long preceded the hatching time.)

Shortly after hatching, the twelve juveniles varied between 12½ inches and 17 inches in length[1], yet the majority approached the larger measurement. All displayed the characteristic coloration present in the adults of the race, and this was more pronounced when the first slough occurred one week later, on the 29th October.

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(1) A communication from Dr. James A. Oliver of the New York Zoological Park indicated that towards the end of June, 1958, the largest of the young taipans measured 31 inches. This represents a gain of 14 inches or 82.3% in eight months.

Though particularly nervous at first, with cautious handling the young snakes did not react beyond the defensive posture typical of the species. After some days of repeated handling, a slowly-moving hand failed to stimulate any excited response, even after physical contact. In view of the constantly maintained disposition of nervous adult individuals in captivity, this behaviour is significant. Whether the juveniles would respond unfavourably to contact when approaching maturity is a matter for future observation. Within a month from the hatching date people of the New York Zoological Society were successful in inducing most of the young snakes to feed on baby mice.

It would appear that egg laying of *O. s. canni* in the Mekeo Sub-district of Papua is a general phenomenon around July-August. Apart from the two individuals mentioned earlier in the introduction, about the time of their capture three other gravid females were collected. Though the eggs of two of these were laid in captivity during July and early August, incubation was not attempted due to unfavourable circumstances. Two sets of eggs were discovered some hours after they had been ploughed up in a cultivated field in July. A mating pair were also collected in the area during late in August of the same year.

REFERENCES.

Slater, K. R. (1956).—On the New Guinea Taipan. *Mem. Nat. Mus. Victoria* No. 20.

EXPLANATION OF PLATE xxxvi.

Fig. 1.—Hatching of New Guinea Taipan eggs.

Fig. 2.—Twelve young taipans shortly after hatching.

Photos.—K. R. Slater.

A Case of Snake-bite

By Roy D. Mackay.

This first-hand account concerns Mr. A.H. and his encounter with a 2-feet-long specimen of the Broad-headed Snake *(Hoplocephalus bungaroides).*

The author, with Mr. A.H. and others, were on a collecting trip to the Waterfall Sanatorium district looking for the above-mentioned species of snake. The Broad-headed Snake was very common around Sydney last century, but the spread of settlement has wiped out most of them from this area. It was subsequently found to be fairly common on the rocky ridges in the Royal National Park-Waterfall-Helensburgh area. It has been recorded from the Hawkesbury Sandstone region only, i.e., from Singleton south to the Blue Mountains, Burragorang Valley, Mt. Keira and Mt. Murray. Specimens up to 3 feet long have been captured and four collectors have been bitten previously.* No treatment was given in either of the two cases of which accounts have been published, but the characteristics of the venom's action were recorded, and very painful and distressing these cases were.

In this case no significant symptoms came about. The particular snake concerned was being photographed an hour or so after its capture. It was allowed to crawl under a thin slab of rock until the photographer (author) was ready, then the snake was to be exposed. As A.H. placed his hand on the edge

* Ormsby, A. I., 1947, Proc. Roy. Zool. Soc. N.S.W.: 19.
Worrell, E., 1952, Dangerous Snakes of Australia: 11.
Messrs. K. Budden and W. Hosmer gave me notes made on the results of bites they received from this species.

of the rock to turn it over the snake bit him on the index finger (right hand). The reaction of pulling his hand away threw the snake several yards away—it was recaptured—and two spurts of blood issued from the fang punctures. One member of the party handed me his ligatures (carried by all members of the party) immediately. One was placed on the upper arm and a second was wound around the base of the bitten finger. The site of the bite was rinsed in water to wash away free dirt and venom.

A razor blade was produced but only one fang mark could be found, as blood had stopped flowing. I made a cut through this fang puncture about $\frac{3}{4}$ in. long by $\frac{1}{8}$ in. deep. Blood flowed a little, then stopped. One ampoule (1,500 units) of Tiger Snake Anti-venene Serum was then injected intravenously in the arm. We then drove off in my car to Sutherland Ambulance Depot, where a fellow-collector-ambulanceman took A.H. and myself to Cronulla District Hospital, Caringbah.

After the first twenty minutes the ligatures were loosened for a few moments till the blood began to flow freely, then reapplied. This procedure was repeated every 10 minutes thereafter for about an hour. At the hospital calcium gluconate was injected, and after a local anaesthetic on the bitten finger four cuts were made on the fingertip to encourage bleeding. As a further safeguard an anti-tetanus injection was also given. The patient showed no evident symptoms of snake-bite or shock. The prompt first-aid treatment, including the anti-venene injection and the swift passage to hospital, probably saved the patient much unpleasantness.

A few points arise from this case which I consider worthy of mention. Firstly, the snake was about 2 feet long and its venom glands appeared full. Mr. A.H. received a full bite, so that a considerable amount of venom must certainly have entered the wounds. The girth of the snake suggested that it had not eaten very recently. Secondly, the question arises regarding the worth of scarifying the punctures. Certainly venom entering the bloodstream is carried away by the veins, and any cut made to cause blood to flow usually produces only fresh arterial blood. Therefore it would seem that very little, if any, venom is shed in scarification. A more modern method, but one not to be practised by inexperienced persons, is venesection. This is done by making a very small cut or nick in a vein draining the area of the bite in front of the ligature and letting the blood flow out; up to a point, according to the severity of the bite and the age of the person. I will not elaborate on this method here. The most positive treatment, of course, is the injection of anti-venene.

The treatment meted out to A.H., excluding the anti-venene injection, is probably the best treatment to be followed by anyone treating a snake-bite victim.

Reptiles of Lion Island, New South Wales

By Roy D. Mackay.

(Plate xxxvii)

In December, 1948, I spent two days on Lion Island, Broken Bay, with members of the Royal Zoological Society, recording the extent of the Mutton Bird population and privately studying the reptile fauna. On that occasion I observed the following species of reptiles: Lace Monitor *(Varanus varius)*, Water Dragon *(Physignathus lesueurii)*, Water Skink *(Sphenomorphus quoyii quoyii)*, and the Coppertail Skink *(Sphenomorphus australis)*. Since then I have been on the Island three times: in December 1954, March 1957 and November 1957. The only other reptile found was the Three-toed Skink *(Siaphos equalis)*. On each trip but the last it was noted that all the specimens seen of the Water Dragon were in a rather emaciated condition. I also noted that the number of these lizards seen since the first trip had dwindled. They were very common in 1948, but on the last two trips very few were seen. These Water Dragons were easily caught, contrary to the usual endeavours to catch this agile species, and could be fed immediately from the hand. Fresh faeces dropped by Water Dragons on the rocks by the sea shore was examined and found to contain seaweed and crab remains. This is interesting, as it indicates that the Water Dragons found on the foreshores of Athol Gardens and Chowder Bay, Sydney, may also fare on marine foods.

Both specimens of the Lace Monitor, or Common Goanna, were found high up on the island prowling around the thick scrubland, and both were easy captures. All reptiles found on the Island were liberated after inspection.

Only two specimens of the Three-toed Skink were found, and they beneath a carpet of *Casuarina* "needles" at the western end of the Island.

The apparently starved condition of most of the lizards is possibly due to the lack of a suitable insect diet. The most abundant insects are ants and leaf-curling spiders are very common. Another interesting feature, possibly allied to the falling numbers of the Water Dragon, is the "dying off" of many of the large *Angophora* trees, the predominant large trees on the Island, which would harbour an insect food supply.

The Water Skinks and Coppertail Skinks were in large numbers on all occasions but they were certainly most voracious. Indeed, the former species would come around us for food at mealtimes and would take meat, bread, and tomato tossed to them about 18 inches away.

Different specimens of Lace Monitor were seen and photographed on the 1948 and 1957 trips. Both were apparently in good condition except that the second specimen had swollen eyelids. Ticks were on both specimens, but not in any large numbers. Each one was a little over four feet long.

There appeared to be a certain amount of habitat preference in even this small number of species of lizards. The Water Dragon is found most often on the rocky foreshores of the Island, particularly the southern side, though individuals are often seen on the rocks on the highest point of the Island—350 feet. The Water Skink shares much the same habitat but is more abundant. Both species prefer heaps of boulders and rock crevices to the vegetated areas.

So far I have not noticed the Coppertail Skink on the seashores, but it is quite common throughout the well-vegetated areas up to the highest point, where I have occasionally seen them scraping away leaves or poking their noses under debris in search of food. When alarmed they streak away to a hollow log, rock crevice, or into a dense clump of grass.

The habitats of the Lace Monitor and Three-toed Skink have already been mentioned. No snakes have been recorded for the Island, yet there is plenty of food for such species as the Brown Snake and Yellow-faced Whip Snake in the form of lizards.

This article may help other naturalists who visit the Island to record their observations on reptiles by using it as a basis for further work.

EXPLANATION OF PLATE.

Mr. Neville Goddard, a member of the Royal Zoological Society party, with one of the Lace Monitors found on the Island.

Photo.—Margaret Mackay.

Ichthyological Snippets

By Gilbert P. Whitley.

(Contribution from The Australian Museum, Sydney.)

(Figures 1-3.)

Family HEMIRAMPHIDAE.

Genus REPORHAMPHUS Whitley, 1931.

REPORHAMPHUS ARDELIO Whitley.

(Figure 1.)

Reporhamphus ardelio Whitley, Austr. Zool. vi, 1931, p. 314. River Garfish of New South Wales, Victoria, and southern Queensland.

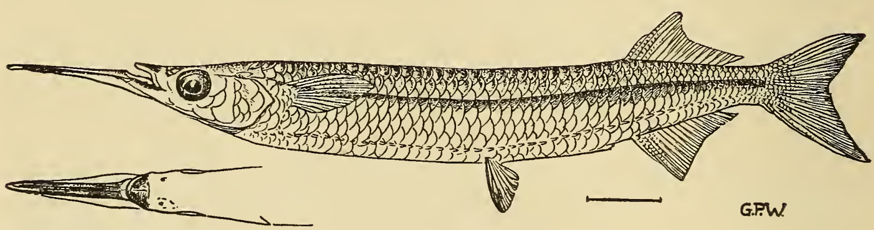


Fig. 1: River Garfish, *Reporhamphus ardelio*. Lectotype.

G. P. Whitley del.

Here figured from the lectotype of the species in the Australian Museum from the Clarence River, New South Wales. It is 11½ inches long and registered No. I.12744.

Family SYNGNATHIDAE.

Genus HISTIOGAMPHELUS McCulloch, 1914.

HISTIOGAMPHELUS MACULATUS ROBENSIS Whitley.

(Figure 2.)

Histiogamphelus maculatus robensis Whitley, Rec. Austr. Mus. xxii, 1948, p. 76. Robe, South Australia.

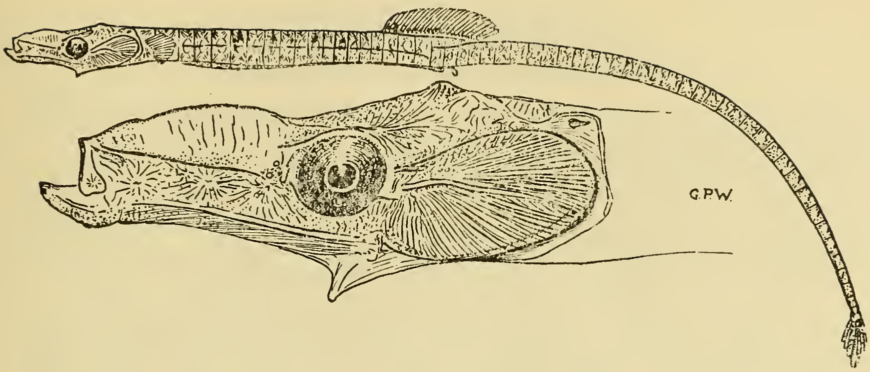


Fig. 2: Pipefish, *Histiogamphelus maculatus robensis.* Holotype.
G. P. Whitley del.

This subspecies is here figured for the first time from the holotype thereof in the South Australian Museum, Adelaide.

Family CENTROPOMIDAE.
Genus HYPOPTERUS Gill, 1861.
HYPOPTERUS MACROPTERUS (Gunther).
(Figure 3.)

Psammoperca macroptera Gunther, Cat. Fish. Brit. Mus. i, 1859, p. 69. "Victoria," i.e., Port Essington, Northern Territory of Australia. And of Australian lists. *Id.* Boulenger; Cat. Fish. Brit. Mus., ed. 2, 1895, p. 366. *Id.* Woodward, W. Austr. Yearbook 1900-1 (1902), p. 270 (N.W. Australia).
Hypopterus macropterus Gill, Proc. Acad. Nat. Sci. Philad. xiii, March 31, 1861, p. 51. *Id.* Whitley, W. Austr. Fish. Bull. ii, 1948, p. 20.

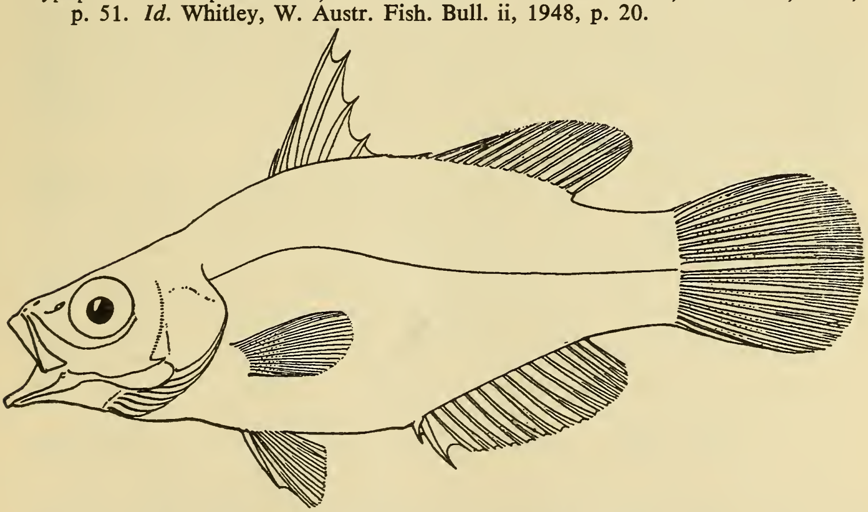


Fig. 3: Spiky Bass, *Hypopterus macropterus.* Holotype.
A. Fraser-Brunner del.

Mr. A. Fraser-Brunner kindly made the accompanying figure from Gunther's holotype in the British Museum for me a number of years ago. This is the first time the species has been illustrated.

Family EPINEPHELIDAE.

Genus EPINEPHELUS Bloch, 1793.

EPINEPHELUS SLACKSMITHI, sp. nov.

D. xi, 15; A. iii, 8; P. 16; L. lat. 60. About 57 transverse rows of scales between head and hypural joint and about 70 rows above l. lat. Tr. 9/1/36 to 6/1/8 on caudal peduncle. Predorsal scales about 25 plus anterior rudiments.

Head (122 mm.) nearly 2.3, depth (98) 2.8 in standard length (280). Eye (24) 5, interorbital and snout (20) 6.1, maxilla (56) 2.2 in head. Depth of maxilla, 15 mm.; length of pectoral, 73; of ventral, 51; of longest (3rd) anal spine, 33; of longest (4th) dorsal spine, 39; of caudal fin, 60; depth of caudal peduncle, 33; suborbital, 9; and width of head, 56 mm.

Head deeper than wide and longer than deep, naked before eyes and on lower surface, otherwise with very small scales. Interorbital concave, scaly, except anteriorly. Posterior margin of preoperculum finely serrated, its inferior border without barbs. Opercular flap very broadly rounded above, with weak spine at its flap; before this and slightly above lies the middle of the three opercular spines which is much nearer to the lower than to the upper opercular spine; the lowest spine is the most anterior. Maxillary truncate, scaleless, with supplemental bone. Tongue rounded, scooplike. Bands of cardiform teeth on jaws, finer ones on vomer (in a V-patch) and palatines; three rows of teeth at sides of mandible, reduced to one row posteriorly; no canines or particularly enlarged teeth. Nostrils oval, close together before eye; anterior with simple skinny fold, posterior open. Pseudobranchiae well developed. Gill-rakers 6/1/15, mostly short, blunt and spiny, the longest one at angle, 8 mm.

Body compressed but robust, deepest at level of gill-flaps. Comparatively large, oblong, ctenoid scales, with about 7 to 11 basal radii, cover most of the body, becoming small anteriorly and hardly trespassing on fins; scale-rows follow body-contours, and the scales are not deeply embedded in the skin. Seven rows of scales between l. lat. and sixth dorsal spine. L. lat. tubes simple.

Dorsal fins slightly notched, soft portion rounded, reaching caudal when adpressed. Base of spinous dorsal fin (95 mm.) much longer than that of soft (62), its fourth spine longest but shorter than longest ray (45). Third anal spine slightly longest; its rays as long as those of dorsal. Pectoral rounded, eighth ray longest; a scaly membrane at dorsal edge of pectoral fin base is connected with body. Ventrals originate under pectoral base. Caudal broadly rounded. No produced fin-rays.

Colour, in formalin, dark chocolate brown; the head and thorax uniform but elsewhere the fish is mostly covered by brownish-cream spots. On the body the spots occur as light centres to the scales and run along the scale-rows. On the unpaired fins the light spots are rounder, more regular, about 3 mm. in diameter, and generally larger than their interspaces, which form a net or lacework pattern. The soft dorsal, caudal and anal are inframarginally very dark brown with narrow cream edges. Paired fins mostly dark brown with small light spots not as distinct as those on the unpaired fins. A dark brown moustache-mark above maxillary; dark lichen-like markings on cheeks and lips.

Described from the holotype, a specimen 280 mm. in standard length or nearly 13½ inches overall. Australian Museum registered No. IB.3871.

Loc.—Heron Island, Capricorn Group, Queensland; Mr. R. Slack-Smith 1957.

A smaller paratype is in the Australian Museum from the Engineer Group, New Guinea, the "*Serranus microdon*" of Macleay (Proc. Linn. Soc. N.S. Wales viii, 1883, p. 253), *non* Bleeker.

The new species, named after its collector, may be distinguished from its congeners by the very convex arc of the upper flap of the operculum, the comparatively large scales, the light spots forming with their interspaces a network on body and fins, and by its fin-counts and number of gill-rakers.

Family PSEUDOCHROMIDAE.

Genus PSEUDOCHROMIS Ruppell, 1835, s.l.

PSEUDOCHROMIS McCULLOCHI PERPULCHER, subsp. nov.

Pseudochromis purpurascens McCulloch, Biol. Res. Endeav. v, 1926, p. 188, pl. xlix (New Hebrides). NOT *Nesiotes purpurascens* De Vis, Proc. Linn. Soc. N.S. Wales viii, 1884, p. 453 from the South Seas, rediscovered and redefined by Herre, Zool. Ser. Field Mus. xxi, 1936, p. 165, fig. 8, but *Nesiotes* being preoccupied, the taxon renamed *Cypho purpurascens* by Myers, Stanf. Ichth. Bull. ii, 1940, p. 35.

Pseudochromis mccullochi Myers, Copeia 1932, i, April 12, 1932, p. 30. New name for *P. purpurascens* McCulloch, *non* De Vis. Holotype in Australian Museum from Ringdove Bay, Api Island, New Hebrides.
Id. Fowler, Mem. Bern. P. Bish. Mus. xi, 1934, p. 412.
Id. Herre, Zool. Ser. Field Mus. xxi, 353, 1936, p. 167.

Br. 6, D. iii, 23; A. iii, 12; P. 18; V. i, 5; C. 17 et lat. brev. L. lat. 25 + 7 (or 6 on right side). Sc. 30. Tr. 2/1/10. Predorsal Sc. 14 to interorbital.

Head (16 mm.) 3.5, depth (15) 3.7 in standard length (56). Eye (4) equal to snout and greater than interorbital (3). Maxilla, 6 mm.; length of pectoral, 12; of caudal, 13; depth of caudal peduncle, nearly 8.

Maxillary reaching below front of eye. Lower jaw slightly the longer. Four juxtaposed canines in jaws anteriorly, behind them a patch of villiform teeth and on each side a row of small conic teeth becoming taller posteriorly. Fine teeth at back of jaws. A row of conic teeth along side of upper jaw. Teeth on vomer, apparently not on palatines. Tongue acute. Nostrils small, porelike, before eye. Preoperculum without spine, scalloped between pores. Opercules entire, not denticulate. A flat, soft opercular spine. Gill-membranes united across narrow isthmus. Gill-openings wide, rakers slender.

Form compressed, deepest at belly; profiles convex.

Head and body almost entirely scaly but snout, eyes, chin and fins are scaleless except proximal half of caudal fin.

Lateral line tubes running near top of back, one scale-row between it and most of dorsal fin; it is interrupted by three scale-rows before resuming along side of caudal peduncle. Scales thin, mostly ctenoid, transparent; l. lat. tubes simple.

Fins rounded or with bluntly pointed lobes. Ventrals pointed, situated below pectoral base, not reaching vent. Dorsal originating over pectoral base. No pungent spines. Most rays simple, posterior ones branched; anal similar. Caudal bluntly pointed, shorter than head.

Colour in formalin, mostly white or cream (with a greenish tinge probably due to preservative), gradating to light brown on back and top of head. Two black dots on snout. A curved black suborbital line almost encircling eye. Cheeks with few black spots and dumb-bell-shaped marks. Lower surface of head, breast and belly immaculate. Opercules, top of head and sides of body with conspicuous black markings, spot-like on the periphery of this area but laterally forming downward and backward-flowing lines, each of which runs below a transverse scale-row. Fins white with black margins, except the plain pectorals.

Described from the holotype of the subspecies, a specimen 56 mm. in standard length or 2¾ inches overall. Austr. Mus. regd. No. IB.3996.

Loc.—Heron Island, Capricorn Group, Queensland; Mr. R. Slack-Smith. Collector's No. 26387.

The holotype of *P. mccullochi* from the New Hebrides differs from the Queensland subspecies in having slightly different proportions of eye, depth, etc., more numerous scales, and less contrasted colour-pattern on the body, and fins dark and spotted instead of light and black-edged; its mouth reaches farther back below eye. Both differ from true *Pseudochromis (olivaceus)* from the Red Sea in having lower dorsal and anal fins and in formulae.

Family APOGONIDAE.

Genus APOGONICHTHYS Bleeker, 1854.

The true *Apogonichthys* (Bleeker, Nat. Tijdschr. Ned. Ind. vi, 1854, p. 321. Haplotype, *A. perdix* Bleeker) was described as having "Dentes setacei maxillis, vomerini et palatini . . . linea laterali antice tubulis simplicibus notata postice inconspicua," P. 2/11, and coloration different from that of the new species described below, in which I cannot see any vomerine or palatine teeth, and which has a completely tubed lateral line and 15 pectoral rays.

APOGONICHTHYS AHIMSA, sp. nov.

D. vii/i, 9; A. ii, 8; P. 15; V. i, 5; C. 14 main rays. L. Lat. 20. Tr. 1/1/6. One predorsal scale.

Head (11 mm.) 2.3, depth (10) 2.6 in standard length (26). Other dimensions of holotype: eye = interorbital, 4 mm.; maxillary = width of body = depth of caudal peduncle, 5; length of caudal peduncle, 6; head depth at occiput, 9; third dorsal spine = longest pectoral ray, 7; second anal spine, 4; snout, 3.2; predorsal length, 12; snout to anal origin, 17.

Anterior nostril with short tube; posterior open, near eye. Orbit, suborbital and preopercular margins entire or posterior margin of preoperculum weakly serrate. Operculum with two flat spines. Lower lip included. Tongue archly rounded. Maxillary excavated, reaching below posterior part of pupil (not of orbit). Bands of fine villiform teeth on jaws; none on vomer or palatines. Gill-membranes separated by a narrow isthmus. Gillrakers less than pupil of eye, about 8 rudiments on lower part of first gill-arch.

Form high and compressed. Lateral line complete. No subcutaneous gland. Vent just before anal spines.

Third spine of first dorsal fin longest. Ventrals reaching anal. Caudal rounded.

Colour in formalin, greenish (perhaps artificially stained). Three to four subvertical cross-bands on body and often traces along middle of sides of two rudimentary cross-bars posterior to the thoracic ones. Caudal peduncle dark-smudged just before caudal base. Three dark streaks radiate from back of eye, the uppermost ending in a blackish spot over opercle. Pectorals and caudal plain and pale (caudal dark-spotted in one specimen); other fins infuscated, black in parts. Eye blue.

Described from the holotype (Austr. Mus. regd. No. IB.4036) and nine paratypes (IB.4037-39 and 4056), up to 1¼ inches overall.

Loc.—Heron Island, Capricorn Group, Queensland; Mr. R. Slack-Smith, 1957. Field numbers H.29 and K.13.

The complete lateral line, included lower jaw, seven spines in first dorsal fin, small size and the coloration are distinctive characteristics.

Suggested vernacular name: gentle gobbleguts.

APOGONICHTHYS AHIMSA SANTOENSIS, subsp. nov.

As in typical *A. ahimsa,* but with four predorsal scales; interorbital (2.5 mm.) less than eye (4); maxillary, nearly 7 mm.; width of body (6) = depth of caudal peduncle, which is little less than its length (7.5). Longest pectoral ray, 9 mm.; ventral, 7; second anal spine, 4; standard length, 33.

Opercles entire. White villiform teeth on jaws and vomer. Third dorsal spine longest (5 mm.) and strongest. Caudal rounded.

Colour in alcohol, chocolate brown with a tendency to dark longitudinal banding. Spinous dorsal fin almost covered by a black blotch; pectoral mottled and dark basally.

Described from the holotype of the subspecies, a specimen 1⅝ inches overall, with a smaller paratype, Australian Museum regd. No. I.6543.

Loc.—Santo, New Hebrides; Professor W. A. Haswell.

Also 19 paratypes (No. I.13482), $\frac{7}{8}$ to $1\frac{3}{4}$ inches long, from the New Hebrides (Cummins & Stevens).

Family OSTORHINCHIDAE, nov.

Type-genus *Ostorhinchus* Lacepede, as interpreted below.

New family name to replace the Oplegnathidae, Hoplognathidae or Hoplegnathidae of authors.

Genus OSTORHINCHUS Lacepede, 1802.

Ostorhinchus Lacepede, Hist. Nat. Poiss. iv, 1802, p. 23.
Haplotype, *O. fleurieu* Lacepede.
Variants: Osteorhynchus Oken, Lehrbuch, 1816, p. 53; and Agassiz, Nomencl. Zool., 1846.
Ostorhynchus Bosc., Nouv. Dict. ed. 2, xxiv, 1818, p. 221; Agassiz, 1845, and *Ostorinchus* of authors.

Oplegnathus Richardson, Proc. Zool. Soc. Lond. viii, Aug. 1840, p. 27.
Haplotype, *O. conwaii* Richardson.
Emended to *Oplectognathus* by Troschel, Arch. Naturg. vii, 2, 1841, p. 136, and to *Hoplegnathus* by Richardson, Rept. 11th Meet. Brit. Assn. Adv. Sci. 1841 (1842), p. 71; and altered to *Hoplognathus* by Gunther, Zool. Rec. 1865, p. 184 (not *Hoplognathus* Burmeister, 1844 or Chaudhoir, 1848 nor *Oplognathus* Macleay, 1819, in Coleoptera).

Scaradon Temminck & Schlegel, Fauna Japonica, Poiss. 1844, p. 89.
Logotype, *S. fasciatus* T. & S. Spelt *Scarodon* on pp. 91 & 318.

Ichthyorhamphos Castelnau, Mem. Poiss. Afr. Austr., 1861, p. 35.
Haplotype, *I. pappei* Castelnau.

Scarostoma Kner, Sitzungsb. Akad. Wiss. Wien. lvi, 1, 1867, p. 715.
Haplotype, *S. insigne* Kner.

Karodon Bleeker (? Nat. Tijdschr. Dierk. iv, 1873, p. 134—not seen) and/or Vehr. Akad. Amsterdam xviii, 1879, p. 8. Haplotype *Hoplegnathus punctatus* Richardson.

Ostorhinchus was regarded as a subgenus of *Apogon* by Jordan and Evermann in 1896 and in some of Jordan's papers, but Lacepede's description obviously refers to a Knife-jaw. The skull of "*Hoplegnathus*" has been figured by Gregory (Trans. Amer. Philos. Soc. xxiii, 1933, p. 250, fig.). The development of the soldered teeth has been described by Hiyama (Zool. Mag., Tokyo, xlvi, 1934, p. 304 and figs.). The young "Tholichthys" stage of a Chinese fish has been figured by Herre (Lingnan Sci. Journ. xvii, 3, 1938, p. 431, fig. 2). A recent review of the species was supplied by Fowler (Bull. U.S. Nat. Mus. 100, xii, 1933, p. 217).

OSTORHINCHUS CONWAII (Richardson).

? *Ostorhinchus fleurieu* Lacepede, Hist. Nat. Poiss. iv, 1802, p. 23. "Le Grand Océan équinoxial" (Bougainville's voyage).

Oplegnathus conwaii Richardson, Proc. Zool. Soc. Lond. viii, Aug. 1840, p. 27. Port Arthur, Tasmania (locality given on p. 25).

Hoplegnathus conwayii Richardson, Rept. 11th meet. Brit. Assn. Adv. Sci. 1841 (1842), p. 71; Trans. Zool Soc. Lond. iii, 1844, p. 144, pl. vii, fig. 1. *Id.* Gunther, Cat. Fish. Brit. Mus. iii, 1861, p. 357. And of Australian lists. *Id.* Waite, Rec. Austr. Mus. iii, 1900, p. 214.

? *Ichthyorhamphos pappei* Castelnau, Mem. Poiss. Afr. Austr. 1861, p. 35. Kalk Bay, South Africa. African records of *conwaii* are probably referable to *pappei*.

Hoplognathus woodwardi Woodward, W. Austr. Mus. Guide, 1900, p. 78. *Nom. nud.*

Hoplegnathus woodwardi Waite, Rec. Austr. Mus. iii, 1900, p. 212, pl. xxxvii, Swan River, Western Australia.

Oplegnathus woodwardi, Waite and McCulloch, Trans. Roy. Soc. S. Austr. xxxix, 1915, p. 464 (Great Australian Bight records).
Id. McCulloch, Biol. Res. Endeav. iv, 4, 1916, p. 187, pl. liv.
Id. Waite, Rec. S. Austr. Mus. ii, 1921, p. 121, fig. 183; Fish. S. Austr., 1923, p. 143 and fig.
Id. Glauert, Journ. Roy. Soc. W. Austr. vii, 1921, p. 46.
Id. Whitley, Austr. Mus. Mag. iv, 1930, p. 97, fig. (teeth).

Hoplegnathus australis Regan, Ann. Durban Mus. i, 3, 1916, p. 169. Tasmania.

Oplegnathus conwayi, Sherborn, Index Anim., 1925, p. 1507. Emend.

The Red Funnel Trawlers obtained this species (agreeing best with the *woodwardi* form) from 78 to 80 fathoms off Tathra, and Mr. A. P. Grassick presented the 18-inch specimen to the Australian Museum, Regd. No. IB.3965. New record for New South Wales. The species has been found in Western and South Australia, Tasmania, Bass Strait and south-eastern Australia. Related forms are recorded from Norfolk Island, South Africa, South America and Japan. The operculum varies in shape and degree of serration. Regan's *australis* has unusually deep body and long ventrals.

Family GOBIIDAE.

Genus PRIOLEPIS Cuv. & Val., 1837.

Priolepis Cuvier & Valenciennes, Hist. Nat. Poiss. xii, March 1837, p. 67, *ex Ehrenberg,* Ms. Haplotype *P. mica* Cuv. & Val. *Id.* Hemprich & Ehrenberg, Symbolae physicae, 1899, pl. ix, fig. 6—*fide* Zool. Record 1899, p. 24. *Id.* Whitley, Austr. Zool. vi, 1930, p. 123.

Zonogobius Bleeker, Arch. Neerl. Sci. Nat. ix, 1874, p. 323. Orthotype, *Gobius semifasciatus* Kner.

PRIOLEPIS NECOPINUS, sp. nov.

D. vi/i, 9; A. i, 9; P. 17; V. i, 5; Sc. 23. Tr. 7 (to 5 on caudal peduncle). Predorsal area naked.

Head (6.5 mm.) nearly 3.7, depth (6) 4 in standard length (24). Eye, 3 mm.; interorbital, 1; depth of caudal peduncle 3.3; snout 1; maxillary 2.6, depth of head, 6, width of head, 4.5.

Head scarcely compressed, with roundly convex dorsal profile and flatter ventral profile. Eye large, high, anterior; interorbital narrow and deep. Nostrils close together. Snout short, bluntly rounded. Jaws reaching below front third of eye, lower slightly projecting; mouth oblique; no canines; fine teeth apparently in two rows. Tongue truncately rounded, not notched.

Raised mucous-ridges on snout before eyes. Rows of ciliate papillae on sides of head below and behind eye, around preoperculum, and around corner of mouth to under surface of mandible. Anterior part of opercle with a vertical series of papillae and a shorter horizontal one.

Gill-openings large, continued well forward to below middle of eye. Isthmus narrow.

Body fairly robust, compressed, greatest depth just behind head. It is mostly covered by large ctenoid scales but the predorsal area is naked. However, the breast and pectoral base are scaly. Length of caudal peduncle about equals that of head. Vent large.

Two dorsal fins joined by membrane. Dorsal spines slender, the third or fourth longest and filamentous; soft dorsal rays increasing in height posteriorly. Anal similar to second dorsal. Pectoral pointed, subequal to head, reaching vent, its rays not silk-like or modified. Ventral fins separated, not suckerlike or connected by membrane, their inner rays much longer than the outer ones. Caudal rounded.

Colour, after preservation, pale yellow with conspicuous, open, brown reticulations anteriorly, fading ventrally. The brown pattern extends to enclose light round spaces on the dorsal, anal and caudal fins. Ventrals and pectorals plain, pale.

Described from the holotype (Austr. Mus. regd. No. IB.3991), a specimen 24 mm. in standard length or about 1.1 inches overall, and twenty paratypes (IB. 3992-3993) two of them in U.S. National Museum, Washington.

Loc.—Heron Island, Capricorn Group, Queensland; 24 Aug. 1957. Collected and presented by Mr. R. Slack-Smith. Collector's field No. 4.

My largest specimen is 32 mm. (1¼ inches) overall. Laceface Goby is suggested as a vernacular name.

Latin *necopinus*, unexpected.

This goby is distinguished by its reticulated anterior coloration, separated ventral fins, naked predorsal area, scaly pectoral base, etc.

Related to *Quisquilius eugenius* Jordan and Evermann, Bull. U.S. Fish. Comm. 1902, xxii, April 11, 1903, p. 203, from Oahu, but differs in having scaleless predorsal area. From *Priolepis*, sensu stricto, it differs in having the head less compressed and not banded, and in coloration.

Genus CTENOGOBIUS Gill, 1858, s.l.

AURIGOBIUS, subg. nov.

Orthotype, *C. (A.) auriga*, sp. nov.

An Australian goby which differs from all others in having the first dorsal spine produced, much longer than the head. Other characteristics are noted below, particularly noteworthy being the cycloid scales which leave the nape and predorsal area naked.

CTENOGOBIUS (AURIGOBIUS) AURIGA, sp. nov.

D. vi/i, 9; A. i, 9; P. c. 16; V. i, 5. Sc. 24. Tr. 6. Predorsal sc. 0.

Head (9 mm.) 3.2, depth (4) 7.2 in standard length (29). Eye (3) longer than snout (2.3). Width of head (6) greater than its depth and than postorbital (4.5). Length of caudal (8) less than head.

Head rather swollen; no transverse groove behind eyes. Lips exposed. Lower jaw the longer. Mouth reaching below pupil. Tip of snout before lower margin of eye. Eye partly behind front third of head. Bands of villiform teeth in jaws, a row of enlarged hook-like teeth externally. No enlarged mandibular canines. Tongue truncate. Mucus tubes form a V, diverging over snout, and run from eye over opercle and around preoperculum. Two short longitudinal rows of genipores on cheek; minute papillae elsewhere. Cheeks and opercules naked, unarmed; no barbels or fleshy flaps. Front nostril near upper lip, posterior near eye. Interorbital very narrow, orbits almost contiguous. Gill-openings extending to below preoperculum separated by fairly wide isthmus.

Body fairly elongate, slightly compressed with large cycloid scales which extend over the breast. Predorsal area, nape and pectoral base naked.

First dorsal spine produced, longer than head, others normal. Fins all reaching well back, higher than body posteriorly, rather pointed. Pectorals reach below second dorsal; seventh ray longest; upper rays not silky. Ventrals united, with frenum, their fifth ray longest, reaching beyond anal papilla. Caudal broadly lanceolate.

Colour: Greenish in preservative. A few sprinklings of black chromatophores along sides and on fins. Black blotch on membrane between first two dorsal spines. Anal fin infuscated. Ventrals and caudal with narrow black margins.

Described from the holotype, 1½ inches long, and two smaller paratypes Austr. Mus. regd. Nos. IB.4001-4003.

Loc.—Heron Island, Capricorn Group, Queensland. Mr. R. Slack-Smith's field No. H.79.

Perhaps nearest *Ctenogobius cylindricus* Bleeker (Arch. Neerl. Sci. Nat. x, 1875, p. 129) from Singapore, but evidently differing in having no predorsal scales and in its elongate first dorsal spine.

Genus GLOSSOGOBIUS Gill, 1862.

It is with some doubt that I refer the following species to this genus, as it has a rounded tongue, lanceolate caudal fin and hooked canines in the lower jaw, which is longer than the upper.

GLOSSOGOBIUS? BULMERI, sp. nov.

D. vi/i, 8; A. i, 7; P. 17; V. i, 5; C. 13 main rays. Sc. in about 29 transverse rows between head and base of caudal. Predors. and Tr. sc. about 13.

Head (16 mm.) 3.2, depth (10) 5.2 in standard length (52). Eye (4) 4, caudal fin (16) 1, postorbital (7) 2.3; maxilla (5) 3 in head. Predorsal length 19 mm.

Head broader than deep, tapering, rather depressed. No process on pupil of eye. Interorbital narrow, concave. Operculum with small flap. Gill-opening extending well forward below, nearly to below eye. Isthmus narrow. Upper lip thick; lower jaw projecting; mouth oblique, not quite reaching below eye. Six enlarged hooked canines in lower jaw anteriorly. Bands of coarse villiform teeth (enlarged anteriorly in upper jaw) elsewhere on jaws; none on palate. Tongue rounded, not notched, adnate for much of its length. Genipores inconspicuous. Mucous canals around eye, over opercles and around preoperculum. Head naked. Predorsal scales nearly reach to posterior level of eyes; foremost scale on nape not enlarged.

No fleshy flaps on shoulder-girdle. Body with large ctenoid scales becoming smaller anteriorly and with weaker ctenii. Breast and pectoral bases scaly. A small round anal papilla.

Dorsal fins separate; soft dorsal and anal pointed, leaving a long caudal peduncle free. Seventh and eighth pectoral rays longest shorter than head, reaching about 13th scale. No silky rays. Ventrals united, pointed, not reaching vent; with frenum. Caudal pointed, as long as head.

Colour in alcohol brown with darker mottlings or edges to the scales. Fins mostly infuscated but distal half of first dorsal is light and there is a black blotch on the last two membranes of the spinous dorsal fin. Inner ventral rays blackish; outer cream.

Described and figured from the unique holotype of the species, a specimen 52 mm. in standard length or 2⅝ ins. overall. Australian Museum registered No. IB.3564.

Loc.—Kwan Stream, flowing into the lower Lanim River, a tributary of the Lai River, Sepik watershed, New Guinea; altitude 3,000 to 3,500 feet; 28 October 1955. Collected and presented by Mr. R. N. H. Bulmer, of the National University, Canberra, after whom I have much pleasure in naming the species. Taken in association with *Rhombosoma affinis* (Weber) and *Mogurnda aurifodinae* Whitley.

The rounded tongue and lanceolate caudal fin are distinctive apart from the other combination of characters described.

GLOSSOGOBIUS ASARO, sp. nov.

D. vi/i, 9; A. i, 8; P. 17; V. i, 5; C. 15 main rays. Sc. 31 from opercle to hypural joint. Tr. 13 at first dorsal, 8 at second and 5½ at caudal peduncle. About 11 predorsal scales, ceasing well behind eyes.

Head (20 mm.) 3.4, depth (13) 5.2 in standard length (69). Eye (4) 5 in head. Interorbital, 3 mm.; snout 7; postorbital 11; predorsal length, 25; caudal fin, 20 mm.

Head broader than deep, bluntly rounded, the upper lip terminal and the mouth undershot. No process on pupil of eye. Interorbital rather wide and flat. Gillopening extending forward to below preoperculum. Gillmembranes attached to broad isthmus. Mouth reaching below anterior margin of eye.

Lips thick. Teeth on jaws in several rows, outer and inner of which are enlarged, spaced; none on palate. Tongue truncate, mostly adnate.

Rows of minute genipores around and behind eye and in five horizontal rows on cheeks; others along supraopercular canal; a vertical and a curved row down operculum and other papillae around chin. Nostrils about the same distance from the eye and the lip as they are from one another. Head naked. Predorsal scales barely reach level of preoperculum. No transverse groove on back of head. No barbels. Six short slender gill-rakers on lower part of first gill-arch.

No fleshy flaps on shoulder girdle. Body with large, adherent, ctenoid scales, becoming cycloid predorsally. Much of breast, belly and pectoral bases naked. A flattened, fleshy anal papilla.

Dorsal fins separate; soft dorsal, anal, pectoral and caudal rather pointed. No silky pectoral rays. Ventrals short and rounded, united, with frenum, not nearly reaching vent.

Colour in alcohol rich brown with darker edges to scales. Fins densely infuscated. Dark spots on caudal membranes.

Grows to 3½ inches in length. Feeds on gastropod shells.

Described from the holotype, a specimen 69 mm. in standard length or 3½ inches overall, and a series of 36 smaller paratypes.

Australian Museum regd. No. IB.3748.

Loc.—Living under stones and algal tufts in a swift, shallow freshwater stream near Wallace's property, Asaro River, five miles south of Goroka, New Guinea; alt. about 6,000 ft.; 27 October 1956. Collected by hand by Dr. and Mrs. D. F. McMichael and native helpers. The Asaro River flows towards the headwaters of the Purari river-system which reaches the sea to the south of New Guinea.

Distinguished from its congeners by its snub nose, undershot mouth, small round ventral fins, caudal fin equal to head, etc.

Family SYNANCEJIDAE.

SYNANCEJA TRACHYNIS (Richardson, 1842).

The Stonefish can now be reliably recorded from New South Wales. A specimen of this dangerous fish, 29 cm. long and weighing 4 lb., was trawled off Ballina in 7 or 8 fathoms and presented to the Australian Museum in June 1958 by Mr. H. W. Lane, Fisheries Inspector. Registered No. IB.3966.

Family SCORPAENIDAE.

Genus HYPODYTES Gistel, 1848.

HYPODYTES CARINATUS MACROLEPIDOTUS (Ogilby, 1910).

Apistus carinatus (Bloch & Schneider) McCulloch, Biol. Res. Endeavour iii, 1915, p. 160, pl. xxxi.

Hypodytes carinatus McCulloch, Austr. Mus. Mem. v, 1929, p. 389 (q.v. for refs.).

One of these Pilgrim Fish, trawled off Ballina in 7 or 8 fathoms by Fisheries Inspector H. W. Lane in April 1958, constitutes a new record for New South Wales. Austr. Mus. regd. No. IB.3971.

Family CLINIDAE.

Genus CRISTICEPS Cuvier & Valenciennes, 1836.

CRISTICEPS PATAECOIDES, sp. nov.

D. iii, xxviii, 6; A. ii 24; P. 11; V. 3; C. 10.

Head (27 mm.) nearly 4 and depth at anal origin which equals height of first dorsal spine (26) 4 in standard length (105). Eye (5) 5.4, height of soft dorsal lobe which is equal to that of anal lobe (15) 1.8 in head.

A simple tentacle over eye, less than eye-diameter in height. Tentacle at anterior nostril with 3 or 4 ray-like branches. Posterior nostril on each side just before dorsal origin. Maxilla reaching below posterior part of eye. Narrow bands of hooked teeth in jaws and in two patches on vomer. Tongue rounded.

First dorsal fin originating before eye, elevated and with ample membranes; united to lower third of first spine of second dorsal fin by membrane. The rays are without pronounced interspace. Soft dorsal lobe almost reaching over hypural joint. Caudal peduncle slender and fairly elongate, the membrane from the posterior dorsal ray reaching halfway along its length; anal fin ends farther forward. Membranes of fins slightly roughened.

First eighteen or so lateral line tubes close together anteriorly, separating more as they descend and continue along sides to caudal peduncle, about 50 altogether (49/52). No scales.

Pale to yellowish brown on head and body; fins darker and with a dull purplish tinge; dorsal and anal with slightly lighter margins. Tentacles on head and an oblique bar below eye dull purplish-brown. A few very small purple flecks along upper sides of back. Fins without transparent patches.

Described from the unique holotype, a specimen 105 mm. in standard length or a little over 5¼ inches overall. Austr. Mus. regd. No. IB.4014.

Loc.—About five miles off the mouth of the Clarence River, northern New South Wales, taken in prawn-trawl in about 200 feet of water by Mr. Roy Davis and presented to the Australian Museum by Mr. W. R. Weiley, M.L.A. for Clarence, Parliament House, Sydney, who frequently donates fishes of interest from northern New South Wales.

The new species is closest to *C. aurantiacus* from New South Wales and Lord Howe Island (see McCulloch, Rec. Austr. Mus. vii, 1908, p. 38, pl. x, fig. 1) but differs in having the two spinous dorsal fins connected by membrane, darker fins, anterior dorsal fin lower, and in its comparatively slightly longer soft dorsal and anal lobes.

Family BLENNIIDAE.

Genus GRAVICEPS Fowler, 1903.

The following new species differs from the genotype (*Petroscirtes elegans* Steindachner) and its congeners in fin-counts and coloration. The small head, elongate body and high second dorsal in comparison with the first dorsal fin and filamentous caudal rays help to discern it.

GRAVICEPS ANGELUS, sp. nov.

D. 13, 21 = 34; A. ii, 24; P. 14; V. 2; C. 15.

Head (10 mm.) 5, depth (7.5) 6.6 in standard length (50) or 6.2 and 8.2, respectively, in total length (62). Eye (3) equal to snout and greater than interorbital (2.3).

Slight skin-fold along top of head. Profile strongly convex. Some pores on head but no tentacles. Mouth infero-lateral, curved, not reaching below eye, with about 23 incisor teeth across each jaw and with lateral canines. No barbels, but a small lip-fold each side of lower jaw. Gill-opening a short curved oblique slit above pectoral base.

Body compressed, elongate. Lateral line almost obsolete.

Dorsal and anal fins free of caudal. First dorsal fin arising above front of gill-opening, well behind eye, its spines notably lower than the rays, the longest of which (7 mm.) are equal to postorbital. Anal fin about 5 mm. high, thus higher than anterior dorsal spines. First anal spine minute, second ray-like. Pectoral length (9 mm.) less than that of head; ventrals nearly 9 mm. long, neither extends to vent. Caudal with tips of rays filamentous, beyond membranes.

Colour in formalin, light brown with grey markings as blotches along middle sides of body. Brown spots and bars on lower parts of head; brown band from eye to chin. A dark blue blotch behind eye. First dorsal fairly uniform brown, second pale grey with about seven layers of curved brown lines crossing rays. Anal fin pale brown, darker distally, with tips of anterior rays white. Two grey spots, one above the other, on caudal peduncle, arising from each of which is an indistinct brown stripe passing backwards over caudal fin. Viscera and eyes bluish.

Described from the unique holotype, a specimen 50 mm. in standard length or nearly 2½ inches overall. Austr. Mus. regd. No. IB.3995.

Loc.—Heron Island, Capricorn Group, Queensland. Mr. R. Slack-Smith.

Near *Petroscirtes kranjiensis* Herre (Bull. Raffles Mus. xvi, 1940, p. 25, fig., Singapore), but differs in proportions, disparity in height between two dorsal fins, and the mouth does not reach below middle of eye.

Family ANTENNARIIDAE.

Genus ANTENNARIUS Daudin, 1816.

ANTENNARIUS DOREHENSIS Bleeker.

Antennarius dorehensis Bleeker, Act. Soc. Sci. Ind. Neerl. vi, 1859, p. 21 and Atlas Ichth. v, 1865, pp. 9 & 19, pl. cxcix, fig. 7. Doreh, New Guinea. *Id.* Herre, Copeia 1945, 3, p. 149. *Id.* Schultz, Proc. U.S. Nat. Mus. cvii, 1957. pp. 61 & 97, pl. xii, fig. B.

D. i, i, i, 12; A. 8; P. 8; V. 5.

Gill-opening at pectoral elbow. Skin soft, not warty, almost covered with tiny spines. Dorsal and anal fins well free of caudal. No smooth illicial trough, spinules being present between dorsal spines.

Illicium short, slender, shorter than second dorsal spine. Esca a simple, lanceolate flap. Third dorsal spine movable. Second dorsal spine about one-sixth soft dorsal base. Last few dorsal and anal rays branched. Eight simple pectoral rays and five ventral, the last divided. General features as given by Bleeker.

Colour dark grey, later changing to brown in alcohol, with lichen-like pale grey patches and a number of white spots along lateral line and elsewhere on body. Dorsal and anal with whitish at margins. Bases of caudal rays cream. A black spot on soft dorsal and another on back. No large ocelli, or marked stripes or bands.

Described from a specimen 36 mm. in standard length or about 1¾ inches overall. Australian Museum regd. No. IB.1537.

Loc.—Bat Island, Purdy Archipelago, New Guinea (Lat. 2° 50′ S. x Long. 146° E.); collected by Flight-Lieutenant Duncan C. Swan in 1945.

Other species seen or collected at the same place were *Mapolamia spallanzani, Siderea picta,* a belonid, *Kutaflammeo sammara* var. *laevis, Holocenthrus violaceus, Myripristis murdjan, Oedalechilus cirrhostomus, Ellochelon vaigiensis, Epinephelus corallicola, E. forsythi, E. caeruleopunctatus, Cephalopholis argus, Terapon servus, Caranx* sp., *Caesiomorus baillonii, Chorinemus tolooparah, Trachinotus blochi, Elagatis bipinnulatus, Lutjanus semicinctus, L. lineatus, L. fulviflamma, L. Coatesi* ?, *Gerres acinaces, Mulloidichthys samoensis, Lethrinus papuensis, Opisthistius cinerascens, Platax orbicularis, Chaetodon trifasciatus, Teuthis triostegus, Premnas biaculeatus, Novaculichthys taeniourus, Carapus* sp., *Leptecheneis neucrates,* the above *Antennarius dorehensis. Balistapus undulatus, Balistoides flavimarginatus, Hemibalistes chrysopterus, Rhinecanthus aculeatus, R. echarpe.*

ANTENNARIUS PHYMATODES Bleeker.

Antennarius phymatodes Bleeker, Act. Soc. Sci. Indo-Neerl. ii, 1857, p. 69. Amboina. *Id.* Bleeker, Atlas Ichth. v, 1865, pp. 8 & 11, pls. cxcvii, fig. 1 & cxcix, fig. 5. *Id.* Schultz, Proc. U.S. Nat. Mus. cvii, 1957, pp. 54, 59, & 90, pl. xi, fig. A.

One specimen, 135 mm. long, from Heron Island, Capricorn Group, Queensland; presented by Miss Barbara Dew. Austr. Mus. regd. No. IB.3906. New record for Australia.

Family BALISTIDAE.

Genus RHINECANTHUS Swainson, 1839.

RHINECANTHUS ACULEATUS (Linnaeus).

Balistes aculeatus Linnaeus, Syst. Nat., ed. 10, 1758, p. 328. India.

A young specimen, 1⅝ inches long, was collected at Long Reef near Sydney on March 1, 1958, by Mr. Harold Cogger.

New record for New South Wales.

RHINECANTHUS ECHARPE (Anon.).

Balistes echarpe Anon., Allgem. Lit. Zeit. iii, 287, Sept. 24, 1798, p. 682. Based on "Le Baliste écharpe" (vernacular name only) Lacépède, Hist. Nat. Poiss. i, 1798, p. 352, pl. xvi, fig. 1. "Habitat in Mari Indico." *Balistes rectangulus* Bloch & Schneider, 1801, was also based on this, and the species has often been called *Balistapus rectangulus* by authors.

Balistes garnoti Castelnau, Proc. Zool. Acclim. Soc. Vict. ii, May 10, 1873, p. 107. Knob Island, Queensland. New synonym.

Balistes garnoti is evidently the young of this species. The Australian Museum has specimens of *Rhinecanthus echarpe* from Oahu, Ontong Java (Lord Howe's Group, Melanesia), Bat Island (Purdy Archipelago, New Guinea), Ugi (Solomons), St. Crispin and Maori Reefs (Great Barrier Reef, Queensland). The species may now be added to the New South Wales list, as Mr. Harold Cogger collected one young *"garnoti"* at Long Reef near Sydney on 2 March 1958. He found that the above two species of *Rhinecanthus* inhabited holes in rocks in about 18 inches of water and that they made underwater noises.

Family TETRAODONTIDAE.

Subfamily OVOIDINAE, nov.

Toadoes with a single nostril on each side, often appearing as two tentacles, and with a single lateral line reaching tail on each side. This subfamily is represented in Australia by *Ovoides* spp., *Cyprichthys, Boesemanichthys,* and possibly *"Tetrodon" staigeri;* other examples are given in the Arothroninae of Fraser-Brunner (Ann. Mag. Nat. Hist. (11) x, Jan. 1943, p. 15).

Genus OVOIDES Anon., 1798.

OVOIDES AEROSTATICUS OTTERI Whitley,

Ovoides aerostaticus otteri Whitley, Great Barrier Reef Exped. Sci. Rept. iv, 9, 1932, p. 311, pl. iii, fig. 2. Batt Reef, Queensland.

One from Ballina, New South Wales, Feb. 1958, caught by Dr. A. A. Racek, who states that it swam very fast. New record for New South Wales for this subspecies. Abe (Bull. Biogeogr. Soc. Japan xiv, 1949, pp. 128-129) regards it as a synonym of *Tetraodon stellatus,* but the dorsal fin of *otteri* is unspotted.

Family CANTHIGASTERIDAE.

Genus CANTHIGASTER Swainson, 1839.

CANTHIGASTER JANTHINOPTERUS (Bleeker).

Tropidichthys janthinopterus Bleeker, Nat. Tijd. Ned. Ind. viii, 1855, p. 429. Amboina. *Id.* Weber, Siboga Exped., Fische, 1913, p. 587.

Anosmius janthinopterus Bleeker, Act. Soc. Sci. Indo-Neerl. vi, 1859, p. 202.

Psilonotus janthinopterus Bleeker, Act. Soc. Indo-Neerl. viii, 1860, p. 13; Ned. Tijd. Dierk. ii, 1865, p. 272; and Atlas Ichth. v, 1865, pl. ccxiii, fig. 2.

Canthogaster janthinopterus Bleeker, Atlas Ichth. v, 1865, pp. 79 & 82; Ned. Tijd. Dierk iii, 1866, p. 39.

Canthogaster reticulatus Bleeker, Atlas Ichth. v, 1865, p. 82. "Un titre plus juste" for *janthinopterus.*
Tetrodon janthinopterus Gunther, Cat. Fish. Brit. Mus. viii, 1870, p. 302.
Canthigaster janthinopterus Herre, Fish. Herre Exped. 1934, p. 9.
Id. Fraser-Brunner, Ann. Mag. Nat. Hist. (11) x, 1943, p. 9.

Id. Smith, Ann. Mag. Nat. Hist. (13) i, 1958, p. 60, pl. 1, fig. a.

D. 9; A. 9; P. 18; C. 9.

Colour in formalin, greyish brown fading to almost white on fins and along the plain chin and median part of belly. Sides of head and body with large dirty-white spots, larger than their interspaces, the latter forming an open brown network. A dozen short, thick brown bars radiate from the blue eye. Base of dorsal fin dark brown. Caudal fin plain.

Length $2\frac{3}{4}$ inches.

Loc.—Heron Id., Queensland. Mr. R. Slack-Smith's No. 26371.

Austr. Mus. regd. No. IB.3998.

New record for Australia. The Australian Museum also has a small specimen from Santo, New Hebrides.

CANTHIGASTER BREDERI, sp. nov.

New name for *Canthigaster punctatissimus reticulatus* Breder (Bull. Bingham Oceanogr. Coll. ii, 3, 1936, p. 50 & figs. Lower California), preoccupied by *Canthigaster reticulatus* Bleeker (Atlas Ichth. v, 1865, p. 82).

Addendum to Family APOGONIDAE (page 314, above).

Genus SIPHAMIA Weber, 1909.

SIPHAMIA ZARIBAE, sp. nov.

A fuller account with a figure has been prepared for later publication, and some Queensland colleagues intend to give some account of the interesting habits of this fish, for which I provide the above name. It is near *Siphamia cuprea* Lachner (Bull. U.S. Nat. Mus. ccii, 1953, pp. 415, 418, 423 & 424, fig. 72) from the Philippines but differs in having the second dorsal spine longest of the six in that fin and in having a much longer and slenderer caudal peduncle. The holotype is Austr. Mus. regd. No. IB.4129, and there is a larger paratype (IB.4132) measuring $1\frac{3}{16}$ inches overall. Both from spines of a sea-urchin, Heron Island, Queensland; coll. Mr. K. Gillett, 1958.

D. vi/i, 9; A. ii, 8; P. 15. Sc. c. 21. Tr. about 2/6. Head and depth 40% of standard length; predorsal length 45% of same (20 mm.). Depth of caudal peduncle, 2.3 mm. Preoperculum entire.

Colour in formalin, black with the fins white but with the proximal parts of fin-rays of unpaired fins pigmented black.

A New Genus of Bees in the Family Colletidae

By Tarlton Rayment, F.R.Z.S.

Honorary Associate in Entomology, National Museum, Melbourne.

(Plate xxxviii)

In May, 1946, Norman W. Rodd visited a typical sandstone gully a few miles from Sydney and collected a few wild-bees, chiefly in the genus *Exoneura.* Among them was a small but remarkably slender black male, which was put aside for the time being with the hope that further material might come to hand, including the female.

Several years passed, but the fates were not propitiou, and it has become advisable to describe the insect. At first glance the bee might be mistaken for a small species of *Euryglossa,* but critical examination reveals several surprising characters.

The general facies is not extraordinary, but the morphological details certainly are. The head is small, and the mouth-parts are quite unlike those of any other Australian bee, for they are excessively long for so small an insect, and under a hand-lens appear to consist of 14 long fine amber threads, among which it is impossible to identify the glossa.

However, when the exceedingly tenuous mouth-parts are dissected out and mounted in "Euparel," the actual glossa can then be identified as a very short, obscure organ at the extreme base of the bundle of "threads." The threads themselves are seen to be 12 exceedingly long filaments springing from the apices of the galeae of the short maxillae, and the two exceedingly long labial palpi. Although the labial palpi are so spectacular, the apices of both have been broken off, and it is, therefore, impossible to determine how many segments were in the complete palpus.

The maxillary palpi, each of six segments, are equally tenuous, the fourth segment being very long and the sixth very small. The measurements in microns, together with the diagrams, will enable the student to appreciate better the remarkable character of the mouth-parts.

The sculpture of the dorsum of the epinotum has an area similar to that of many Halicti, for there is a dome-shaped line enclosing a number of fine rugae. Beyond the area the declivity is steep, and the sculpture a kind of coarse, scale-like tessellation. The abdomen has the same peculiar "net-work" sculpture that is found on certain species of *Euryglossa,* but the apical segment is acute. The neuration of the wings resembles that of certain *Megachile,* for there are only two large cubital cells, the second being almost as long as the first; the radial cell is pointed on the costa; the pterostigma long and conspicuous.

A study of the genitalia demonstrates that this bee, notwithstanding its unique mouth-parts, undoubtedly has affinities with *Lysicolletes,* which has only short primitive mouth-parts. The author believes that the distinctive morphological characters amply justify him in proposing a new genus, *Filiglossa,* in the Family Colletidae, and appends this specific description of the new species. *F. filamentosa* is the type-species.

FILIGLOSSA FILAMENTOSA, gen. et. sp. nov.

Genotype, Male—Length 5.4 mm. approx. Black and very slender.

Head transverse, and shining; face with long plumose white hair not dense; frons coarsely punctured in a fan-like pattern; clypeus with a semicircular flat area, polished, with a very few rather large shallow punctures; it is nevertheless generally convex; supraclypeal area polished, rising to a fine carina that reaches the median ocellus; vertex short, punctures closer and even in size; compound eyes large, converging a trifle below; facial foveae are deeply incised, but very short, curving inwards on the vertex to surround the lateral ocelli with a highly-polished area; genae somewhat lineate, with long plumose hair; labrum black, it appears to be a long oval, but cannot be critically examined; mandibulae narrow, bidentate, amber, black on basal fifth, reddish apically; antennae long, submonoliform, segments longer than wide, apical one obliquely truncated to a point; scapes of medium length but slender.

Prothorax long, but far below the mesothoracic disc, polished; tubercles black; mesothorax may be described as polished, although there is a trace of a lineate sculpture, scattered large shallow punctures, a very few long white plumose hairs; scutellum convex, with closer punctures, the delicate sculpture more evident; postscutellum rougher, otherwise similar to scutellum; metathorax shining, with a well-marked sculpture between rugosity and tessellation, with a dome-shaped enclosed area, like that of *Halictus,* containing a few short longitudinal rugae, the rim of the enclosure bears a number of microscopic cross-bars; there is some long loose white hair around the metathorax; abdominal dorsal segments black, bright, a delicate striation with punctures forming a net-like sculpture; ventral segments with amber margins, fringed with white hair.

Legs black, knees and median and anterior tibiae amber; sparse long white hair; tarsi amber, slender; claws short, stout, bifid, amber-red; hind calcar finely serrated; tegulae amber, suffused with black; wings hyaline, iridescent; nervures blackish, basal slightly curved, falling just shore of nervulus; recurrents received just inside the intercubiti; two cubital cells, the second more than half as long as the first; radial pointed on the costa; pterostigma conspicuous, blackish; hamuli six, weakly developed.

The new genus stands next to *Lysicolletes* Raym. which was published as a subgenus of *Paracolletes,* but the present study has shown the advisability of raising it to full rank.

The malus of the strigilis of the female *Lysicolletes* is simple, like that of *Megachile;* in *Filiglossa* it has several spines, the velum is wide and convex in the first, but narrow and straight in the second.

The area of the dorsum of the epinotum has no rugae or striae in *Lysicolletes,* but in *Filiglossa* the margin of the area is sharply defined, and there are numerous rugal or striae.

The abdomen is ovate in *Lysicolletes* but clavate in *Filiglossa,* and the sculpturing of the first is duller, owing to the excessively close puncturing, in *Lysicolletes* the terga are smooth with a microscopic lineation. In all the specimens examined, the second cubital is narrower in *Lysicolletes,* and more contracted at the top.

The legs are stouter and the tarsi shorter in *Lysicolletes,* and the hind calcar of the female bears a number of rounded, almost nodular teeth; it is finely pectinate in *Filiglossa,* and the legs are very slender indeed, with longer tarsi; the comb opposing the strigilis on the anterior legs is very long indeed in *Lysicolletes.*

Antenna—Scape: 350; flagellum 1,650; total length 2,000.

Glossa—145; mentum 600; total length 745.

Labial palpus—broken off at 1,445; total length unknown.

Maxillary palpus $\left\{\begin{array}{l}\text{1 seg. 120; 2 seg. 160; 3 seg. 130;}\\ \text{4 seg. 220; 5 seg. 100; 6 seg. 70.}\end{array}\right\}$ total 800.

$\left.\begin{array}{l}\text{Filaments of Max.—1,625.}\\ \text{Maxilla + galea—540.}\end{array}\right\}$ total length 2,165.

Mandible—590; 110 at narrowest part.

Genitalia—450 long and 275 wide.

The filaments, and also the labial palpi, are true tubes, being hollow throughout their entire length. The filamentaceous maxillae are probably the most remarkable in the Apoidea, and the author suggests that the bees are associated with an equally remarkable flower.

Locality: Lane Cove, New South Wales, May, 1947, leg. Norman Rodd.

Genotype in the collection of the author.

Allies: Not near to any other species, and persistent collecting in the area should bring in the female.

No female from the Lane Cove locality agrees with the remarkable male, but two females taken at Patonga, some 45 miles north of Sydney, conform with the generic diagnosis of *Filiglossa* with the exception of the mouth-parts. However, the long filaments of the male may be a sexual character, but the short broad glossa of the females is heavily fringed on its anterior margin. They are undoubtedly colletids, with two large cubital cells in the wings, and a strongly arched basal nervure. The pterostigma is large and conspicuous, and there is considerable loose plumose hair. The genotype has the titillatum of *Paracolletes,* which has three cubital cells.

The abdomen is smooth, with a similar microscopic cancellate sculpture, and the tiny apical plate is masked by the caudal tuft; the dorsum of the metathorax has an enclosed area, with numerous striae. The legs are slender, but the basitarsus is broad; the hind calcar finely pectinate.

From the sculpture of the dorsum (See Nos. 2 and 23 in Pl. xxxvii) it does not seem that either of these females could be the other sex of *F. filamentosa,* but they are undoubtedly closely allied. The specific descriptions are appended.

FILIGLOSSA STRIATULA, sp. nov.

Type, Female—Length 5 mm. approx. Black, red tarsi.

Head wide for so small a bee; rather dull; below the antennae shining; face with considerable long, loose white plumose hair; frons wrinkled, microscopically longitudinally striate; clypeus convex, polished, a few large punctures, long, loose white hair; supraclypeal area polished, with a fine carina that reaches the median ocellus; vertex with the striae converging on the ocelli, somewhat radially; compound eyes with anterior margins parallel; genae shining, with piliferous punctures and a beard of long white hair; labrum a small oval, black; mandibulae black, narrowly bidentate, a reddish mark in middle; antennae with curved scapes, black.

Prothorax black, tessellate; tubercles black, with a fringe of white hair; mesothorax polished, a few large shallow piliferous punctures, and a few white hairs; parapsidal and medium furrows conspicuous; scutellum similar, highly polished, a median sulcus; postscutellum rougher; metathorax with an enclosed area finely longitudinally striate (See No. 23 in Plate xxxviii); the rim rather sharp; abdominal dorsal segments clavate, black, posterior margins narrowly amber, a microscopic lineation more or less transverse, impunctate, a few smoky hairs apically; ventral segments reddish, with much long white plumose hair.

Legs black, with considerable long white forked hair, a small ctenidium apically on tibiae; tarsi red; basitarsus rather wide; claws red, bidentate; hind calcar white, finely pectinate tegulae pale-amber; wings subhyaline; the large radial cell rounded on the costa; nervures brown, the two recurrents received by the long second cubital cell; the first at the first quarter; basal arched; cells: the two discoidals are very large; pterostigma very large, brownish, hamuli seven, weak.

Locality: Patonga, New South Wales, 14th Oct., 1947, leg. Norman W. Rodd.

Type in the collection of the author.

Allies: This can hardly be the female of *F. filamentosa,* sp. nov., but it approaches rather closely a larger female, *F. proxima,* sp. nov., which has transverse striae in the enclosed area of the dorsum of the epinotum. Both females were taken at the same time and place.

FILIGLOSSA PROXIMA, sp. nov.

Type, Female—Length 7 mm. approx. Black, red tarsi.

Head shining, considerable long white loose plumose hair, almost circular from the front; facial foveae, at a certain angle, appear to be large smooth cunieform marks; frons bright, microscopically lineato punctate; clypeus highly polished, convex, scattered large piliferous punctures, a few white hairs;

supraclypeal area elevated, polished, impunctate, a fine carina reaches the median ocellus; vertex with the striae converging on the ocelli, a few smoky hairs; compound eyes with anterior margins parallel; genae rugosopunctate, with a beard of long white hair; labrum a narrow oval, black; mandibulae narrow, black, bidentate; antennae with curved scapes, blackish above, obscurely brown beneath, submoniliform.

Prothorax inconspicuous, black; tubercles black, with a fringe of long white hair; mesothorax polished, a few large piliferous punctures, and some long smoky hair, parapsidal furrows conspicuous; scutellum polished, disc impunctate, a few smoky hairs; postscutellum rougher, with large punctures; metathorax with many fine transverse striae in an enclosed area, laterally there is much long white hair; abdominal dorsal segments clavate, smooth, impunctate, a delicate cancellate sculpture, a few dark hairs apically with a dark caudal tuft; ventral segments with fringe of long white plumose hair.

Legs black, slender, knees red, considerable long white plumose hair; tarsi red, hair somewhat golden; claws bidentate, reddish; hind calcar buried in a mass of golden pollen-grains (myrtaceous); tegulae testaceous; wings slightly milky, iridescent; nervures brown, the first recurrent received farther in; cells: as in *F. striatula;* pterostigma large, amber-brown; hamuli seven.

Locality: Patonga, New South Wales, 14th Oct., 1947, leg. Norman W. Rodd.

Type in the collection of the author.

Allies: Close to *F. striatula,* which has longitudinal stripe in the enclosed area of the dorsum.

LYSICOLLETES IMITATOR, sp. nov.

Type, Male—Length, 6 mm. approx. Black, some reddish colour on legs.

Head transverse, bright; face with considerable long white plumose hair; frons minutely wrinkled; clypeus more shining, convex, a few small punctures, the delicate tessellation almost obsolete; supraclypeal area convex, impunctate, with the tessellation more evident, and rising to a fine carina that reaches the median ocellus; vertex finely rugose, a few smoky hairs; compound eyes with anterior margins practically parallel; genae tessellate, a few white hairs; labrum a narrow oval, black; mandibulae black, narrow, finely bidentate; antennae submoniliform, black above, coffee-brown below.

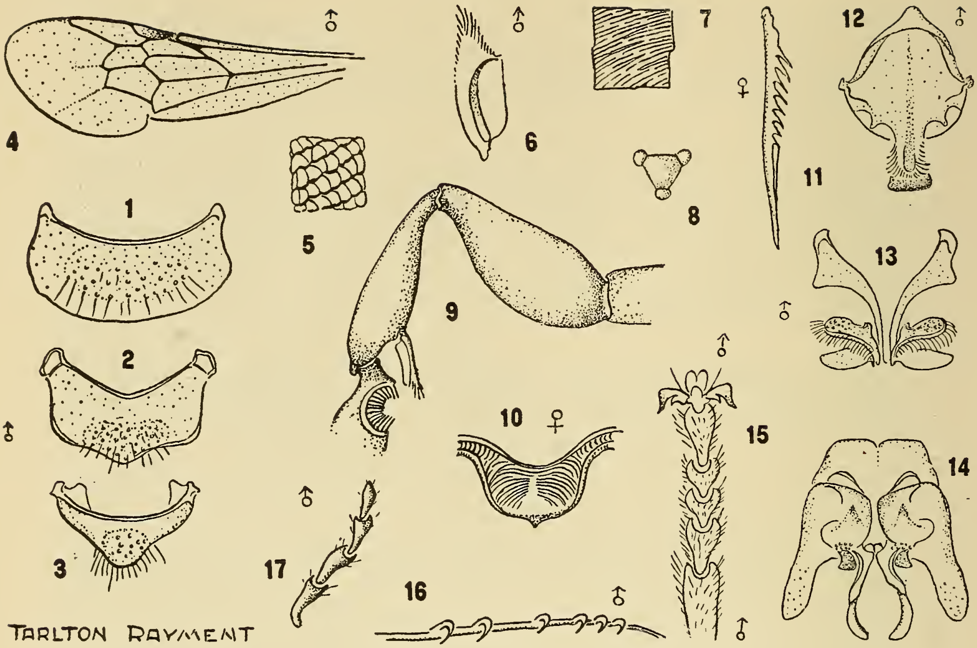
Prothorax long, black, tessellate; tubercles black, with a fringe of white hair; mesothorax shining, a delicate cancellate lineation, and scattered piliferous punctures, and a few dark hairs almost black; scutellum and postscutellum of similar sculpture; metathorax with the tessellate area barely defined, almost nude; abdominal dorsal segments clavate, brown deeply suffused with blackish, the margins somewhat luteous, a delicate transverse lineation, practically nude, a rare white hair; ventral segments reddish-amber, a few long white hairs.

Legs blackish, anterior tibiae red, others brownish, white hair; tarsi reddish-brown, quite stout, a few white hairs; claws bidentate, reddish-amber; hind calcar pallid; tegulae polished, black; wings subhyaline nervures brown, the two recurrents received at equal distances by the second cubital cell; which is large, but not so long as in *Filiglossa,* and is contracted at top, basal nervure not so strongly arched; pterostigma large, brownish; hamuli six, weak.

Locality: Engadine, New South Wales, 13th July, 1947, leg. Norman W. Rodd.

Type in the collection of the author.

Allies: The male has a close superficial likeness to *Filiglossa filamentosa* Raym., but the mouth-parts are similar to those of *Lysicolletes,* and the velum of the strigilis is strongly convex; apical segment of flagellum conical, not obliquely truncate as in *Filiglossa.*



EXPLANATION OF TEXT-FIGURE.

1, 2, 3. Apical plates of the male abdomen, *Lysicolletes imitator,* sp. nov.

4. Anterior wing; note the two cubital cells and large pterostigma.

5. Scale-like sculpture of the metathorax.

6. Strigilis of the anterior leg.

7. Lineate sculpture of the abdomen.

8. The female of *Filiglossa proxima,* sp. nov., carried large loads of pollen, probably from *Leptospermum* sp.

9. Portion of front leg of *Lysicolletes imitator.*

10. Lineate sculpture of metathorax of female *Filiglossa proxima.*

11. The hind calcar of *F. proxima* is long and slender, and finely pectinate in the middle only.

12. Ninth sternum of male *Lysicolletes imitator.*

13. Eighth sternum.

14. Genitalia of *L. imitator.*

15. Anterior tarsus of male.

16. Hamuli of male.

17. The labial palpus is short and stout in *Lysicolletes* (very different from that of *Filiglossa*).

EXPLANATION OF PLATE

1. Adult male bee, *Filiglossa filamentosa,* sp. nov.
2. The dorsum of the epinotum has an enclosed area with a few longitudinal fine rugae.
3. The mandible of the male is narrow, but finely bidentate.
4. Antenna has 13 segments; the apical one is obliquely truncate.
5. The glossa is minute, but the labial palpi are excessively long, although the apices of the tenuous second segments were broken off.
6. Cross-section of the second segment of the labial palpus, showing the tube.
7. Each maxilla bears a minute lacinia, and a tuft of six very remarkable filaments of extreme length and tenuity.
8. Appearance of the base of one of the filaments.
9. View of the interior of the base; the filaments are hollow like the palpus.
10. Genitalia of the male; the gonostyli are nude, but in *Paracolletes* they bear a heavy vestiture of plumose hair.
11. Sculpture of the mesothoracic disc; the punctures are widely separated.
12. Sculpture of the abdominal segments.
13. Strigilis of the anterior leg.
14. The claws of the fifth tarsus are bifid; the pulvillus small.

15, 16, 17, 18, 19. Apical sterna of the male abdomen. The actual structure of the last plate cannot be accurately determined from the mounted preparation. The missing portion is probably attached to the ninth sternum.

20. Apical tergum of the male.
21. The fourth segment of the slender maxillary palpus is the longest.
22. Black plumose hair on caudal segments of abdomen.
23. Knee-plate or patella of the posterior leg.
24. Striate area of metathorax of female *F. striatula,* sp. nov.
25. Facial fovea reaches the lateral ocelli.
26. One of the pollen-grains from female *F. striatula,* sp. nov.
27. Sculpture on one of the corners of the pollen-grain.
28. The hind calcar of the female is finely pectinate.
29. Ctenidium at base of basitarsus of female.

Hyperparasitism by a Minute Fly and the Specific Description of a New Species

By Tarlton Rayment, F.R.Z.S.
Honorary Associate in Entomology, National Museum, Melbourne, Victoria.
(Field Work by Clifford Beauglehole.)

(Plate xxxix)

A new series of nests of the wasp *Sericophorus victoriensis* Raym. was investigated in the Mount Richmond Reserve, Victoria, on the 17th February, 1956, by Clifford Beauglehole, a member of the Portland Field Naturalists Club, and an indefatigable student of the biota of his district. The observations confirm those of the senior author made in 1935.

The new locality is alongside Telegraph Road, on the N.E. slope of Mt. Richmond. Since the land forms portion of a proposed flora reserve, it is heavily timbered, with a large number of native shrubs, thus ensuring an abundance of wild-flowers.

The Myrtle Family is, of course, well represented, and tea-trees are numerous, especially *Leptospermum juniperinum,* so that a plentiful supply of food for the adult wasps is assured. Indeed, this is a late-flowering species, and the observer's patience was rewarded by seeing a *Sericophorus* female feeding on the nectar of the blossoms.

Later on, Clifford Beauglehole was again fortunate in discovering many shafts of these wasps excavated on the side of the road leading west of Mt. Gambier, in South Australia. It was a busy thoroughfare at that season, and the dense automobile traffic precluded any successful investigation of the shafts. A week or so later the surface was bull-dozed, and then received a thick dressing of crushed limestone.

While the avalanche of loose stone was almost disastrous for the wasps, yet it was not an unmitigated evil, for it restrained the motorists and caused them to seek a deviation, thus leaving the coast clear once more for the naturalist to continue his observations on a colony of about eight sericophorine shafts engaged in moderate activity.

On the 19th February, 1956, Beauglehole observed several small nyssonid wasps emerge from the shafts and then apparently disappear. However, on investigating another larger sericophorine colony containing some 20 or more shafts, he saw the parasites again reconnoitring the pit-mouths. These small wasps proved to be *Nysson portlandensis* Raym., and the observer confirmed the senior author's account which was published, with a plate, in the Victorian Naturalist, November, pp. 123-127, 1953.

By 11 a.m. on the same date the sericophorines were already busy with their hunting, but this habit is, of course, in strong contrast to that of *S. teliferopodus* Raym., which hunts her golden-haired blowflies soon after dawn, sometimes as early as 4.45 a.m. The prey of the Mt. Richmond species is a black, bristly fly of medium size. Needless to add, all the dipterons were males. The activities of the sericophorine colony had practically ceased by the end of March, when only one wasp was observed excavating a shaft.

The nyssonids loaf about the doorways of the wasps, but usually keep out of sight behind the tumulus of loose sand over the entrance. One parasite was timed to wait half an hour before the sericophorine emerged to depart on another hunting expedition.

The parasite then quickly entered and descended the shaft. She remained below for several minutes before re-emerging, and when she did come out, "licked her chops" several times, and then engaged in a general clean-up, repeatedly drawing her legs over her wings and back as though brushing off the last specks of dust. The performance was continued for five minutes.

On several occasions the parasite attempted to descend other shafts, but hastily retreated, having ascertained, probably by scent, that the moment was inopportune for the execution of her fell task. Perhaps she detected vibrations from the huntress down below.

At another time it was noted that a sericophorine flew within a quarter of an inch of the skulking marauder, but there was no evident reaction on the part of either insect. On one occasion the nyssonid parasite drew back nervously, as though in a state of tension, and poised herself alertly, giving one the impression of a cat awaiting the psychological moment to spring on a bird. At that moment a sericophorine departed from the shaft, and the parasite literally hurled herself down the crater. It was also observed that not infrequently the small parasite appeared to experience some difficulty in emerging from the shaft, and now and then even fell back into it, but closer investigation with a magnifying glass revealed that the parasitic wasp was actually engaged in pushing sand back into the aperture, as though attempting to seal it.

It would be logical to postulate that the parasite's action could be the vestiges of the fossorial instinct to close a cell after the depositing of the egg. On the other hand, it may possibly be argued that the closing of the she shaft would mislead the sericophorine hostess, on her return, into regarding the shaft as being completed and sealed, and thus refrain from disturbing the status quo on discovering the foreign egg in place of her own. The first postulate is, perhaps, the sounder one.

An isolated sericophorine shaft was excavated during the day, and it was ascertained that several cell-chambers were present, so that the architecture is unlike that of *S. teliferopodus,* which conforms with the typical dichotomous pair (see Memoirs National Museum, Victoria, No. 19, pp. 11-105, 1955), and follows the pattern of *S. chalybaeus* Sm., which was illustrated in the Australian Zoologist, Vol. xii, Pt. 2, July, 1955.

Number 1 cell contained three male flies; No. 2 cell four male flies; No. 3 cell four male flies. The first fly brought in receives the egg of the hunting wasp, but in each of the cells investigated the egg of the sericophorine had been slashed or devoured by the paratisic nyssonid, that had then selected a spot on the sternal surface of the second fly, immediately between the coxae of the median and posterior legs of the right side, and deposited her own egg there.

The elongate white egg of the nyssonid parasite measured 1,000 microns at its long and 310 microns at its short axis. It was only very slightly bowed, and showed little or no sculpture on the chorion. There was some slight elongation of the egg when segmentation of the larva became apparent.

In other wasp shells excavated by this observer there were present neither nyssonid nor sericophorine larvae, but it was demonstrated later that both had been devoured by numbers of larvae of a minute long-legged blackish fly in the genus *Ephydroscinus,* and, as it is new to science, the specific description is appended.

The senior author had already obtained another closely-related species, *Ephydroscinus raymenti* Curran, from the "nests" of a fossorial bee, *Halictus raymenti* Ckll. (see A Cluster of Bees, p. 245, 1935.), and other closely-related chloralictine bees. The behaviour is alike, for both small parasites skulk about the entrance until the industrious hostess departs for the field; the parasites then dash quickly down the shaft, deposit an egg, and as quickly retreat to the surface, hence the necessity for their very long legs to cover the distance rapidly before the hostess returns.

All nature-lovers should read Fabre's inimitable account of "The Gnat" that is parasitic on certain French bees, not only for its good observations but for the beauty of the language. The essay will also serve to illustrate a European parallel with our own species of minute dipteron.

These microscopic flies had often been observed frequenting the vicinity of the sericophorine shafts, but their incidence on the biology of the sericophorines was unknown. However, on 18th March, 1956, an average of 30 small puparia were obtained from certain cells. They were of two sizes, the larger ones being reddish-brown, measuring 4.25 mm. in length, with a diameter of .80 mm., but the smaller ones were yellowish-amber, being 2.50 mm. in length, with a diameter of .62 mm. It is presumed that females issued from the larger puparia and males from the smaller. Most of the tiny dipterons had emerged by the 1st April, 1956.

It would appear, from the senior author's researches, that with one or two exceptions each species of *Sericophorus* normally confines its attacks to one species of Diptera, but should that supply deteriorate from any cause, then a closely-related fly will be captured. There is no doubt of the sericophorines' ability to distinguish one species of fly from another.

No copulation of the sexes was observed in either of the wasps, and the time spent in hunting and capturing a fly varied considerably, the shortest time was one and a half minutes, and the longest 30 minutes, but there is little doubt that, during this last period, the wasp refreshed herself at the flowers.

The female of *S. victoriensis* Raym.* hunts her prey later than *S. teliferopodus* Raym. does, and it was interesting to confirm the senior author's conclusions that the wasp will attack other species of Diptera when the normal supply of specific food is curtailed from any cause. As the biology has been dealt with rather comprehensively in the Australian Zoologist, 1955, it would be redundant to repeat it here.

Family CHLOROPIDAE.

Genus EPHYDROSCINIS Malloch, 1924.

EPHYDROSCINIS PROXIMA, sp. nov.

A minute, blackish, long-legged parasitic fly, measuring not quite 2 mm. in length, and closely related to *E. raymenti* Curran.

The new species may be separated from *E. raymenti* by the pattern of the peculiar metallic silvery-green sheen on the dorsal surface of the thorax, which is divided by three black longitudinal lines; posteriorly the lines gradually converge, leaving a large green macula laterally, in the centre of which is a black dot, and a coarse lateral scutellar bristle. Scutellum very elevated.

The pleural region is exceedingly silvery, and so is the gena of the head. The black abdomen is even smaller than that of *E. raymenti,* and the blacker legs are a trifle shorter, with the anterior tibiae very different, being angulated basally. Two distal segments of all tarsi are jet-black.

The neuration of the wings is black (amber in *E. raymenti*), and in the marginal and submarginal cells is a blackish long-oval mark (suffused light band extending over three cells in *E. raymenti*).

The chaetotaxy could not be studied critically, but it would appear to be very similar to that of *E. raymenti,* although there is a very strong pleural bristle on the new fly, and four dorso-centrals.

Locality: Mt. Richmond, Victoria, 18th March, 1956, leg. Clifford Beauglehole.

Bred from puparia taken from the cells of *Sericophorus victoriensis* Raym.

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* The prey of *Sericophorus victoriensis* is almost certainly the male tachinid fly, *Austrodexia communis* Mall. in the subfamily Dexiinae, Family Tachinidae.

EXPLANATION OF PLATE.

1. Lateral view of minute fly, hyperparasite *Ephydroscinis proxima* Raym.
2. Pattern of black lines on dorsal surface of thorax.
3. Arista is minutely plumose.
4. White antisquame.
5. Two apical segments of fly are black, and the claws simple.
6. Squame.
7. Cluster of puparia of fly in cell of *Sericophorus victoriensis* Raym.

8-9. Puparia of fly enlarged.

10. Basal end of puparia enlarged to show tubercles.
11. Surface of wing of fly is densely covered with microscopic hair.
12. Ventral surface of the bristly prey, showing position of the sericophorine egg.
13. Ventral surface of the bristly prey show the position of the nysonnid egg between the median and posterior coxae.
14. View of the underneath of the head of the prey.
15. Chaetotaxy of the buccal region enlarged.
16. Shaft of *Sericophorus victoriensis* Raym.
17. Tumulus at entrance.
18. Cells of *Sericophorus* were disposed in a radial pattern: a, b, c, d, e, and f, positions of the cells.
19. Black excremental scale in base of wasp cell.
20. Second abdominal tergite of prey, showing the main bristles on a median ridge.

A New and Remarkable Colletid Bee

By Tarlton Rayment, F.R.Z.S.

(Plate xl)

While working on a collection of small leaf-cutting bees from New South Wales, the author was more than surprised to find a very remarkable male with the general aspect of a *Megachile,* but which proved, on critical examination, to have no relation whatever to that genus and to be the genotype of a new one.

It is a very strange insect, for it combines in itself the distinctive characters of several other genera, and the morphologist is thus able to identify the elements of structure present in the highest bees. The tracing of homologous structures in comparative anatomy is, perhaps, one of the most interesting and informative phases of biological research.

To enable the student to appreciate better the unique character of this insect and assist him in the easy identification of the new genus, the author has compared the characters in some detail with those of other genera. The illustrations appended to the generic diagnosis will preclude any possibility of error in determination.

Family COLLETIDAE.

PROTOMORPHA, genus nov.

Genotype: *P. tarsalis,* sp. nov.

The general facies is that of a black *Megachile* some 7 mm. in length, ornamented with much long white hair; the abdomen is small and ovate, with the terga coarsely punctured and the posterior margins broadly depressed; the head, too, is rather large; with a very strong resemblance to species such as *M. gilbertiella* Ckll.

The mouth-parts are, however, very different, for the glossa is exceedingly short and broad; there are four stout segments in the labial palpus, and six of almost equal length in the maxillary palpus; the maxillae are large and strong. The mandibles are acute, but nevertheless bidentate, and arcuate. All these characters fit the male of certain *Paracolletes* such as *P. pusillus Ckll.*

The metathorax is large, and the dorsum coarsely sculptured with large anastomosing rugae almost forming conspicuous pits; a structure very similar to that of *Binghamiella antipodes* Sm. The angles of truncation, too, are produced to small teeth as in that genus, which shows, perhaps, some approach to the new bee.

The legs are, however, of a remarkable type, and utterly unlike the slender legs of *Binghamiella.* The tarsi are short and broad, the basitarsus, however, nothing less than astonishing, for it is triangular, and deeply concave; a form seen clearly in the highly evolved social bees, *Trigona carbonaria* Sm. The tibiae undoubtedly exhibit a homologue of the honey-bee, for they have a well-defined groove that is unmistakably the elements of the harvesting corbiculae of the highest of all bees, *Apis mellifera* L. There is also a conspicuous pecten along the apical margin of the tibiae to strengthen the likeness to *Apis,* while the hind calcariae leave no doubt whatever that they are homologous with the pecten of the hive-bee.

The author (1935) had already traced the evolution of the pecten, with diagrams showing its gradual development from the calcariae of the solitary wild bees, and there could be no more striking evidence in support than that provided by the new species. A glance at the diagrams will convince the most sceptical.

Many species in the genus *Nomia* have expanded tibiae and tarsi, and *Goniocolletes,* too, has many hooks and concavities, but they are all far removed from those of the new genus.

The neuration of the wings approaches that of *Halictus;* there is a large pterostigma (inconspicuous in *Paracolletes*) with three cubital cells, the second being small and somewhat contracted at the top; the third not quite so long as the first. The basal nervure is strongly arched as in *Halictus*.

The new genus approaches *Binghamiella,* but the hair is not conspicuously plumose. The mouth-parts are undoubtedly collectiform, and the bee is, therefore, placed in the Family Colletidae, but it is very unfortunate that no details of the biology are available to assist the taxonomist, for the unique character of the legs and the calcariae leads the author to postulate that the "nest" would not be excavated in the ground after the habit of fossorial bees.

PROTOMORPHA TARSALIS gen. et sp. nov.

Type, Male—Length 7 mm. approx. Black, bright, with much white hair.

Head extremely short, practically circular from the front; face entirely masked with long silvery-white plumose hair; frons shining, close punctures of medium size; a fine carina; clypeus closely punctured, punctures somewhat pyriform; supraclypeal area similar to clypeus (it is difficult to examine); vertex with punctures contiguous; rather large ocelli in a low curve; distance from compound eye to lateral ocellus not quite twice the diameter of the latter; compound eyes converging slightly below; genae striato-punctate with much white hair; labrum a small narrow oval (colletiform), black, polished; mandibulae acute, but bidentate, obscurely reddish, black basally; antennae with short slender scapes, with shallow punctures; flagellum long and filiform, three basal segments shortest, apex acute.

Prothorax not visible from above; tubercles black, with a fringe of long white hair; pleura shining, closely punctured, with much long white hair; mesothorax with many punctures, but shining between; long white hair; scutellum long, polished, with scattered punctures, and long white hair; postscutellum rough, bright, with a low tubercle, and similar hair; metathorax shining, a large area with a few coarse rugae forming deep pits, beyond the area the pits are circular and very much smaller, angles of truncation convex, and produced to a minute tooth, much white hair; abdominal dorsal segments shining, punctures contiguous, posterior margins broadly depressed and somewhat pallid, with fringes of long white hair, ventral segments much contracted, very bright, a few punctures, light fringes of white hair, fifth with a long conspicuous comb of long curved amber setae which extends back over the depressed apical segments which look like those of a female, and somewhat pallid.

Legs very remarkable, black, obscurely brown, some white hair; the anterior coxae very large and femora thick, anterior tibiae with an amber line anteriorly and distally, basitarsus rather narrow; medium femur stout, the basitarsus broader, and black; posterior legs very stoutly formed; femora curved, triangulate, highly polished, and nude on the inner surface; some white hair above; posterior tibiae curved, stout, nude on the under surface, which has a microscopic duller tessellation, the apical third with a conspicuous curved ctenidium of eight spines, the longer calcar forming the ninth; on the upper surface is a lineate grooved area undoubtedly homologous with the corbicula of the hive bee, the white hairs are hardly barbed; the posterior basitarsus is short, triangular, and the deep hollow on the exterior surface is aligned with the corbicula of the tibiae; a small but strong ctenidium distally; the second segment is small but stout; tarsi amber, short, triangular, some golden hair; claws reddish-amber, short, bifid, pulvillus small; hind calcar amber, one very long, curved, practically simple, the other excessively short, and of a compound form of four spines bent at a right angle, and pallid; tegulae polished, black; wings hyaline, iridescent, more angulate than curved; especially the posterior one; nervures brown, the first recurrent entering the second cubital just before its middle, the second recurrent practically meeting the third intercubitus; cubital cells three, the first largest, the second smallest, somewhat contracted at the top, the third almost as long as the first; pterostigma conspicuous blackish; hamuli about eight.

Locality: Caldwell, New South Wales, 21st Dec., 1951, leg. V. Robb.

Type in the collection of the National Museum, Melbourne.

Not close to any described species; a remarkably distinctive bee not to be confused with any other.

EXPLANATION OF PLATE.

1. Adult male bee *Protomorpha tarsalis,* gen. et sp. nov.
2. Genitalia of the male.
3. Lateral view of portion of the head with mouth-parts extruded.
4. Rugose dorsum of the metathorax.
5. The compound calcariae of the posterior leg.
6. Strigilis of the anterior leg of the male.
7. Tarsal segments of the anterior leg.
8. The four stout segments of the labial palpus.
9. Mouth-parts showing the short broad glossa.
10. One of the paraglossae at higher magnification.
11. Pharyngeal plate: the ducts of the pharyngeal gland (marked with an arrow) are very poorly developed.
12. Galea and maxillary palpus much enlarged: note the maxillary comb.
13. The short wide labrum bears a long fimbria.
14. Ventral view of the apical segments of the abdomen to show the long fimbria on the gaster.
15. The stout posterior leg bears a corbicula which also extends to the first tarsal segment.
16. Bidentate mandible of the male.
17. The large punctures of the abdominal terga have many microscopic punctures interspersed.

Corrigendum

Australian Zoologist, Vol. xii, Aug. 1956. Owing to an engraver's error, the block for Nos. 6, 12, 18, 24 (p. 182) was detached from Fig. 3 (Pollen-grains), although the legends for these items appear in their proper sequence below; consequently, as a corollary of the transposition, the block for Fig. 6 (Details of the Bee) included the pollen-grains Nos. 6, 12, 18, 24 without any explanatory legend.

—Tarlton Rayment.

Observations On Some Australian Forest Insects

3. The Biology and Larval Taxonomy of Some Lepidoptera Attacking Trees and Timber.

By K. M. Moore.

(Plates xli-xliii)

SUMMARY.

Lepidopterous larvae which feed on injured or dead tree-tissues and building timbers, usually associated with dampness and rotting, were reared and correlated with their damage. Attack sometimes extended into the truewood, thus making some species of economic importance. Damage is described.

Of those reared, several species of *Barea* (Oecophoridae) predominated, but *Hieroxestis omoscopa* Meyr. and *Tinea diaphora* Meyr. also occurred. The habits of *Barea consignatella* Walk., the type species of *Barea,* are probably representative of the whole genus. The distribution, hosts, larval habits, and some parasites of this species are recorded. Distinguishing features of this and other species of wood-destroying larvae are compared and their last instar larvae are described. The distribution, hosts, parasites, and some habits of other species are given. Observations on a parasite (Bethylidae) are recorded.

Adults, larvae, larval setal maps and pupae are figured.

INTRODUCTION.

Reports of damage to trees and constructional timbers by lepidopterous larvae during the years 1953 to 1956 (years of abnormally high rainfall) were referred to the author. Larvae and pupae of various species were received, accompanied by details of attack on ornamental, forest, and fruit trees, fence posts, rails and palings, stacked timber, joists, bearers, and flooring of houses and verandahs.

Damage of this kind had not previously been recorded in the literature. As early attempts to rear the larvae to the adult stage in the laboratory were unsuccessful, field investigations were commenced to discover the species responsible and details of their biology.

The species dealt with in this paper are primarily forest insects, and because they damage constructional timbers, fencing, posts, poles, etc., they may be of some economic significance. Dead limbs, stumps, or areas of injury on living trees are also subject to attack. It soon became evident that several species were concerned, and, although only limited observations were possible, some of the species have been correlated with the damage they cause.

Most of the larvae which were reared to the adult stage confined their attacks to sapwood, but truewood was sometimes attacked, despite the presence of sapwood. Wood in damp situations appeared favourable to most larvae, but apparently the species do not all require dampness in the wood during their later instars. Most of the species studied were found feeding in secluded positions, often in proximity to the ground where grass, weeds, or debris reduced the light intensity, or under the bark of damaged areas on trees. It was found that in such situations moisture was retained and injured tree tissues tended to decompose. These factors probably encouraged or increased the extent of the attack.

SPECIES REARED FROM TREES AND TIMBER.

Of those larvae reared by the author, species of the genus *Barea* (family Oecophoridae) predominated, and it appears that attack on both living and dead trees, shrubs, or timber by their larvae is a characteristic of the genus. Specimens of the Tineidae were reared in or on the sapwood of commercial timbers or on forest trees, and specimens of the Lyonetiidae were reared on a wide range of hosts.

The following species were reared:

OECOPHORIDAE

Barea consignatella Walker 1864.
B. confusella (Walker) 1864.
B. banausa (Meyrick) 1883.
B. turbatella (Walker) 1864.
B. melanodelta (Meyrick) 1883.
B. asbolaea (Meyrick) 1883.
Barea sp., near *epethistis* (Meyrick) 1902.
Philobota vilis Turner 1944.

TINEIDAE

Tinea diaphora Meyrick 1892.

LYONETIIDAE

Hieroxestis omoscopa Meyrick 1892.

(1) OECOPHORIDAE.

Prominent morphological features of this family are the long, ascending labial palpi which curve upwards between the compound eyes, close to the head, extending beyond its dorsal aspect, and the mottled colour patterns on the forewings together with the plain colour of the hindwings.

Peterson (1951) records that the feeding habits of the larvae of this family vary considerably, that they may be found on foliage, terminals, and blossom heads of both wild and cultivated shrubs and trees, or they may roll leaves, or web foliage together. Other species are found in decayed wood, stored products, etc. Imms (1948) records some species as feeding among seeds.

According to McKeown (1945), over 1,500 species (more than half the known species of this family) have been recorded from Australia. They web together foliage, make cases, or act as scavengers in birds' nests. Mr. I. F. B. Common (personal communication) mentions that there are now 2,251 described species indigenous to Australia, with possibly another 1,000 species still to be discovered.

The Genus *Barea.*

This genus is widely distributed in Australia, species being found in all States, including Tasmania (Tillyard 1926). Three species are known to occur in Western Australia (Turner 1896). It is confined to Australia except for three species occurring in New Zealand, one of which is indigenous and two introduced (Turner 1935).

Although all the species reared were from the coastal area of N.S.W., species of this genus have been recorded from Mt. Kosciusko, and Barrington Tops (5,360 ft.).

B. hyperarcha Meyrick 1888, with a wing-span of 31 mm. to 38 mm. for the male, is apparently the largest species of the genus. The various species are often similar in appearance. Common (personal communication) says: "Many species in the genus are difficult to separate, and my identifications in some cases have not so far been checked by making genitalia mounts."

Meyrick (1883), referring to larvae of the genus *Phloeopola (Barea),* says: "There is considerable reason to suppose that the larvae feed in bark or dead wood."

(A) *Barea consignatella* (Pl. xliii, fig. 20)

This species was the most widespread and numerous in the genus *Barea* and is therefore dealt with here more fully than the other species. The adult is apparently one of the largest of the genus, the female having a wing-span of up to 32 mm., while the male is slightly smaller.

DISTRIBUTION.

B. consignatella is apparently confined to eastern Australia, specimens being recorded from the coastal area, the Great Dividing Range to an approximate altitude of 3,000 feet, and westward as far as Canberra, A.C.T. (approximately 83 miles in a direct line inland from the coast; altitude 1,840 ft.), and Toowoomba, Queensland (90 miles inland; altitude 2,000 ft.).

HOSTS.

The following hosts are known to the writer: *Eucalyptus saligna* J. E. Smith (Sydney blue-gum), *E. acmenioides* Schauer (white mahogany), *Casuarina torulosa* Aiton (rose she-oak), *Angophora intermedia* A. P. de Candolle (rough-barked apple), *Podocarpus dacrydioides* A. Richard (Kahikatea or New Zealand white pine).

BIOLOGY.

Oviposition occurs within a few days of the emergences of the adult females, during the months of October to January.

The egg (Plate xlii, fig. 10) is approximately 0.5 mm. in length and 0.25 mm. to 0.3 mm. in diameter. It is white and translucent, the surface being marked with minute longitudinal striations which culminate in projections on the rim of the chorion surrounding the operculum.

The habits of the larvae are probably typical of all the larvae in the genus *Barea*. The following label data on an adult male specimen of this species in the collection of the C.S.I.R.O., Canberra, "emerged 22 October 1956, ex rotting sapwood. I.F.B.C.," and the label data mentioned under *B. confusella*, are the only references located by the writer to the feeding habits of the *Barea* spp.

Three adult specimens which emerged by 9 December 1953 were the first of this species to be bred by the writer. The larvae were collected on 28 June 1953 in rotting hardwood at Strathfield (Sydney).

The larvae ((Pl. xliii, fig. 21) are creamy-white to pale grey in colour during the early instars, becoming darker as they approach metamorphosis. The alimentary tract is clearly visible, and the various body segments may be differentiated by the folding of the exoskeleton, which gives the appearance of darker creamy-white bands between the segments. These bands and the alimentary tract become less noticeable later, because of the darkening of the larvae.

The workings of *B. consignatella* are apparently confined to the sapwood, and larvae may eventually work as deep as 2 in. below the timber surface, excavating passages slightly larger than their own diameter, usually longitudinally with the grain of the timber. They feed in separate galleries, which may be numerous in the attacked area, and workings of these larvae are sometimes found with those of other species of the same genus, or other families of the Lepidoptera. A loose webbing which is spun by the larvae, and to which their excreta becomes attached, covers the entrances to their workings during the later instars. Strands of silk and excreta also hang from the webbing. This covering is apparently of doubtful protection against attacks by parasites, as species of Hymenoptera and Diptera have been reared from larvae of *B. consignatella*. The larvae, during their later instars, keep the workings free of excreta by voiding it at the entrances. They are aggressive when disturbed, twisting and moving forward or backward violently and endeavouring to attack with their mandibles.

Larvae have often been found in building timbers in damp situations close to the ground or in shaded areas, fallen branches, or trees and timber lying in contact with the soil where moisture would be retained, dead stumps, and fence posts or palings. Although these sites are apparently preferred, last instar larvae have been found feeding at three feet above ground-level in a stump of *E. saligna* at Lisarow, N.S.W. No moisture was evident in the area from which they were collected. Larvae were collected at Merrylands (Sydney) on 16 August 1956 in lining boards of *Podocarpus dacrydioides*. These boards, removed from a building because they were heavily attacked by larvae of *Anobium punctatum* deGeer (common furniture borer), and left lying exposed to rain and in contact with wet soil, were attacked by larvae of *B. consignatella*. These larvae appear to be most numerous during seasons of high rainfall or excessive humidity.

Larvae from a single collection from the same host varied in length from 27 mm. to 40 mm. The species may usually be recognised by the prothoracic segment or the exuviae of the last instar larva which is often found near the pupa or attached to its posterior segments. Pupation occurs in the tunnels constructed by the feeding larvae. The length of the pupa (Plate xlii, figs. 11, 12, and 13) is approximately 11 mm., width 4 mm. It is light brown at first, deepening to dark red-brown prior to the emergence of the adult.

Apparently there is one generation of *B. consignatella* each year.

PARASITES.

(i) Hymenoptera. Wasps of the family Ichneumonidae, *Pimplopterus* sp., also an undetermined species of that family, and a species of the family Chalcididae, probably *Brachymeria* sp., were bred from larvae.

(ii) Diptera. Flies of the family Tachinidae, Meigeniini, the species of which has not yet been determined, were also bred from larvae.

(iii) Fungus. Pupae infected with *Cordyceps* sp. (F. Hypocreaceae) (Pl. xliii, fig. 24) were collected at Lisarow. Members of the genus *Cordyceps* are parasitic on larvae and pupae of many species of the Lepidoptera.

Description of last instar larva (Plate xli, fig. 1).

Length, approximately 40 mm. General colour varies from a steel-grey to a creamy- or pinky-grey. Prolegs on abdominal segments 3 to 6 and 10. Head capsule (Plate xlii, fig. 14), bearing six ocelli (Plate xli, fig. 6), is dark red-brown; mandibles almost black.

Pro-thoracic segment. A dark red-brown to black transverse band approximately three-fourths the width of the segment, is divided longitudinally by a narrow cream mid-dorsal line. The band extends to below the spiracle, and is marked from its posterior edge near the spiracle by a thin cream-coloured curved line which gradually narrows to its anterior extremity. This line extends across approximately three-quarters of the width of the band. An elongate dark area with two setae near its anterior apex is above the base of the leg. Legs with brown markings; the anterior narrow brown basal mark almost black, the posterior brown.

Meso-thoracic segment. A large dark area bearing four setae anteriorly is below the mid-dorsal line. On the anterior margin of the segment is a narrow, transverse dark area. Two smaller spots are longitudinally below the large area, the anterior spot bearing two setae, the posterior a single seta. A small dark area with two setae near its centre is above the base of the leg. Leg-colouring as for the previous segment.

Meta-thoracic segment. Two dorsal dark areas each bearing two setae are placed transversely from the mid-dorsal line. Anterior to the lower area and on the edge of the segment is a narrow transverse dark area. Beneath the lower area are two smaller spots placed longitudinally, the anterior spot bearing two setae, the posterior a single seta. A small dark area with two setae near its centre is above the base of the leg. Leg-colouring as for the previous segments.

Abdominal segments 1 and 2. Two spots each bearing a single seta are near the mid-dorsal line, the larger near the anterior border, the smaller near the posterior border of the segment. A dark area encircling a single seta is above, and a spot with two setae below, each spiracle. Near the ventral posterior margin of the segment is a spot with a single seta, and two spots are placed transversely from the mid-ventral line, the nearer one bearing a single seta, the larger, three setae.

Abdominal segments 3 to 6. Dorsal and lateral spots as on abdominal segments 1 and 2. An elongate dark area with two setae is on the base of each proleg laterally. On most specimens this area extends to surround the seta anterior to each proleg.

Abdominal segment 7. Dorsal and lateral spots as on abdominal segments 1 to 6. Two small spots are placed transversely from the mid-ventral line, the nearer one bears a single seta, the larger, two setae.

Abdominal segment 8. Dorsal and lateral spots as on abdominal segments 1 to 7. Three small spots, each with a single seta, are placed transversely from the mid-ventral line.

Abdominal segment 9. The dorsal aspect of this segment is approximately half the width of the other abdominal segments. Two dorsal spots, each with a single seta, are placed transversely from the mid-dorsal line near the posterior margin, and anterior to the area between these spots is another spot with a single seta. A similar spot with two setae is below the group of three spots. Three small spots, each with a single seta, are placed transversely from the mid-ventral line.

Abdominal segment 10. The dorsal aspect of this segment is modified to form a dark red-brown to black plate. There is a ventral pair of prolegs, each with an elongate dark brown area laterally, and a narrow crescentic area with two setae across the base anteriorly. A curved dark area with two setae is anterior to each proleg.

Larvae are in the collection of the Forestry Commmission of N.S.W.

(B) *Barea confusella.*

This species appears to be almost as numerous and widespread as *B. consignatella* and is of importance because of its wide host-range, and the fact that the larvae attack both the sapwood and the truewood of constructional timbers.

Female adults of this species have a wing-span of approximately 24 mm. The male is slightly smaller. The forewings are mottled in the manner typical of the *Barea* species, the colours being black and cream, the cream varying to almost white in some specimens. The hind-wings are shiny and deep cream in colour.

DISTRIBUTION.

Walker (1864) records the species from Sydney and Moreton Bay, while Meyrick (1883) gives the distribution as Sydney and Melbourne, later (1888) adding Newcastle, N.S.W.

Adults were reared by the author from larvae collected at Coff's Harbour, Lisarow, Fivedock (Sydney), Auburn (Sydney), and Rozelle (Sydney). From label data supplied by Common (May 1957) the following distribution in N.S.W. is recorded: Glen Innes (3,520 ft.), Canberra, Richmond River, Ebor, Niagara Park, and Gosford.

HOSTS.

The larvae taken at Coff's Harbour on 2 July 1956 were collected and reared in the stems of stored dahlia bulbs, while those collected at Fivedock on 18 October 1956 were feeding in rotting *Tristania conferta* R. Brown (brush box). Larvae collected at Auburn on 29 August 1956 were attacking *E. pilularis* J. E. Smith (blackbutt), and the specimens collected at Rozelle on 1 August 1956 were taken on a damaged area at the base of an apricot tree.

Specimens were reared at Lisarow in the thick rough bark of a living tree of *Angophora intermedia,* and larvae were collected at Epping on 3 June 1956 on *Cassia bicapsularis* Linnaeus, and reared to adults.

BIOLOGY.

The larvae are translucent and pale cream in colour during their early instars, later changing to a deep cream colour. The cream bands between the segments are visible as early as the first instar and are more noticeable in the later instars than those in the later instars of *B. consignatella.*

Damage by the larvae of *B. confusella* is not confined to the sapwood, and considerable damage to the truewood of *E. pilularis* was observed. There was no moisture evident in this timber sample when it was received, or apparently for some time previously, but the piece of timber was taken from the external end of a verandah floor-board which had been exposed to rain.

Silk webbing, to which excreta are attached, covers the entrances to their larval workings. A thick, shiny silken tunnel is sometimes constructed on the timber surface or in damp soil beneath timber. Larvae do not appear to require damp situations, as reared specimens were able to develop successfully without the presence of apparent moisture. Those collected and reared at Lisarow were taken at five feet above ground-level where no moisture was evident.

Considerable variation was found in the length of larvae taken from the one host. The species may sometimes be identified by the pro-thoracic segment of the last instar exuviae on or near the pupa in the larval workings or on the timber surface, in silken cocoons covered with excreta and debris. The length of the pupa is approximately 8 mm., width 2.5 mm. It is very similar to that of *B. consignatella,* but the abdominal segments are more sharply constricted at the base of the wing-covers.

Meyrick (1883) mentions that this species is "locally common at rest on the trunks of *Eucalyptus,* especially in Sydney parks."

Adult specimens of *B. confusella* in the collection of the Australian Museum bear the label data "ex rotten wood in city building. Bred Australian Museum October-November 1945."

All the adult insects of this species reared by the author emerged during October and November, and label data supplied by Common give collection dates as October to January.

Apparently there is one generation of *B. confusella* each year.

PARASITES.

Wasps, probably of the genus *Eupsenella* (Bethylidae) (Plate xliii, fig. 23) were reared on larvae of either *B. confusella* or a very similar species, collected at Turramurra (Sydney) on 16 July 1956, and others at Lisarow on 19 July 1956.

When collected, the wasp larvae were minute, and judging from observations on their growth rate they had probably been feeding no longer than 24 hours. The larvae were white and translucent, and after feeding for eight or nine days they pupated in white silken cocoons. Two adult specimens emerged 27 days after the spinning of the cocoons, the third adult emerging on the following day. Five larvae of the same species of wasp which were collected at Lisarow took approximately the same time from the early larval stage to the emergence of the adults.

The development of this parasite from eclosion to the adult stage occupies approximately 36 days.

Description of last instar larva (Plate xli, fig. 3).

Length approximately 22 mm. General colour, cream. All markings are paler in colour and more reduced in size than those on *B. consignatella,* and those on the abdominal segments are not clearly visible without magnification. Prolegs on abdominal segments 3 to 6 and 10. Head capsule light brown, mandibles dark brown.

Pro-thoracic segment. A light tan to red-brown transverse band approximately three-fourths the width of the segment is divided longitudinally by a narrow cream mid-dorsal line. The coloured band extends almost to the spiracle, where it is separated by the cream-coloured background from an area of the same colour adjoining the spiracle anteriorly. On the band and antero-dorsal to the spiracle is a paler oval mark, while on the dark area adjoining the spiracle is a series of smaller oval marks in a more or less longitudinal line anterior to the spiracle. The number of these marks appears to be variable, and their function is not known to the writer.

Setae, marks, and spots on the meso- and meta-thoracic, and abdominal segments 1 to 7, are as those on the corresponding segments of *B. consignatella.*

Abdominal segment 8. Near the spiracle is a seta usually in line anteriorly with its highest point. The placement of the remainder of the setae is as for segment 8 of *B. consignatella.*

Abdominal segment 9. The anterior spot in the group of three is nearer to the mid-dorsal line than in *B. consignatella,* and almost in line longitudinally with the higher spot.

Abdominal segment 10. The dorsal plate is light brown in colour. The remainder is as for segment 10 of *B. consignatella.*

Larvae are in the collection of the Forestry Commission of N.S.W.

(C) *Barea banausa.*

Adult female specimens have a wing-span of approximately 25 mm., the males being slightly smaller. The typically mottled forewings are black and gold. The hindwings are shiny and pale grey in colour.

DISTRIBUTION.

Meyrick (1883) gives distribution as Sydney, and Blackheath (3,500 ft.) in N.S.W., Melbourne and Fernshaw in Victoria, and Deloraine in Tasmania. He records (1888) the additional localities in N.S.W. of Newcastle, and Bathurst (2,500 ft.); and Albany in Western Australia. The months when adults were to be found are given as September to November.

All the larvae collected and reared to the adult stage by the author were taken at Lisarow, N.S.W., during August and September 1956. From label data supplied by Common (May 1957) the following distribution is recorded: N.S.W.: Glen Innes (3,520 ft.), Bulli Pass, Niagara Park, Braidwood, Canberra. Victoria: Gisborne and Melbourne. South Australia: Reynella.

BIOLOGY.

Larvae of *B. banausa,* bearing series of black spots, are very similar to those of *B. consignatella* but are smaller and paler in colour. The markings on the pro-thoracic segment permit the identification of the species. Larvae which were reared to the adult stage were taken at Lisarow feeding in the sapwood of a partly-decayed stump of *E. saligna* and in association with larvae of *B. consignatella.* They were approximately three feet above ground-level where no moisture was evident. The working occupied by each species of larva is separate, but workings are contiguous in the same area of sapwood. Larvae of this species usually pupate closer to the timber surface than do those of *B. consignatella,* and they may be distinguished from the latter species by the pupal chamber in the sapwood, very close to the surface, which they line with silk. Damage by this species could not be distinguished from that of *B. consignatella.*

The length of the pupa is 7 mm. to 9 mm., width 2.5 mm. to 3.5 mm. It is very similar to that of *B. consignatella,* but is usually smaller. The adults emerged prior to those of *B. consignatella,* the latter emerging during October, November, and December, the former during August and September, at Lisarow. Numerous adults which had emerged from their pupal cases were taken in the pupal chamber below the timber surface, and at the end of the working farthest from the opening where frass was extruded.

Label data supplied by Common record collection dates as September to November.

There is apparently one generation of *B. banausa* each year.

Description of last instar larva (Plate xli, fig. 2).

Length, approximately 30 mm. General colour and head capsule similar to *B. consignatella.* The six ocelli appear to be in the same position as for that species.

Pro-thoracic segment. A dark red-brown to black transverse band approximately three-fourths the width of the segment is divided longitudinally by a narrow cream mid-dorsal line. The band extends almost to the spiracle, where it is separated by the cream-coloured background from an area of the same colour surrounding the spiracle. On abdominal segments 1 to 7 the supra-spiracular setae are surrounded by a minute black circle joined anteriorly and posteriorly by brown markings (Plate xli, fig. 2), the posterior mark being much reduced on segment 8. Segment 9 is the same as that of *B. consignatella* except that the anterior spot in the group of three dorsal spots is approximately half the size, and the lower approximately one-quarter the size of the highest spot.

The remaining segments are as for *B. consignatella.*

Larvae are in the collection of the Forestry Commission of N.S.W.

(D) *Barea turbatella.*

One male and one female specimen collected at Lisarow during August and September 1956 was reared from *E. saligna* and *E. acmenioides.* In the case of *E. saligna,* sapwood only was attacked, while both the sapwood and the truewood of *E. acmenioides* were attacked. Over the entrances to the workings the larvae construct fine webs to which excreta is attached. Both adult specimens reared by the author emerged on 29 October 1956.

Walker (1864) records specimens from Tasmania, and Meyrick (1883) from Sydney, Brisbane, and Melbourne from September to December. He mentions that adults were principally taken at light.

(E) *Barea melanodelta.*

One female specimen was reared from a pupa collected from rotting hardwood at Lisarow on 25 September 1956. The adult emerged on 4 October 1956.

Meyrick (1883) gives distribution as Brisbane in September and Sydney in December. He says: "I have found, but not succeeded in breeding, a larva found feeding on the bark of *Banksia,* in a loose web among the crevices, which I expected to produce this species."

(F) *Barea asbolaea.*

One pupa was taken in association with *B. confusella* on *Tristania conferta* at Fivedock on 18 October 1956. An adult female specimen emerged from this pupa on 24 October 1956.

Meyrick (1883) gives distribution as Deloraine, Tasmania, in November; and Warragul, Victoria. From label data supplied by Common (May 1957) the following distribution is recorded: Beaconsfield, Victoria (March); Waratah, Strahan, Wilmot, Mt. Wellington (1,500 ft.), and Scottsdale, Tasmania (January and February).

(G) *Barea* sp., near *epethistis.*

One larva was collected under bark in rotting sapwood of *A. intermedia* on 25 September 1956 at Lisarow. This had pupated by 14 November, and the adult emerged on 12 December 1956.

(H) *Philobota vilis.*

Referring to the genus *Philobota,* Meyrick (1883) records: "Wholly confined to Australia. A large proportion, at least, of the larvae must feed on grass, possibly on roots; but I have not hitherto succeeded in finding a single one." According to Common (personal communication), this genus at present is probably a composite of several genera.

One female specimen was reared at Lisarow. The larva collected on 25 October 1956 was taken in a thick, shiny silken tunnel on the under-surface of timber lying in contact with wet soil. The timber appeared to be attacked by the larva, but it was not possible to verify this. Pupation took place in a silken cocoon, and the adult emerged on 17 November 1956.

In his original description of *P. vilis,* Turner (1944) gives distribution as follows—Queensland: McPherson Range (2,500 ft.) in November, Toowoomba in October. From label data supplied by Common (May 1957) the following distribution is recorded:—Queensland: Lamington National Park (3,100 ft.) November and December (2♂♂ including type), Toowoomba (2,000 ft.) October and November, Brisbane November. N.S.W.: Tyringham (17 miles from Dorrigo, 2,396 ft.) December.

(2) TINEIDAE.

Species of the Tineidae are world-wide in distribution. The feeding habits of the larvae appear to be the most diverse of any family in the Lepidoptera. They feed on various dried animal or plant materials, clothing, carpets, furs, feathers (Imms 1948); lichens, animal hair or wool (McKeown 1945). Three species which construct mines in the leaves of *Eucalyptus* spp. have been reared by the author.

Tinea diaphora (Pl. xliii, fig. 22)

The adults of this species have a wing-span of approximately 16 mm. The forewings are of a dark velvety brown colour on the costal area, and banded on the dorsum and apex with a broad irregular whitish area, suffused with yellow and grey towards the apex. The hindwings are uniformly silvery-grey in colour.

DISTRIBUTION AND HOSTS

Specimens in the collection of the Department of Agriculture, Sydney, were collected at Mt. Drummond, near Wollongong, N.S.W., under the bark of a eucalypt. The adults were bred from cocoons held in an incubator, and they emerged during the month of September.

A larva was collected at Miranda (Sydney) on 13 July 1956 at the rotting base of a "smooth-barked gum tree" and others at Ourimbah State Forest attacking a dead branch of *Cryptocarya microneura* Meissn. (murrogun, or brown jack).

At Lisarow larvae were collected on 18 October 1956 under the bark of dead *Acacia decurrens* Willdenow (black, or Sydney green, wattle), and reared to the adult stage. Others were reared on *Angophora intermedia* which had been felled approximately nine months previously. Many young larvae were taken during March to July 1957, feeding on the internal face of dead bark and sapwood of *E. saligna* which had been severely fire-damaged three months previously. Larvae were 10 mm. in length on 12 July 1957.

Meyrick (1892) records the following collection sites: Sydney, N.S.W.; Melbourne, Victoria, from October to January.

From label data supplied by Common the following distribution is recorded:—A.C.T.: Canberra (January). Queensland: Lamington National Park (December), Mt. Tamborine (November), Brisbane (October), Eumundi (November).

Label data on adult specimens in the collection of the Australian Museum record specimens from the following places:—N.S.W.: Port Macquarie (November), Sydney (December), Killara (November), Allyn River (December), Narrabeen (November).

BIOLOGY.

Larvae bear pale coloured bands between the segments, and superficially resemble some species of the genus *Barea*.

The larvae of this species were observed to feed either in workings or on the surface of sapwood beneath loose bark, or on the internal surface of bark during their later instars. During their early instars they appeared to feed solely on a fungus growing on the inner bark surfaces or sapwood. They were covered by a thin silken webbing to which excreta were attached, or were found in thick silken tunnels covered with excreta, on the wood or bark surfaces. At Miranda, moisture was apparently evident in the area where they fed, but this was not always so at Lisarow.

Larvae and pupae were collected during October, and adults emerged from late October to the end of December. When preparing to pupate, or if they are parasitised, the larvae spin silken cocoons either on the timber or the inner bark surface, and attach to the cocoons excreta or fragments of wood or bark.

Meyrick (1892) refers to the larvae as feeding "on dead wood of *Eucalyptus* between loose pieces, spinning a good deal of web, mixed with refuse, in August and September. Adults not uncommon on *Eucalyptus* trunks."

The length of the pupa (Plate xlii, figs. 15 and 19) is approximately 8 mm., width 3 mm. It is at first pale yellow in colour, becoming dark brown prior to the emergence of the adult.

There is apparently one generation of *T. diaphora* each year.

PARASITES.

An undetermined species of wasp of the superfamily Chalcidoidea has been reared from immature larvae of this species during May and June.

Description of the last instar larva (Plate xli, fig. 4).

Length, approximately 17 mm. General colour, creamy-white. Head capsule and mandibles light to dark tan, ocelli as in fig. 8. Prolegs on abdominal segments 3 to 6 and 10.

Pro-thoracic segment. A tan to dark brown transverse band approximately three-fourths the width of the segment, is divided longitudinally by a narrow cream mid-dorsal line. The band extends to below the spiracle and is marked from its posterior margin above the spiracle by a cream-coloured angular line narrowing to its anterior extremity almost at the anterior margin of the band. A small dark area with two setae near its centre is above the base of the leg. Legs bear brown lateral markings, their bases narrow anterior and posterior markings, the anterior mark being dark, the posterior often indistinct. A dark transverse area is on the edge of the segment posterior to the legs and is produced anteriorly towards the area between the legs with its apex reaching the posterior aspect of their bases.

Meso-thoracic segment. A variable dark area with three setae is below the mid-dorsal line. A narrow transverse dark area is on the anterior edge of the segment. Two small dark areas are below the large dark area, the anterior and smaller sometimes indistinct and with two setae, the posterior with a single seta on its ventral margin. An indistinct, small dark area with a single central seta is above the base of the leg. Leg-colouring as for the previous segment There is no ventral brown area posterior to the legs.

Meta-thoracic segment. Markings are less distinct than those on the previous segments. A group of four lateral pale brown areas each with a single seta are on this segment. Anterior to these, on the border of the segment, is a narrow transverse darker brown area. A small indistinct area with a single central seta is above the base of the leg. Leg-colouring as for the previous segments. There is no ventral brown area posterior to the legs.

Abdominal segments 1 and 2. No dark areas on abdominal segments 1 to 9. A single dorsal seta is on the anterior half of the segment near the mid-dorsal line, in line transversely with the spiracle. One seta is near the spiracle and one below on the anterior half of the segment, with single corresponding setae longitudinally opposite each of these on the posterior half of the segment. There are four ventral setae; one primary seta on the posterior half of the segment and one primary seta between two secondary setae on the anterior half and nearer to the mid-ventral line.

Abdominal segments 3 to 6. Dorsal and lateral setae as on segments 1 and 2. A ventral primary seta is on the posterior half of the segment postero-laterally to the base of the proleg. Three secondary setae are on the base of the proleg laterally, and one anteriorly near the mid-ventral line.

Abdominal segments 7 and 8. Setae as those on abdominal segments 1 and 2.

Abdominal segment 9. Two primary and two secondary lateral setae alternately, in a central transverse row. One ventral primary seta between two secondary setae on the central transverse line, with an isolated secondary seta on that line near the mid-ventral line.

Abdominal segment 10. The dorsal aspect of this segment is modified to form a pale brown plate with four setae each side. A pair of prolegs each bear a lateral brown area with two setae. Two groups, each of three secondary setae in the form of a triangle, the apex being nearest the crochets in the anterior group, but farthest from the crochets in the posterior group, are on the prolegs.

Larvae are in the collection of the Forestry Commission of N.S.W.

(3) LYONETIIDAE.

Apparently little is known concerning the feeding habits of the larvae of this family except that most of the species are leaf-miners (Tillyard 1926).

Adults are mostly small in size.

Hieroxestis omoscopa (Pl. xliii, fig. 22).

Meyrick (1892) erected the genus *Hieroxestis,* in which he placed *omoscopa.* Concerning the genus he comments: "This curious genus stands so far isolated from other Australian forms that, taking into consideration its mode of feeding, I have suspected it to be an introduction from another region; however, I know no evidence of its occurrence elsewhere. It is allied to the *Tinea* group but has undergone great modification."

The adults of this species are small, dark brown moths with a wing-span of approximately 20 mm. The forewings are long and narrow, shiny, and brown to almost black in colour, the hindwings and the wide cilia being shiny and of a buff colour. The males have a variable number of cream-coloured spots near the centre of the dorsum and near the base or the apex of the wings.

DISTRIBUTION AND HOSTS.

Larvae attacking wood were first observed by the writer during July 1955.. They were in stacked hardwood and a fence of hardwood in the yard of a Sydney firm. The timber was exposed to rain, and the samples submitted were very wet. Larvae and pupae of this species were collected at Lisarow on 24 September 1956, feeding in the stalks and on the decaying remains of *Sida rhombifolia* Linnaeus (Paddy's lucerne), which had been cut some months previously. A large stone had been rolled on to these cut plants, and considerable moisture was retained beneath it.

During August 1956 larvae were collected at Merrylands (Sydney), feeding in association with *B. consignatella* in the *Podocarpus dacrydioides* lining-boards previously mentioned. Larvae feeding on pieces of damp, rotting *Eucalyptus grandis* Maiden (rose-gum) were collected at Roseville (Sydney) during July 1956.

Larvae attacking *E. saligna* were collected at Lisarow during June 1956. Last instar larvae, collected at Seven Hills on 21 May 1957 and found at the base of rhubarb plants were stated to be damaging the crowns. Larvae were collected at about 2 inches below soil level at Lisarow on 16 July 1957. They were found among young corms attached to the older corm of a *Gladiolus* sp. left in the ground from the previous season. They appeared to be feeding on the old corm. During July 1957 larvae were collected at Lisarow feeding on and in the decaying stems of *Amaranthus hybridus* Linnaeus (Prince of Wales' feathers), and larvae were collected during the same month at Lisarow attacking the flower-ends of mature *Cucurbita pepo* Linnaeus (pumpkin) which had been lying in contact with the soil. On 23 June 1956, last instar larvae were collected at Lisarow feeding on rotting *Pteridium aquilinum* Kuhn. (bracken fern).

Meyrick (1892) writes concerning the adult: "It has been bred from larvae feeding on sheets of cork." The distribution is given as Sydney and Newcastle.

From label data on specimens in the Australian Museum the following distribution is recorded:—Sydney, September 1911, 1912, 1913, and 1917; December 1919 and 1932, and January 1911; and from label data supplied by Common:—N.S.W.: Sydney; Queensland: Brisbane, Gympie.

BIOLOGY.

Oviposition occurs soon after the adults have emerged, and probably extends over some weeks, as larvae of all instars, and pupae, have been collected at the one time from the one feeding-site. The egg, approximately 0.3 mm. in length, is smooth, shiny, and ovoid. It remains translucent and almost white in colour from oviposition to eclosion. Embryonic development is evident about the fifth day, and enclosion occurs from 10 to 12 days after oviposition. The chorion is not consumed by the young larvae, which, before feeding, are transparent and almost colourless.

Larvae of this species have been collected in association with those of *Barea* spp. or with species of the family Pyralidae. In all instances they were found in areas of dampness such as among decaying vegetable matter or under boards, usually in contact with the soil.

Pupation occurs in silken cocoons composed of fine webbing and excreta, either in the workings in timber, in stems of weeds, grass, etc., or externally on the surface. Pupation occupies approximately 25 days during June at Lisarow. The cocoons are usually covered with particles chewed from the host plant. The pupal shell is protruded for approximately two-thirds of its length from the cocoon when the adult is emerging.

During the warmer months of the year at Lisarow the approximate time taken for the life-cycle from oviposition to the emergence of the adult is 10 to 12 weeks, but during the colder months the period occupies approximately four months.

The length of the pupa (Plate xlii, figs. 16, 17, 18) is approximately 10 mm., width 2.5 mm. It is at first pale yellow in colour, becoming dark brown prior to the emergence of the adult.

Meyrick (1892) records adults "from June to December, sometimes common on fences near houses." Adult specimens have been collected at Lisarow during the months of June to November, and February to April, while label data supplied by Common give collection dates as May, and July to December in Brisbane.

More than one generation of *H. omoscopa* occurs each year. No parasitism of this species by other insects was observed.

A larva being reared at Lisarow was infected by a fungus, *Vermicularia* sp. (Family Melanconiaceae), a genus containing entomogenous fungi.

Description of last instar larva (Plate xli, fig. 5).

Length, approximately 20 mm. Colour, very pale grey, almost transparent in all instars. Head capsule and mandibles dark red-brown, yellow laterally. Head capsule flattened dorso-ventrally, with a single ocellus (Plate xli, fig. 9); mouthparts prognathous. Prolegs on abdominal segments 3 to 6 and 10. The integument bears numerous micro-setae except where the darker markings occur. On living specimens the darker coloured spots on the abdominal segments are translucent.

Pro-thoracic segment. A dark brown transverse band, approximately three-quarters the width of the segment, is divided longitudinally by an indistinct mid-dorsal line. Paler brown anterior and posterior areas reach almost to the margins of the segment. The coloured band extends almost to the spiracle, where it is separated by the lighter coloured background from an area of the same colour and width surrounding the spiracle. A dark area with two setae near its centre is above the base of the leg. Brown ventral areas are anterior and posterior to the bases of the legs. Legs with brown markings; their bases with narrow black markings anteriorly, dark brown posteriorly.

Meso-thoracic segment. Two large brown areas, paler anteriorly, each with two setae, placed transversely from the mid-dorsal line. A narrow transverse brown area is anterior to the lower of these areas. Two brown lateral areas, the anterior with two setae, the posterior and larger with a single seta, are longitudinally in line with the spiracle of the pro-thoracic segment. A dark area with a single seta near its centre is above the base of the leg. Leg-colouring as for the previous segment.

Meta-thoracic segment. Two brown areas each with two setae are placed transversely from the mid-dorsal line; a spot with a single seta is anterior to the higher, and one with two setae anterior to the lower area. Two brown lateral areas, the anterior with two setae, the posterior a single seta, are longitudinally in line with the abdominal spiracles. A dark area with a single seta near its centre is above the base of the leg. Leg-colouring as for the previous segments.

Abdominal segments 1 and 2. Two pale brown spots of approximately equal size, each with a single seta, are placed longitudinally near the mid-dorsal line. Below these, two lateral brown spots anterior to, a small brown triangle above, and a spot posterior to the spiracle, each with a single seta. Two ventral spots, the lower with a single seta, the other with three setae, are placed transversely from the mid-ventral line. Posterior to the latter is a spot with a single seta.

Abdominal segments 3 to 6. Dorsal and lateral markings as on abdominal segments 1 and 2. A ventral spot with a single seta is postero-laterally to each proleg.

Abdominal segments 7 and 8. Dorsal and lateral spots as on abdominal segments 1 to 6. Two ventral spots placed transversely from the mid-ventral line, the lower with a single seta, the other with two setae. Postero-laterally to the latter is another spot with a single seta.

Abdominal segment 9. This segment is approximately half the width of the previous segments. Two brown spots closer to the mid-dorsal line than those on abdominal segments 1 to 8. A series of four spots placed transversely, the two upper and the lower with a single seta, the other with two setae. Two ventral spots placed transversely from the mid-ventral line, each with a single seta.

Abdominal segment 10. The dorsal aspect of this segment is modified to form a shiny brown plate. A pair of prolegs, each with an elongate, curved, postero-lateral dark brown area, and two pale brown spots anteriorly.

Larvae are in the collection of the Forestry Commission of N.S.W.

CONCLUSION

Larvae of the species studied feed in or on timber, in or under the bark of trees, or among decaying vegetable matter.

Attack by most of these larvae appears to be associated with shaded and damp situations, often near the ground, and damaged or rotting areas on trees and shrubs. They are partly protected by the webbing and excreta which cover the entrances to their workings and pupation sites.

The elimination of dampness would probably reduce attack by some of these larvae.

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REFERENCES.

1864 Walker, F., "List of the Lepidopterous Insects in the Collection of the British Museum." Pt. 29.

1883 Meyrick, E., "Description of Australian Micro-Lepidoptera IX, Oecophoridae." Proc. Linn. Soc. N.S. Wales 8:320-383.

1888 Meyrick, E., "Descriptions of Australian Micro-Lepidoptera XV, Oecophoridae." Proc. Linn. Soc. N.S. Wales 3:1563-1703.

1892 Meyrick, E., "Descriptions of Australian Micro-Lepidoptera XVI Tineidae." Proc. Linn. Soc. N.S. Wales. 7 (4) (2nd Ser.):537.

1896 Turner, A. J., "Descriptions of Micro-Lepidoptera from Queensland." Trans. R. Soc. S. Aust. 20 (1):17.

1902 Meyrick, E., "Descriptions of New Species of Lepidoptera (Oecophoridae)." Trans. R. Soc. S. Aust. 26 (2):154.

1926 Tillyard, R. J., "The Insects of Australia and New Zealand." 424 pp. Angus & Robertson, Sydney.

1935 Turner, A. J., "Revision of Australian Lepidoptera, Oecophoridae, IV." Proc. Linn. Soc. N.S. Wales 60 (5-6):315-339.

1944 Turner, A. J., "Revision of Australian Lepidoptera, Oecophoridae, XII." Proc. Linn. Soc. N.S. Wales 69:264.

1945 McKeown, K. C., "Australian Insects." 250 pp. Roy. Zool. Soc. N.S.W., Sydney.

1948 Imms, A. D., "A Textbook of Entomology." 448 pp. Methuen & Co., London.

1951 Peterson, A., "Larvae of Insects." 1:95. Edwards Bros., Michigan, U.S.A.

EXPLANATION OF PLATE xli.

(Setae not drawn to scale).

1. Setal map of last instar larva of *Barea consignatella* Walk.
2. Pro-thoracic segment of *Barea banausa* Meyr.
3. Pro-thoracic segment of *Barea confusella* Walk.
4. Thoracic segments of *Tinea diaphora* Meyr.
5. Setal map of last instar of *Hieroxestis omoscopa* Meyr.
6. Ocelli of *B. consignatella.*
7. Ocelli of *B. confusella.*
8. Ocelli of *T. diaphora.*
9. Ocellus of *H. omoscopa.*

EXPLANATION OF PLATE xlii.

(All magnifications approximate only).

(Setae not drawn to scale).

10. Egg of *Barea consignatella* Walk. (x 95).
11. Pupa of *B. consignatella,* ventral aspect (x 5).
12. Pupa of *B. consignatella,* dorsal aspect (x 5).
13. Pupa of *B. consignatella,* lateral aspect (x 5).
14. Position of setae on head capsule of *B. consignatella.*
15. Pupa of *Tinea diaphora* Meyr., ventral aspect (x 7).
16. Pupa of *Hieroxestis omoscopa* Meyr., ventral aspect (x 6).
17. Pupa of *Hieroxestis omoscopa* Meyr., dorsal aspect (x 6).
18. Pupa of *Hieroxestis omoscopa* Meyr., lateral aspect (x 6).
19. Pupa of *T. diaphora,* lateral aspect (x 7).

EXPLANATION OF PLATE xliii.

20. Adults of *Barea consignatella* Walk. (male and female).
21. Larvae of *Barea consignatella* Walk.
22. Adults of *Tinea diaphora* Meyr. (left), and *Hieroxestis omoscopa* Meyr (right).
23. Larva of *Barea confusella* (?) attacked by larvae of *Eupsenella* (?) sp. (Hymenoptera, Family Bethylidae).

    Photo—R. Moulton.
24. Pupae of *B. consignatella* infested with fungus (*Cordyceps* sp.)

    Photo—R. Moulton.

Badamia exclamationis Captured in the Sydney District

By L. Courtney Haines.

The skipper butterfly known as *Badamia exclamationis* Fab., 1775, is a species commonly occurring in the islands of Torres Strait and northern parts of Australia.

Enormous eruptions of the butterfly occur in certain seasons, and it has been recorded that countless thousands pass over for days on end. This migrational tendency is usually from south to north.

Badamia exclamationis is exceedingly rare as far south as Sydney, and until recently only four specimens had been caught. It is therefore of interest to place on record another capture for Sydney of this northern species.

Whilst watching butterflies hovering about Buddlia bushes on 21st March, 1958, in my garden at Haberfield, I was surprised to see a large dingy coloured skipper alight on the Buddlia flowers and begin to probe for nectar.

Hurriedly finding my net, I hit at it and missed, but fortunately it quickly returned to the flowers, and with my next sweep I succeeded in taking it. On examination, the captive proved to be a male *Badamia exclamationis* in fairly good condition, with the exception of a small piece torn from the right hind-wing. It would appear that this is the fifth specimen taken in the Sydney District, and the sixth capture for New South Wales. The other five specimens are in the late G. A. Waterhouse s collection now housed in the Australian Museum. The data on their labels are as follows:—

Hornsby, N.S.W., 19th February, 1936. Tom Guthrie, 2 specimens.
Waverley, N.S.W., no date. G. A. Waterhouse. 2 specimens.
Richmond River, N.S.W., 27th April, 1901. G. A. Waterhouse. 1 specimen.

Book Review

"A Reclassification of the Order Odonata." By F. C. Fraser. Royal Zoological Society of New South Wales, Sydney, November 27, 1957, pp. 1-133, frontisp. graph showing origin and descent of the order Odonata, 62 text figures, bibliography and index. Obtainable from the Hon. Secretary of the Society, 28 Martin Place, Sydney, N.S.W. Price 12/6. (Plus postage).

This comprehensive study of the Odonata of the world has provided entomologists with a basis on which to work on this group in their respective countries and should prove an invaluable work of reference to systematists and workers everywhere who are interested in these insects.

This monograph is based on new interpretations of the venation of the dragonfly wing and the evolution of the dragonflies, and fossil forms from various countries have been considered at some length.

The author, since his previous work in association with the late Dr. R. J. Tillyard (Aust. Zoologist 9, 1938-1940), has had the opportunity of studying the wing venations of the fossil forms (figured and described by Carpenter) from the fossil beds of Oklahoma and later those of Arkansas (1939-1947). Apart from their fossil history, the author has been able to trace what he believes to be the true courses of the subcostal and anal veins in the Odonata, by studies carried out on a great number of wings of recent species; all of which studies have tended to show that the narrowing of the dragonfly wing has been a progressive process which has eliminated the two marginal veins and fused others.

One new superfamily and seven new subfamilies have been erected. Keys to the orders, suborders, families and subfamilies are given, and the genera included in the subfamilies, together with their world distribution are listed.

Specialists, and entomologists in general, will welcome this monograph and the author is to be commended on its publication.

—E.H.Z.

New Genera and Species of Odonata from Australia in the Dobson Collection

By Lieut.-Col. F. C. Fraser, I.M.S. Retd.

(Text-figures 1-4.)

Mr. Roderick Dobson, who has recently retired from Australia, has loaned me the part of his collection of Odonata containing the still undetermined species and others of which he is in some doubt as to his own determinations. Along with these he has also sent an interesting nymph collected in North Queensland by that keen coleopterist Mr. E. Adams, which I have since determined as belonging to *Antipodogomphus proselytus* (Selys in Martin).

The collection has furnished some interesting surprises, the most valuable acquisitions to the Australian fauna being two new genera of the *Corduliidae*. An extraordinary richness in the family *Corduliidae* is one of the most striking characteristics of the Australian Odonata, and all evidence seems to point to the origin of this important family in that continent or in a former Antarctic continent which connected South America with Australasia, the positive close relationship of the *Corduliidae* of the two areas strongly supporting this thesis. From a Corduline stock and the Australian *Synthemidae* arose the recent great family *Libellulidae*, which has populated the whole of the Earth's surface.

The descriptions of the new genera and species, together with some notes on the *Argiolestes* follows:—

Micromidia gen. nov. (Fig. 1).

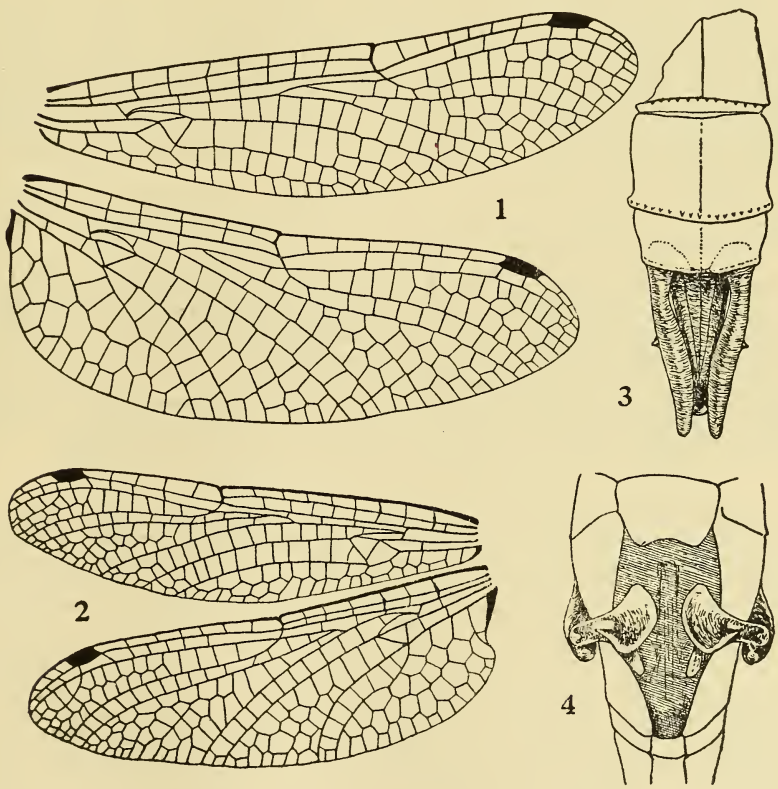
Small, slender dragonflies belonging to the family *Corduliidae* with the following venational characters: Discoidal triangle of forewing with or without a bend in the costal margin, which, if present, is situated far distally; discoidal field of the same wings with parallel borders throughout and containing a single row of cells almost to the border of wing; discoidal triangle of hind wing with its base slightly distal to the line of arculus; anal-loop very variable, of 5 to 8 cells in all, arranged in two rows or rarely one row and one double cell (fig. 3, *e*); anal field of forewings two cells deep, that of hind four cells deep; 1-4 cross-veins to the Bridge nearly constantly in all wings; anal vein in forewings subpectinate; base of hindwing shallowly notched but the tornal angle prominent; membrane present; pterostigma small, covering only one or two cells, usally braced; an incomplete basal subcostal antenodal almost constantly present in the forewings; anal triangle broad and long; one cubital cross-vein in forewings and two in the hind, the distal one in line with the arculus and forming a somewhat quadrate subtriangle (this vein absent in one hindwing of one female); sectors of arculus arising from the same point in the forewings and then immediately divaricate; those of the hindwing fused for a short distance; primary antenodals strongly differentiated from the secondaries and separated by a single secondary; the distal antenodal of hindwings commonly incomplete (50 per cent); the secondaries of forewing frequently not coinciding. (In addition, in one of the males, the right forewing has a cross-vein in the basilar space, but obviously as an aberration.) Head relatively large; legs rather short, slim, the tibiae with long, fine spines, and the male with the usual tibial keels common to the *Corduliidae;* Abdomen slim, but slightly broadened at base and slightly fusiformly so at end segments; cylindrical and a little compressed in the female; male genitalia very prominent, the hamules projected and so deeply emarginate as to appear forked. Anal appendages rather long and slim in the male, short in the female.

Type species of the genus *Micromidia rodericki.*

Micromidia rodericki sp. nov. (Fig. 1, 2-4; 3, *e*).

Male. Abdomen 25 mm. Hindwing 23 mm. Pterostigma 1.75 mm.

Head: Eyes large, dark reddish brown (but green during life), labium reddish brown, labrum dull ochreous, rest of head a dark steely black. Thorax dark green or prussian-blue metallic without any pale markings save the antealar sinus and the middorsal carina, which are bright ochreous. Legs with femora blackish brown, the tibiae similar but with a yellow line on the flexor surfaces. Femora with very closely-set, minute spines but two or three longer distal ones. Wings hyaline, pterostigma black; nodal index—8-9 antenodals (rarely 10) and 4-6 postnodals in forewings; 5½-6 antenodals and 6-8 postnodals in the hind.



1. 1, Wings of *Austrophya mystica* Tillyard, from the type in the British Museum (Natural History), for comparison with; 2, Wings of *Micromidia rodericki* sp. nov., 3, Anal appendages of the male, same species; 4, Male genitalia of same species.

Abdomen glossy black marked with bright chrome yellow on the sides of segments 1 and 2 and on the dorsum of segments 1 to 7, a small apical triangular spot on segment 1, a linear stripe on the middorsum of 2, extending the whole length of the segment, broader middorsal stripes on segments 3 to 7 which taper apically and terminate just short of their apical ends. Genitalia on segment 2 bright yellow, the hamules very large and projecting conspicuously, deeply emarginate, the inner end of notch produced into a short sharp spine, the outer produced into a curved, rather obtuse, hook. Anal appendages black, narrowly cylindrical, separated at base, converging towards apices which are rounded and rather obtuse; the outer border of appendages rather sinuous and with a small spine situated about their middle; seen in profile they first curve downwards, thickening towards the apices, which curve gently upwards. The inferior appendage of almost the same length as superiors, triangular. (Fig. 1, 3).

Female. Abdomen 23.5 mm. Hindwing 24 mm.

Very similar to the male in colouring, but the thorax is more cupreous than green metallic; occiput black. Yellow markings on abdomen more extensive, the bands broader and not interrupted at the segmental joints from 1 to 7. Anal appendages shortly conical, black, barely longer than segment 10. Ovipositor short, inconspicuous, minutely emarginate at its middle. Wings hyaline, anal-loop less developed, consisting of 5 to 6 cells (as against 8 to 9 in the males); nodal index—9 antenodals and 4-5 postnodals in the forewings; 5½-6 antenodals and 5-7 postnodals in the hind.

Habitat: N.E. AUSTRALIA: Thursday Island, Torres Strait, Queensland, 2 males and 2 females collected by R. Dobson, 15.i.57. A shade-loving insect with weak flight, inhabiting rain-forest.

The genus and species appears to lie closest to *Syncordulia,* especially by the formation and arrrangement of the primary antenodals. It probably belongs to the group *Austrophya, Neophya,* and *Cordulephya,* matching the latter in its small size. The great irregularity of the venation, which is unstable in so many respects, suggests that it is a species in-the-making, in which the venation of the wings is still far from crystallisation. The persistence of the primary antenodals stamps it as quite archaic in nature. The incomplete antenodal in the hindwing is an extremely rare character in the Anisoptera and is evidently specific in nature. Type, allotype and cotypes in the Dobson collection.

ARCHAEOPHYA gen. nov. (Fig 2).

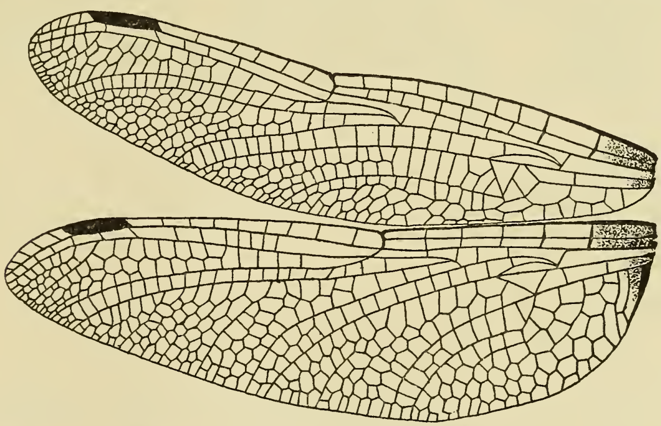
Rather large dragonflies belonging to the family *Corduliidae,* with the following venational characters: Discoidal triangle of forewing with distal and proximal sides equal and slightly longer than the costal, which is straight; discoidal field of forewing with sides at first parallel and then widely divaricate, beginning with 2 rows of cells at triangle and then running for a distance of about 5 cells as a single row of cells, changing then to 2 rows to as far as level of nodus, after which it broadens rapidly to 10 or more cells at border of wing; discoidal triangle of hindwing with its base well distal to level of arculus; anal-loop small and compact, made up of only 7 cells in two rows, the midrib highly zigzagged; anal field of forewing 2 cells deep, that of the hindwing 5 cells deep; only 1 or 2 cross-veins as additionals to the Bridge; anal vein in forewings pectinate; no incomplete basal antenodals present; one cubital cross-vein in forewings, 2 in the hind, the distal one proximal to arculus, and so the subtrigone not formed; sectors of arculus arising from a common point but divaricate from origins; primary antenodals strongly differentiated, with no secondaries intervening and much more widely separated than the secondaries, which are non-coinciding save by accident; pterostigma elongate, covering one to two cells, braced but the brace divorced slightly from the end of the organ. Venation generally close. Head large; thorax bulky, abdomen compressed. Legs of moderate length and robustness, ovipositor inconspicuous (distorted and rather concealed in the specimen, which is decidedly teneral).

The type species of the genus is *Archaeophya adamsi,* and the holotype is in the Dobson collection.

ARCHAEOPHYA ADAMSI sp. nov.

Female. (Male unknown). Abdomen 42 mm. Hindwing 41 mm.

Head: labium blackish brown; labrum dark reddish brown, anteclypeus yellow, postclypeus and frons dark ochreous but the latter with a suggestion of metallic colouring beginning to develop; vesicle black, occiput dark brown; behind head bright ferruginous. Prothorax brownish; synthorax dull reddish brown with a poor violaceous or bluish lustre (which probably becomes definitely metallic in the full adult?). The middorsal carina finely mapped out in pale yellow; laterally two bright creamy-yellow oblique stripes, one centred over the mesopimeron, the other covering the lower half of the metepimeron. Legs black, of moderate length and slimness, the femora with closely-set minute spines, the tibiae with moderately robust longer spines. Wings hyaline with dark brown vittae in the subcostal, costal, and cubital spaces extending to the first antenodal anteriorly but short of the *Cuq* in the cubital space. Pterostigma long and narrow, 4 mm. in length, braced, blackish brown. Nodal index—8-9 antenodals and 7 postnodals in forewings, 5 antenodals and 8 postnodals in the hind. Abdomen steely black marked with citron yellow—a pair of obliquely oval transverse spots on dorsum of segment 2, followed laterally by a small rounded spot; a pair of rounded or squared spots against the jugal sutures of segments 3 and 4, and a small spot on each side on the ventral border near the base of these segments; 5 to 8 with similar spots growing progressively



2. Wings of *Archaeophya adamsi* sp. nov., female.

smaller from segment to segment and more rounded. Apal appendages widely separated, slim, tapering to a point, and rather longer than segment 10, black.

Habitat: N. QUEENSLAND: Edungalba, 28.xii.53, a single rather teneral female, collected by E. Adams, after whom this fine new species is named. It bears a superficial resemblance to the larger forms of *Synthemis* of New Caledonia, and by coincidence has the same body-colouring and markings as those of *Synthemis miranda* Selys from that island. The persistence of the primary antenodals is an archaic character, as in the *Syntheminae,* but the sectors of the arculus are separated and there are no cross-veins in the basilar space; the discoidal triangle of the hindwing is more recessed than in those insects, nor do the antenodals of the hindwings alternate as thick and thin. One can only place the genus at the root of the Corduliidae in a somewhat isolated position.

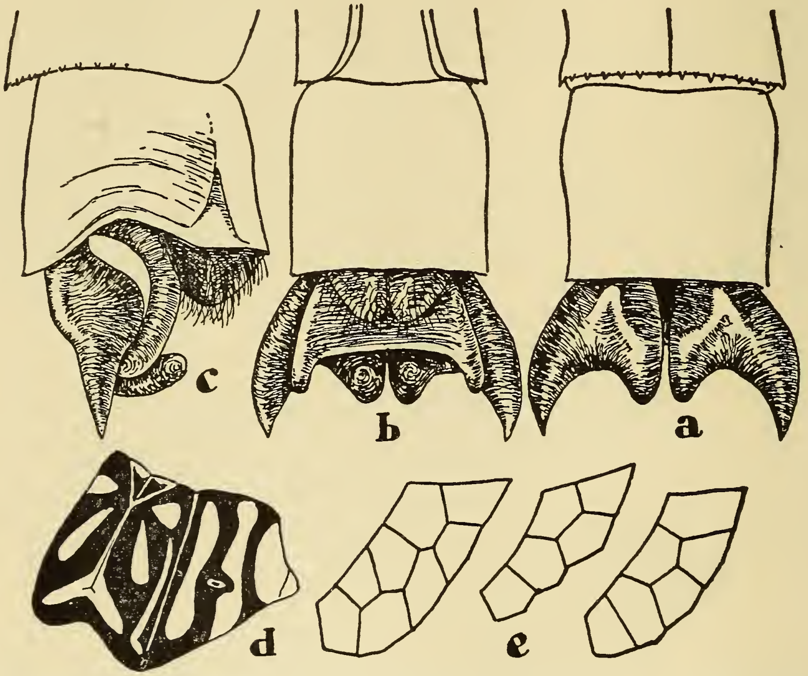
EUSYNTHEMIS AUROLINEATA Tillyard.

Tillyard disposed of this species in ten short lines, describing it as a subspecies of *guttata;* it seems to me that its differences are so wide as to give it specific rank. There is an adult male in the Dobson collection from Barrington

Tops, N.S.W., 8.i.54, collected by D. Sands, which offers the opportunity of describing this beautiful species in full.

Male. Abdomen 35 mm. Hindwing 30-34 mm. Pterostigma 2.75 mm.

Head: labium citron yellow, labrum black, anteclypeus yellowish, postclypeus black with the outer ends pale bluish; frons pale blue, its lower border anteriorly lined with black, the base in front of eyes narrowly black but prolonged forward into the frontal sulcus; vertex dull blue black, occiput glossy black. Behind



3. Male anal appendages of *Austrogomphus turneri* Martin, *a,* Dorsal view; *b,* Ventral aspect; and, *c,* Right lateral view; *d,* Markings of thorax of same species (diagrammatic); *e,* Anal-loop of male *Micromidia rodericki* sp. nov., showing extreme variation met with.

head glossy black but with a broad citron yellow band on the margin of the eyes. Prothorax yellowish brown. Synthorax a brilliant metallic prussian-blue, the middorsal carina delineated in yellow, alar sinus dull brown, antehumeral stripes yellow, parallel with the median carina and situated half-way between the latter and the humeral suture. Laterally two pale citron yellow stripes, the anterior on the mesopimeron with irregularly sinuous borders fore and aft, the posterior covering the lower part of the metepimeron and with its lower end curved strongly forward. Legs black, the anterior femora citron yellow on the flexor surface near the proximal ends. Abdomen black marked with bright yellow spots—a pair of these on all segments from 3 to 8, greatly enlarged and pyriform in shape on the last; a pair of transversely oval spots situated obliquely on the dorsum of segment 2, an apical spot on 1 and a pair of triangular basal spots on 3, which together with the pair of jugal spots enclose a large diamond-shaped spot of black. Anal appendages black, the superiors simple, obtuse at apices, forcipate and with a robust baso-lateral spine. Inferior appendage of the same length, triangular but slightly truncated at apex. Wings hyaline, nodal index—14 antenodals and 9 to 10 postnodals to forewings, 11 to 12 antenodals and the same number of postnodals to the hindwings. Anal-loop of 9 to 10 cells arranged in two horizontal rows, 2 medial and 5 cubital cross-veins; membrane and pterostigma black.

EUSYNTHEMIS NIGRA NIGRA Tillyard.

Two females of this subspecies are very large (Abdomen 42 mm., Hindwing 39 mm.), and one (Kuranda) has the wings tinted with amber and deeply enfumed throughout, the cell middles paler. The other (Dunk Island) has dark amber rays in all wings extending almost to the arculus. In both, the thoracic stripes are uninterrupted; the yellow areas on the frons are well separated, the labrum and anteclypeus are blackish brown, the postclypeus yellow at its centre only; the middorsal carina of thorax is finely delineated in yellow. Venational details of the Dunk Island specimen are as follows: Nodal index—15 antenodals, 8 to 10 postnodals to forewings, 3 cross-veins in median space, 6 cubital cross-veins in forewings and 4 in the hind. Kuranda specimen had nodal index—14 antenodals and 9 postnodals to forewings, 11 antenodals and 11 to 13 postnodals in the hind; other details similar to the Dunk Island specimen. Kuranda, 13.xii.54. Dunk Island 13.x.55.

Nymph of ANTIPODOGOMPHUS PROSELYTUS Selys.

Material: a single exuviae from Edungalba, N. Queensland, xi.56, collected by Mr. E. Adams. It was unassociated with the imago which had probably emerged some time before, so that the determination is by supposition. However, the nymph bore a striking resemblance to those of *Macrogomphus, Phyllogomphus, Merogomphus,* etc., and it is found in all of these that the lengthening of the terminal segments in the nymph is reflected in the imago, which also have the end segments of the abdomen abnormally lengthened. Now the only Australian gomphine genus which is known to possess this peculiar character is *Antipodogomphus,* so that there can be little or no doubt about the correct identification of Mr. Adams' nymph. The species *proselytus* appears to be more restricted to N. Queensland, whilst *acolytus* is found further to the south and N.S. Wales; of the two species, *proselytus* is the more likely determination of our nymph, although it is probable that the nymph of the former will show little or no differences from that of *proselytus.*

Description of Nymph (Fig. 4, *a*).

Total length, 23 mm. The nymphal case or exuviae is a pale yellow, but possibly a pale green or greenish grey in the living state. The labium (mask) is subrectangular, longer than broad and broader anteriorly than towards the mentum. The anterior border crenate, the middle crenation representing the midlobe, which is shallowly cupped and fringed with stiff setae or teeth. Lateral lobes comparatively massive, ending in a very stout fang which bears minute teeth along its medial border; the two overlap across the mid-line, and each is furnished with a long robust mobile hook, which also overlap; apart from the teeth, there are no spines or hairs visible throughout. Head triangular, the eyes occupying the greater part as each is rather more than an hemisphere; between them the ocelli are plainly visible. The antennae are 4-jointed, the scape short and cylindrical, the pedicel similar but shorter and smaller, the first segment of the distalia is massive, flattened, somewhat curved inwardly and ridged longitudinally; the distal segment is pointed and very minute; the whole structure is coarsely hairy on the medial side. Thorax bulky and the broadest part of the nymph; wing-pads compressed and of the pea-pod shape, extending posteriorly to the end of the 3rd abdominal segment. Legs robust, the femora and tibiae exceptionally so, strongly curved inwardly, the tibiae ending outwardly in a strong short spine adapted for digging or burrowing in sand; the hind tibiae are without this spine and these legs are apparently used only for locomotion; the whole length of the legs fringed with long coarse hairs. Abdomen strongly tapered from base to apex, cylindrical or torpedo-shaped, segments 8 to 10 progressively elongated, 9 and 10 very narrow and greatly elongated. Segments 5 to 8 with a middorsal apical spine, segments 7 and 8 with small lateral spine. Type in the Dobson collection.

AUSTROGOMPHUS TURNERI Martin. (Fig. 3, *a-d.*)

Male. Abdomen 33 mm. Hindwing 26 mm. Pterostigma 3 mm.

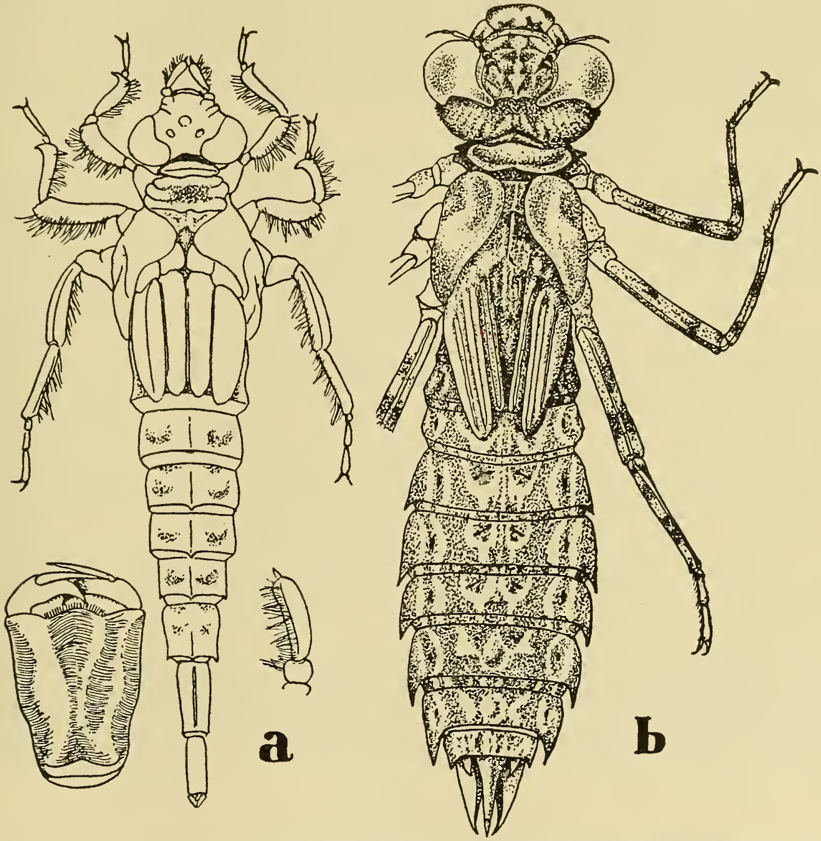
Head: face including the lips and frons bright ochreous, the latter with a narrow black border anteriorly against the postclypeus and a narrower one at its base before the eyes; vertex and occiput black but with a small oval spot of yellow just prior to the ocelli. Prothorax black with two small dorsal points of yellow on the middle lobe and the hinder border of the posterior lobe broadly citron yellow. Thorax black on dorsum marked with citron yellow as follows—two small spots in the alar sinus, isolated triangular upper humeral spots followed after a break by very narrow humeral stripes; the middorsal carina narrowly, which is connected below to a complete mesothoracic collar; oblique elongate oval antehumeral spots tapered above to a point but somewhat truncated below. Laterally a broad posthumeral yellow stripe followed by a complete sinuous black stripe centred over the spiracle, which is again followed by a second, narrower, sinuous yellow stripe. Finally a black stripe over the second lateral suture bordering the metepimeron, the greater part of which is yellow. Wings hyaline, pterostigma black, braced, slightly swollen; costa bright citron yellow as far as apex. Nodal index—11 to 12 antenodals and 7 postnodals to fore-wings, 8 to 9 antenodals and 7 to 8 postnodals to hindwings. Anal field of hindwing 4 cells deep, anal-loop absent; anal triangle variable, 3-celled on the right hindwing, 4-celled on the left (atypical). Abdomen with segments 1 to 6 black marked with yellow; 7 to 8 ochreous with thick black apical annules covering a little less than half of the segment. Segment 2 with a middorsal linear marking expanded into an oval at the middle of segment, the lower parts of the sides and the oreillets also yellow; segments 3 to 6 with basal yellow rings prolonged middorsally to join up with an elongated oval middorsal spot just posterior to the jugal sutures; segments 9 and 10 and the anal appendages bright ochreous without any dark markings. Anal appendages of the conventional Austrogomphine shape; superiors nearly as long as segment 10, seen from above, they are bifurcated, the outer branch a robust horn tapering to a point curved slightly posteriorly, the inner branch ungulate and with rounded apex; a ridge or keel runs from the base and splays out posteriorly to lose itself on both branches. Laterally the outer branch has an angulated upper border corresponding to the dorsal keel and the prolonged apex of the horn, whilst below it is swollen into a ball-like subbasal protruberance; the inner branch is seen to be turned downwards sharply to end in a robust reflexed tooth or spine. The inferior appendage is broad at base, with its outer angles prolonged into strongly upcurved branches which interlock with the branches of the superior appendages. (Fig. 3, *a-c.*)

Habitat: QUEENSLAND. Rockhampton, xi.55, collected by C. Vallis. This species is known only from the holotype male in the Senckenberg Museum and a doubtful half-destroyed female in the Tillyard collection. The above redescription is given for the benefit of Australian readers, since the original description by Martin is not readily available. Also, the present specimen has some important differences, the most important being the entire mesothoracic collar, which is interrupted in the type. In my monograph on the Australian Gomphidae I stated that, owing to not having seen the type, I was not able to state with certainty whether the species was a true *Austrogomphus,* but I am now able to confirm this and also to give figures of the anal appendages, which I then knew only from Martin's crude figures. The species differs from all other Austrogomphines by the terminal abdominal segments being ochreous and without any dark markings.

AUSTROGOMPHUS AMPHICLITUS Selys.

AUSTROGOMPHUS PRASINUS *Tillyard*

Three specimens of *Austrogomphus amphiclitus* Selys were present in the Dobson collection sent for identification, and in the course of examination it was observed that there was more than one cross-vein between the sectors of the arculus in the hindwings, which showed the species to be an epigomphine. All three specimens were from the Tamborine Mt. area, and it was at first considered that this venation might be a local aberration; however, on referring this point to Mr. Kimmins, of the British Museum, he reported that the type also had the same venational character, so that it became evident that *amphiclitus* must be transferred to genus *Austroepigomphus.* In the course of his examination Mr. Kimmins noticed also that *Austrogomphus prasinus* had the same epigomphine venation. A subsequent examination of a long series of examples of *prasinus*



4. Nymphs of, *a, Antipodogomphus proselytus* Selys in Martin (Labial mask and antennae inset); and *b, Austroaeshna unicornis pulchra* Tillyard.

collected by Mr. Dobson showed that all, without a single exception, were positive in this respect, so that now a third species, *prasinus,* must be transferred to genus *Austroepigomphus.* The occurrence of more than one cross-vein between the sectors of the arculus in the hindwing (and usually more than 3 in the forewing) actually means that the recession of Riv+v towards the arculus is incomplete in the *Epigomphinae* and that they are a stage behind the *Gomphinae* in evolution; thus, on the grounds of good taxonomy, it is imperative that those two species should be relegated to that subfamily.

The *Argiolestes icteromelas-griseus* complex.

Tillyard, in his paper "On some new and rare Australian Agrionids," 1913, *Proc Lin. Soc. N.S.W.*, 37: 410-415, split up the two species *Argiolestes icteromelas* Selys and *griseus* Selys into a number of races according to their size and colouring;

he made no comments on their venation, which appears to have been overlooked. Mr. Dobson's long series of both species exhibits a remarkable variation in their venation, especially in the development of the Anal field, which varies from 4 to 1 row of cells deep, a character which is of great taxonomic importance. Size alone is a variable factor, depending largely upon the altitude at which the species breed (at least this is so with the Zygoptera), the largest and most robust species being found at the greater altitudes. Regarding colour and the degree of pruinosity of the body in these insects, much depends on the age of respective specimens, so that, unless species are collected throughout a whole season, these characters are very unreliable. By employing the degree of development of the Anal vein and field, a number of subspecies or races can be established on sound anatomical grounds.

Argiolestes icteromelas icteromelas Selys.

Selys' measurements for the type are: Male, abdomen 23, hindwing 27-28, but as this gives the hindwing longer than the abdomen it is obvious that "33" should be read for "23." The Dobson series vary from 34 to 38, with wings from 27 to 29. In all specimens there are 2 rows of cells behind the Anal vein. Rarely in occasional specimens there are 2 rows of cells following the pterostigma.

Habitats: S. QUEENSLAND: Bouldercombe, 20 miles W. of Rockhampton, 2 males collected by C. Vallis; Montville, Blackall Range, 1 male, 23.ix.55; Tamborine, 15.iii.53, and ii.v.53, 3 males, collected by D. Curtis; N.S. WALES: Tenterfield, 27.xii.55, 1 female; Blackheath, Blue Mts., 27.xi.49, 1 male, 2 females; Upper Kangaroo Valley, 25.xi.49 and 29.xi.53; Wahroonga, 24.x.56 and 27.xi.53, one pair; Wentworth Falls, 2.ii.49, 1 male; Galston Gorge, Hornsby, 28.iii.51, several of both sexes; near Sydney, 16.ii.12, collected by R. J. Tillyard; Narrabeen, Sydney, 25.xi.50, and Mittagong, 30.xi.50, several of both sexes. (Unless otherwise mentioned, all specimens collected by R. Dobson.)

Argiolestes icteromelas nobilis Tillyard.

Tillyard's measurements give: Male, abdomen 39.5, total length 40! hindwing 32 mm. As only .5 mm. would be left for the head and thorax, it is obvious that for "total length 40" should be read "50." Female, abdomen 34.5, hindwing 33 mm.

The types came from Ebor, Dorrigo Plateau, N.S. Wales; there is a pair in the Dobson collection which I associate with this subspecies and which come from the Ben Lomond Range, 4500 ft., N.S.W., 27.xii.54. This race is distinguished by the greatest development of the Anal field, in which there are three rows of cells. One male has only 2 rows in the forewing but 3 in the hind; females have 3 rows in both wings. Usually 2 rows of cells after pterostigma.

ARGIOLESTES CALCARIS Fraser.

It is possible that this species has been mistaken for a small example of *icteromelas,* or more probably for the common *griseus,* which it so closely resembles, the spine on the superior anal appendage having been overlooked.

A. calcaris resembles *icteromelas* in possessing a spur to the superior anal appendages, but is at once distinguished from it by its much smaller size and by there being only a *single row of cells* posterior to the Anal vein. It is, of course, distinguished from *griseus* by the possession of the spur.

Argiolestes calcaris race *tenuis* Fraser.

Has only a single row of cells posterior to the Anal vein. Male. Abdomen 32. Hindwing 24. (Against "Abdomen 26 and hindwing 22" in *calcaris calcaris.*) The high ratio between the lengths of abdomen and hindwing of *tenuis* may indicate a new species rather than a race, but I have not been able to detect any other differences. Two males from Barrington Tops have abdomen 30 and hindwing 27.5, and the abdomen is stouter than in *tenuis.*

Argiolestes griseus griseus Selys.

This species was described by Selys from a single male, exact location not stated, so that it is impossible to distinguish it from any of its races, as formulated by Tillyard. The venation of the Anal field was not given by Selys, which is unfortunate, as I find wide differences existing in this area between specimens from different localities. For purposes of classification I am assuming that the Anal area in *griseus griseus* has constantly 2 rows of cells, and that the venation in the same area of other races either exhibits inconstant venation or only one row of cells, varying at the most by the presence of occasional double cells, that is, single cells traversed by a horizontal vein to form the capital letter "H." In *griseus griseus* I also note the Anal vein is deeply zigzagged, and shows evidence of a vestigial pectination, as later develops in the larger forms of *Argiolestes* and reaches its completion in the *Amphipterygidae.* By comparing a series from *calcaris,* through *griseus* (and its various races), *icteromelas nobilis* and *alpinus* Tillyard, we find a graphic history of the evolution of the Anal vein and field which led up to the higher forms in the *Amphipterygidae* and *Agriidae.*

Measurements of *griseus griseus* are: Male. Abdomen 28, hindwing 22. Female. Abdomen 23 to 25, hindwing 24 to 25. Tillyard's race *eboraceus* belongs here, with 2 rows of cells posterior to the Anal vein.

Argiolestes griseus subgriseus Fraser.

Only a single row of cells posterior to the Anal vein. Male. Abdomen 26, hindwing 20. Female unknown. Wahroonga, N.S.W., x.56.

Argiolestes griseus intermedius Tillyard.

Only a single row of cells posterior to the Anal vein. Male. Abdomen 27, Hindwing 22. Female. Abdomen 23, Hindwing 21. The difference between this race and the typical one are given fully by Tillyard, although I have found them difficult to appreciate. Glen Wills, 3500 ft., 24.x.56, Victoria.

Argiolestes griseus albescens Tillyard.

Only a single row of cells posterior to the Anal vein. Male. Abdomen 27-30, Hindwing 20-22. A very slender form with a high ratio between lengths of abdomen and hindwing. The species is best differentiated by the double belt of pruinescence on segment 2, which encloses a black, goblet-shaped marking on the dorsum. Occasional double cells are found posterior to the Anal vein. Palm Groves, S. Queensland, 2 males, 4 females, 24.ix.55; Tamborine, 4.i.53, collected by B. Salkild.

REFERENCES

Fraser, F. C., 1953.—*Cat. Coll. Selys,* 21, *Gomphidae;* 31, fig. 8, F.

Martin, R., 1901.—*Mem. Soc. Zool. France,* 19: 230. Id. 1906, *Cat. Coll. Selys, Cordulines:* 8.

Selys, 1862.—*Bull. Acad. Belg.* (2), xiv: 40. Id. 1886, *Mem. Cour.* xxxViii: 88.

Tillyard, R. J., 1910.—*Proc. Linn. Soc. N.S.W.,* 35: 311-377.

——, 1913, *ibid,* 37: 410-415 and 575.

George French Angas: The Father of Australian Conchology

By Tom Iredale

George Fife Angas is well esteemed as the Father of South Australia, while his son, George French Angas, can as justly be termed the Father of Australian Conchology. In the *Monograph of the Australian Loricates,* by Iredale and Hull (1927), appeared a short note, with an illustration of him, which is rather misleading. The picture shows a delicate-looking artist, whereas it appears, although he was an artist he was a determined, daring young adventurer. Little has been published here, but Hedley somehow unearthed an autobiographical sketch of Angas, which was issued in *"The Little Journal"* just before his death. He had a typewritten copy made, which is preserved in the Australian Museum Library. From that the following account has been prepared:—

Angas was born in the county of Durham, England, on April 25, 1822. He was born with a passion for natural history, drawing crude pictures of birds before he was three years old, and was greedily reading travel books at eight years. The family came south to Dawlish, in Devonshire, where, on the "Warren Beach," he became an enthusiastic conchologist at a very early age.

School at Tavistock and local travel with his father came to an end with an attempt to teach him business practice in a London office. One year sufficed to satisfy him, and probably his relatives, that business was not to be his life, and he borrowed a small schooner from a relative and set out *alone* for Malta. This port he reached, and he left in a native boat for Sicily, arriving at Syracuse, travelling overland, still alone, to Messina, climbing Mount Etna as a side effect. On his return to London he published an account called *"A Ramble in Malta and Sicily,"* illustrated by sketches he had made on his tour. He then became a pupil of the natural-history artist Waterhouse Hawkins, who taught him how to lithograph. Then he spent some weeks in the Channel Islands sketching the peasantry. Now having reached the mature age of twenty, he set out to travel in earnest, and reached South Australia, a young colony in which his father was interested, in 1843. Here he stayed three years, travelling with (Sir) George Grey, making water-colour drawings and sketches of the natural history. Again, as an offshoot, he went to New Zealand, where for three months he wandered on foot some eight hundred miles, living with the natives, going inland as far as Lake Taupo and the Tongariro volcano. All the time he was very busy sketching and painting the native places, the Maoris and their customs. He reached port with his treasures, but no money left save five pounds, which secured him a steerage passage in a small tramp schooner to Sydney. There he exhibited his sketches and paintings of South Australia and New Zealand, some four hundred in number. He decided to return to London, and secured a passage in a small schooner which was detained at Rio de Janeiro several weeks, during which time he sketched "the charming Brazilian scenery." The ship eventually reached London 198 days from Sydney. He exhibited his paintings in the Egyptian Hall for three months from April, 1847, inviting subscriptions to the two volumes of illustrations he proposed publishing, but the result was not profitable. However, the Prince Consort visited the exhibition, Angas became "lionised," and was presented to the Queen, but he was not a "socialite," and soon was on the move again. This time it was to South Africa, and as soon as his works were published he shipped to the Cape, taking ninety-seven weary days. He travelled into the Zulu country, via Natal, and reached the King, painting his portrait and others. After two years' troubles and tribulations, "adventures in wildest Africa," his portfolio full, he returned to England. Again he exhibited his paintings and also published a companion work on the Kaffirs.

He received an appointment as Naturalist to the Turko-Persian Boundary Commission, but never reached the Boundary. Delays in Turkey held the Commission up, and Angas, who apparently was delicate, having had fever in Africa, caught fever again, and "for some weeks his life was despaired of," and he was invalided home. Probably on this account he went to South Australia again, but took a wife with him. This time a different fever broke out, the gold fever, and he joined the first parties that went to the Ophir diggings, New South Wales, crossing the Blue Mountains on foot, and sleeping under a dray at night, in the depth of winter. He did not get much gold, but made sketches, which he sent home for publication. Then he went to the goldfields in Victoria, but still the gold escaped him, and after six months he returned to Sydney with just enough to pay his fare from Melbourne. After such an adventurous life he settled in Sydney, and in 1853 he became Secretary to the Australian Museum, a post he held for some seven years. But now his travels had begun to take toll of his health, and he was compelled to retire through illness. Nevertheless, during this time he visited Queensland and various parts of New South Wales, collecting and sketching. Analysing his report on New South Wales shells, he had collected as far north as Port Stephens and south to Illawarra, Jervis Bay, every local collecting spot in Sydney Harbour, dredging, and at every place north and south of Port Jackson, collecting as well shell-sand. Instead of going direct to England in 1861, as elsewhere commonly stated, he went to South Australia, "where he spent three years residing in the country and filling the post of magistrate, returning officer, and chairman of District council. Returning to England with his wife and family for the better education of the latter, he resided in London until the end. "For several years past (in 1884) ill-health had compelled him to spend the winters abroad, in the Riviera, Madeira, and in the West Indies. He also wrote in late years for the press tales of adventure and travel, and contributed sketches to the *Graphic* and the *Illustrated News,* also a long series of articles to the Colonies and India on "Commercial Natural History," and had written books on "Australasia" and "Polynesia," as well as a small volume of poems.

Although an artist and lithographer, Angas did not illustrate his conchological papers except the one dealing with the Naked Marine Slugs. However, when Cox prepared his *Monograph of Australian Land Shells* he asked Angas to examine some species in the British Museum, and Angas prepared coloured paintings which Cox included in two additional plates. This explains a quaint anomaly, as Cox stated on the title page eighteen plates, whereas there are twenty always. However, apparently one or two copies were sent out, as Smith at the British Museum recorded: "Cox says figured, but there is no figure." The figure appears on plate nineteen.

Angas, however, provided illustrations to accompany travel books such as those by McDouall Stuart and Forrest, and lithographed many of the illustrations in his first two large illustrated works.

In Waugh's *Australian Almanac* for 1858 there is an article "On the Aboriginal Inhabitants of N.S. Wales," occupying pp. 52-59, with 3 plates and 13 text-figs., signed G.F.A.

Angas' first papers were sent to London and Paris, probably asking for their correction, etc., and offering joint authorship as they appeared in that state:—

Adams, Arthur, & Angas, 4, 5, 6.

Adams, Henry, & Angas, 9, 10, 21, 34.

Crosse H. 3. This was edited by Crosse and ascribed to Angas, but indexed as by Angas & Crosse.

BOOKS.

South Australia Illustrated. Large folio, 60 plates. Pref. July 1846. Issued in ten parts. "Each part to appear at an interval of about two months." Part 1, dated 1846, each of the remainder, 1847. Title page, 1847. Data from parts in Mel. Ward's possession. A. Musgrave (Bibl. Austr. Entom., p. 5, 1932) has recorded new names of insects which are not included in the following index.

The New Zealanders Illustrated. Large folio, 60 plates. Companion volume to preceding. Pref. July 1, 1846. Issued in ten parts, each dated 1847, as is the title page.

The Kaffirs Illustrated. Large folio, as preceding, 30 plates only. Dates on record, 1847, 1848, 1849.

Savage Life and Scenes in Australia and New Zealand. In two volumes, small octavo. Really an account of the first two folio volumes of plates, "Writing as an artist and with no pretensions to literary ability." Pref. Sept., 1846, a second edition in 1850, succeeding the first one, which appeared in 1847.

A Ràmble in Malta and Sicily. His first work does not concern us here.

CHRONOLOGICAL LIST OF PAPERS INDEXED.

1849.

1. Description of *Tragelaphus Angasii* Gray, with Some Accounts of its Habits. *Proc. Zool. Soc. (Lond.),* 1848: 89, 90. Mamm., pl. 4, 5. Mch. 13, 1849.

   "Mr. Gray has named this species after my father, George Fife Angas, Esq., of South Australia, who has always taken a lively interest in my travels and researches in natural history." This is the original description.

1861.

2. Notes on the Broad-fronted Wombat of South Australia *(Phascolomys latifrons* Owen). *Proc. Zool. Soc. (Lond.),* 1861, 268-271. Sept. 16. Written from Collingrove, South Australia. April, 1861.

1864.

3. Description d'especes nouvelles appartenant a plusiers genrés de Mollusques Nudibranches des environs de Port-Jackson (Nouvelle-Galles du Sud), accompagnee de dessins faits d'apres nature (G. F. A. & H. Crosse). *Journ de Conchyl.,* xii: 43-70, pls. 4-6. Jan. 1.
4. Descriptions of New Species of Freshwater Shells collected by Mr. F. G. Waterhouse during J. McDouall (sic) Stuart's Overland Journey from Adelaide to the North-west Coast of Australia. (Arthur Adams & G.F.A.) *Proc. Zool. Soc. (Lond.),* 1863, 414-418. Apl. 20.
5. Descriptions of New Species of Shells from the Australian Seas, in the collection of George French Angas (Arthur Adams & G.F.A.) *Proc. Zool Soc. (Lond.),* 1863, 418-428, pl. 37. Apl. 20.
6. On the Land Shells of South Australia. *Proc. Zool. Soc. (Lond.),* 1863, 519-523. Apl. 20. Note: In This paper Angas includes names of species given by Pfeiffer in a succeeding paper.
7. Descriptions of New Species of Shells, Chiefly from Australia, in the Collection of Mr. Angas. (Arthur Adams & G.F.A.). *Proc. Zool Soc. (Lond.),* 1864, 35-40. June 24.
8. Observations on the Geographical Distribution of the Species of *Voluta* and *Cymbium* in the Australian Seas. *Proc. Zool. Soc. (Lond.),* 1864, 50-54. June 24.
9. Descriptions of New Genera and Species of *Chitonidae* from the Australian Seas, in the Collection of George French Angas. (Henry Adams & G.F.A.). *Proc. Zool. Soc. (Lond.),* 1864, 192-194. July 7 (pl. 2, pt. in following paper).

1865.

10. Descriptions of Two New Species of Shells in the Collection of George French Angas. (Henry Adams & G.F.A.). *Proc. Zool. Soc. (Lond.),* 1865, 54, pl. 2 (pt.). June 13.
11. Descriptions of Ten New Species of Shells, Chiefly from the Australian Seas. *Proc. Zool. Soc. (Lond.),* 1865, 55-58, pl. 2, pt. June 13.
12. Descriptions of Four New Species of Marine Shells from South Australia. *Proc. Zool. Soc. (Lond.),* 1865, 154-155. June 13.

13. On the Marine Molluscan Fauna of the Province of South Australia, with a List of all the Species known up to the present time, together with Remarks on their Habitats and Distribution, etc. *Proc. Zool. Soc. (Lond.)*, 1865, 155-"180" (= 190). June 13.
14. (Continuation). Part II. *id.* pp. 643-657. Apl 24, 1866.
15. Description of a New Species of *Gouldia* from Port Jackson. *Proc. Zool. Soc. (Lond.)*, 1865, 459-460. Aug. 26.

1866.

16. Descriptions of Two New Species of Marine Bivalve Shells from South Australia. *Proc. Zool. Soc. (Lond.)*, 1865, 697. Apl. 24, 1866.

1867.

17. Description of Thirty-two New Species of Marine Shells from the Coast of New South Wales. *Proc. Zool. Soc. (Lond.)*, 1867, 110-117, pl. 13. May 23.
18. List of Species of Marine Mollusca found in Port Jackson Harbour, New South Wales, and on the adjacent Coasts, with Notes on their Habits, etc. Part 1. *Proc. Zool. Soc. (Lond.)*, 1867, 185-233. May 23.
19. Part II, *id. ib.* 912-935. Apl. 3, 1868.

1868.

20. Descriptions of Six New Species of Helicidae from the Solomon Islands, Western Pacific. *Proc. Zool. Soc. (Lond.)*, 1867, 888-890, pl. 43 (pt.). Apl 3, 1868.
21. Description of a New Species of Land-shell belonging to the Genus *Coeliaxis*. H. Ad. and Angas. (H. Adams and G.F.A.). *Proc. Zool. Soc. (Lond.)*, 1867, 907, pl. 43 (pt.). Apl. 3, 1868.
22. On a New Genus and some New Species of Marine Mollusca from Port Jackson, New South Wales. *Proc. Zool. Soc. (Lond.)*, 1867, 908-911, pl. 44. Apl. 3, 1868.
23. Description of a New Species of *Helix* from South Australia. *Proc. Zool. Soc. (Lond.)*, 1868, 257, fig. in text. Sept. 15.

1869.

24. Descriptions of twelve new Species of Land and Marine Shells from Australia and the Solomon Islands. *Proc. Zool. Soc. (Lond.)*, 1869, 45-49, pl. 2. June 21.

1870.

25. Descriptions of Eight New Species of Helicidae from the Western Pacific Islands. *Proc. Zool. Soc. (Lond.)*, 1869, 624-626, pl. 48. Apl. 7, 1870.

1871.

26. Descriptions of Thirty-four New Species of Shells from Australia. *Proc. Zool. Soc. (Lond.)*, 1871, 13-21, pl. 1. June 12.
27. A List of Additional Species of Marine Mollusca to be included in the Fauna of Port Jackson and the adjacent Coasts of New South Wales. *Proc. Zool. Soc. (Lond.)*, 1871, 87-101. June 12.

1872.

28. Descriptions of Ten New Species of Land and Marine Shells. *Proc. Zool. Soc. (Lond.)*, 1872, 610-613, pl. 42 (pt.). Nov. 3.
29. Description of a New Species of *Voluta*. *Proc. Zool. Soc. (Lond.)*, 1872, 613-614, pl. 42 (pt.). Nov. 3.

1873.

30. Description of Eight New Species of Land and Marine Shells from Various Localities. *Proc. Zool. Soc. (Lond.)*, 182-184, pl. 20. June.

1875.

31. Descriptions of Three New Species of Shells from Australia. *Proc. Zool. Soc. (Lond.),* 1875, 389-390, pl. 45 (pt.). Oct. 1.

1876.

32. Remarks on the South Australian *Helices,* with a notice of All the Species known up to the present date. *Quarterly Journal of Conchology, I* (9), 134-135. May-Aug. No. 1876.
33. Descriptions of Four New Species of *Helix,* with some notes on *Helix angasiana* of Pfeiffer. *Proc. Zool. Soc. (Lond.),* 1876, 265-268, pl. 20. June 1.
34. Descriptions of Five New Species of Land-Shells from Madagascar, New Guinea, Central Australia, and the Solomon Islands. (Henry Adams and G.F.A.). *Proc. Zool. Soc. (Lond.),* 1876, 488-489, pl. 47. Oct. 1.

1877.

35. On Species of Marine Shells found on the Coasts of South Australia. *Quarterly Journal of Conchology, I* (2), 178-179. **Jan.-Feb.**
36. Description of a New Species of *Helix* from South Australia. *Proc. Zool. Soc. (Lond.),* 1877, 33-34, figs in text. June 1.
37. Descriptions of Two Genera and Twenty Species of Marine Shells from New South Wales. *Proc. Zool. Soc. (Lond.),* 1877, 34-40, pl. 5. June 1.
38. Descriptions of a New Species of *Bulimus* from Western Australia, and of a *Paludinella* from Lake Eyre, South Australia. *Proc. Zool. Soc. (Lond.),* 1877, 170, pl. 26 (pt.). Aug. 1.
39. Descriptions of One Genus and Twenty-five Species of Marine Shells from New South Wales. *Proc. Zool. Soc. (Lond.),* 1877, 171-177, pl. 26 (pt.). Aug. 1.
40. A Further List of Additional Species of Marine Mollusca to be included in the Fauna of Port Jackson and the adjacent Coasts of New South Wales. *Proc. Zool. Soc. (Lond.),* 1877, 178-191. Aug. 1.
41. Notes on a Small Collection of Land and Freshwater Shells from South-east Madagascar, with descriptions of new Species. *Proc. Zool. Soc. (Lond.),* 1877, 527-528, pl. 54 (pt.). Oct. 1.
42. Descriptions of a New Genus of Gasteropodous Mollusca from Japan and of a new species of *Bullia* from Kurachi. *Proc. Zool. Soc. (Lond.),* 1877, 529-530, pl. 54 (pt.). Oct. 1.

1878.

43. Notes on the *Helix sepulchralis* of Ferussac and its Allies; with Descriptions of Two Species. *Proc. Zool. Soc. (Lond.),* 1877, 803-805, pl. 80. Apl 1, 1878.
44. Descriptions of Seven New Species of Land-Shells recently collected in Costa Rica by Mr. Adolphe Boucard. *Proc. Zool. Soc. (Lond.),* 1878, 72-74, pl. 5 (pt.). June 1.
45. Description of a New Species of *Latiaxis. Proc. Zool. Soc. (Lond.),* 1878, 74, pl. 5 (pt.). June 1.
46. Description of a New Genus of Land Shells belonging to the Family Cyclophoridae. *Proc. Zool. Soc. (Lond.),* 1878, 310-311. Aug. 1.
47. Descriptions of Nine New Species of Land and Marine Shells from various localities. *Proc. Zool. Soc. (Lond.),* 1878, 311-314, pl. 18. Aug. 1.
48. Description of a New Species of *Tudicla. Proc. Zool. Soc. (Lond.),* 1878, 610-611. Oct. 1.

1879.

49. Descriptions of Six Species of Bivalve Shells in the Collection of Mr. Sylvanus Hanley, F.L.S., and of a *Helix* from the Solomon Islands. *Proc. Zool. Soc. (Lond.),* 1878, 859-861, pl. 54 (pt.). Apl. 1, 1879.
50. Descriptions of Ten Species of Marine Shells from the Province of South Australia. *Proc. Zool. Soc. (Lond.),* 1878, 861-864, pl. 54 (pt.). Apl. 1, 1879.
51. A List of additional Species of Marine Mollusca to be included in the Fauna of the Province of South Australia; with Notes on their Habitats and Local Distribution. *Proc. Zool. Soc. (Lond.),* 1878, 864-871. Apl. 1, 1879.

52. Descriptions of Ten new Species of *Axinaea* and *Pectunculus* in the Collections of Mr. Sylvanus Hanley and the late Mr. T. L. Taylor. *Proc. Zool. Soc. (Lond.),* 1879, 417-420, pl. 35. Oct. 1.

53. On the Terrestrial Mollusca collected in Costa Rica by the late Dr. W. M. Gabb, with Descriptions of New Species. *Proc. Zool. Soc. (Lond.),* 1879. 475-486, pl. 40. Oct. 1.

1880.

54. Descriptions of Two New Species of *Helix (Eurycratera)* from S.E. Betsileo, Madagascar. *Proc. Zool. Soc. (Lond.),* 1879, 728-729, pl. 57. Apl. 1, 1880.

55. Further Additions to the Marine Molluscan Fauna of South Australia, with Descriptions of New Species. *Proc. Zool. Soc. (Lond.),* 1880, 415-417, pl. 40 (pt.). Oct. 1.

56. Descriptions of Three Species of Marine Shells from Port Darwin, Torres Strait, discovered by Mr. W. T. Bednall; and of a new *Helix* from Kangaroo Island, South Australia. *Proc. Zool. Soc. (Lond.),* 1880, 418-420, pl. 40 (pt.). Oct. 1.

1884.

57. On the Terrestrial Mollusca of Dominica, collected during a recent visit to that Island. *Proc. Zool. Soc. (Lond.),* 1883, 594-597, 3 figs. in text. Apl. 1, 1884.

INDEX OF SCIENTIFIC NEW NAMES

(Mollusca only)

Pilsbry the Master

By Tom Iredale.

It is always an unpleasant task to record the death of friends, and especially so when that friend was the Master Conchologist (better Malacologist) of his age. H. A. Pilsbry probably holds the record for working years, as he was still working in 1957, seventy-odd years after his name came into prominence in the Conchological World. Many friends will write up the details of his career in America, so I will merely touch upon his impact upon his Australian friends. He was a great friend (by correspondence) with my predecessor, Charles Hedley, always helpful with advice in connection with any problem. Hedley met him in 1914 in America, and they issued a joint note on one subject. He corresponded with me from 1911-1923, when I was in England. He was invited to the Pan-Pacific Congress in Sydney in 1923, which I also attended, and it was natural that Hedley, Pilsbry, and myself should get together, though it must be remembered I was "small fry" then. The second part of the Congress was held in Melbourne, and we had collecting expeditions together, one of which Pilsbry never forgot, it was so fraught with (humorous) difficulties, or so they appeared afterwards. Pilsbry was born as long ago as Dec. 9, 1862, the same year as Hedley. He became interested in Land Shells very early in life, and had written very little when he was invited by Tryon to assist him. Tryon, in Philadelphia, had begun a "Manual of Conchology," a dream project of classifying World Mollusca, describing and illustrating each species in colour. He had issued a few volumes when Pilsbry joined him, but Tryon died very suddenly, and Pilsbry was chosen to continue the work. He was then only twenty-five years of age and, as soon as he completed the volumes in progress, he revolutionised the system altogether, and by the time he was thirty he was acknowledged as the Master, a title he held for sixty-five years. The gift of concentration, the greatest of all assets, was his endowment, and many tales have been told how he would work from early morn to late eve without leaving his study, even for a snack. It is also reported that he was a very bad correspondent, but apparently this fault was not allowed to affect his overseas friends, as neither Hedley nor myself ever had cause to grumble. Personally when he was out here he was a delightful friend in every way. Just as a memo for my readers, I may record that, apart from scientific papers, a thousand or so, he prepared over thirty volumes of the Manual, including many, probably thousands, of sketches of dissections of molluscan anatomy. To this, his own specialty, the whole world of malacologists is indebted, though he was also a great student of marine mollusca. I have omitted to note that the Manual was divided into two series, one devoted to Marine Mollusca, the other to Land forms. Of the former he completed the non-bivalve section in seventeen volumes; the latter was left unfinished at Volume 28. A third series on Bivalves was projected but never eventuated, and its absence is severely felt, emphasizing the great value of the volumes otherwise completed.

As a local incidence, the Monograph of the Australian Loricates by Hull and myself was due to his initial work on the subject. These curious (but most interesting) molluscan forms are a feature of our shore life, in numbers and species unequalled elsewhere. A great Englishman, Carpenter, began their world study, and drew up very detailed descriptions from the specimens in the British Museum. He died, but his MSS existed, and years later another great American, Dall, became interested in the group and received Carpenter's MSS. Through other work Dall only began his revision and it was laid aside. When Pilsbry in the Manual reached these Molluscs, Dall passed the MSS over to him. From this basis, without a great deal of material, Pilsbry produced a working account which was so clear that students immediately understood the intricacies of the subject. Sykes, receiving a collection from Victoria, prepared a review of the species, Suter worked out the New Zealand forms, Bednall and Matthews worked out the South Australian genera and species, and Hedley and Hull began on the New South Wales forms. All this enthusiasm was due solely to the work done by Pilsbry, and Hull and I dedicated our compilation to him, as without his pioneer work it might not have been done yet, and a photograph of him in his prime appeared as the frontispiece to our monograph.

Captain Comtesse

By Tom Iredale.

Another unfortunate duty is to record the passing of another friend, David Louis Comtesse, always known by the above title, as he had been the Master of the Sydney dredge "Triton." His casual love of shells led to his name and that of his dredge being associated with a curious discovery of ancient molluscan Sydney life. When R. Johnston, F. A. McNeill and I were working on the Harbour investigating the depredations of the "Shipworm" or Cobra, Johnston mentioned that the Triton's master had been collecting shells and would I like to see them. Of course I would, so he arranged to get me on to the "Triton," where I met Comtesse and his collection of shells. I was amazed at their curious appearance; they were all dead shells, of course, but in excellent condition, yet so many were strangers. I could scarcely believe that they could be local, but he let me see the dredging in the hold, and I picked out some myself, effectively destroying the Thomasian attribute. [It may be interjected that many years before shells of the same form had been shown to local students and rejected.] Comtesse was urged to continue picking out shells, and he received assistance from his crew, as his occupation of Master did not allow him too much time. His was a suction dredge, and as soon as the hold was full the dredge went out to sea and dumped the material into deep water. Many hundreds of shells were picked out, millions more dumped, and these made a great addition to our local knowledge, all of which is due to our lost friend. I use "our" because the Captain became friendly and liked by all the shell students in the city, being a constant attendant at the Marine Section's meetings.

Notwithstanding his French name, Comtesse denied French association, having been born in London in 1883. I met him about 1927. How long he had been in Sydney then I do not know, but he remained here until his death in 1957.

His name in the molluscan literature will be remembered as *Niotha comtessei* and *Thalotia comtessei* were named for him, the former in the paper "Strange Molluscs in Sydney Harbour," issued in the Australian Zoologist, 5: 337-352. Mch 1929, and the latter in Rec. Aust. Mus. 18:208, June 1931.

Book Review

"Guide to the Hawks of Australia," by H. T. Condon.

A second edition of this valuable little book (20 pages, price 2/6) has been made possible through the enterprise of the Bird Observers' Club of Melbourne and the generosity of the Trustees of the M.A. Ingram Trust. The first edition (published in 1949) received the expected support of field workers in ornithology, and for some years now has been out of print.

Mr. Condon (of the South Australian Museum) has long expressed particular interest in the diurnal birds-of-prey, generally referred to in the vernacular as "hawks," and his ability as a competent black-and-white artist and his study of the group generally have been admirably coupled together to produce a field guide very helpful among a number of bird species long considered difficult to identify in the field. Practically all the text-matter has been re-written in the second edition, although the general arrangement of species remains the same. All the plates depicting the underparts and under-wing pattern (for this is the part of the bird most frequently seen in the field in birds-of-prey) have been retained, and there is an additional plate showing the stance and plumage pattern in six confusing species. Furthermore, on the front cover is a pleasing illustration of the Wedge-tailed Eagle—a much more typically Australian species than the Peregrine Falcon which was used in the first edition. A second additional illustration concerns the outline of a falcon, with explanatory detail of all external parts.

All the 24 species of the *Official Checklist* are included, both in the text and the six pages of flight illustrations. The relegation of the White-eyed Buzzard-Eagle, purported to have been collected at Lithgow in 1889, to dubiety is commendable. It is pleasing to see the immature plumage of the Grey Falcon added to the text-matter in the second edition, as it is quite different from that of the adult.—A. R. McGill.

Marine Mollusca of Eastern Australia

1. The Genus CYMBIOLACCA Iredale (Family Volutidae).

By Donald F. McMichael

(The Australian Museum, Sydney).

(Plate xliv and Text-figure 1)

This paper is the first of a series which is planned to review the marine mollusca of eastern Australia. Each paper will take the form of a revision of a genus or family dealing with all the species from this coast as completely as possible, and with species from other areas when necessary. It is hoped that the papers will serve as an aid to identification by amateur collectors as well as to advance taxonomic knowledge of the groups under review.

During recent months a number of unusual specimens of volutes have been forwarded to the Australian Museum for identification. The difficulty of identifying some forms has led to a general revision of the taxonomy of the group of species allied to *Cymbiolacca complexa* Iredale 1924. The latter was a substitute name for *Voluta punctata* Swainson 1823, which is preoccupied by *Voluta punctata* Allan 1818, but the species is still widely referred to under the invalid name *V. punctata.* The other species which are dealt with here have appeared in previous lists as *Cymbiola pulchra* Sowerby 1825, *Cymbiola* (or *Aulica*) *wisemani* Brazier 1868, and *Aulicina perryi* Ostergaard and Summers 1957. Recently (McMichael, 1958) I have added *Cymbiolacca pulchra woolacottae* McMichael to the list of names, and in the following review it is proposed to discuss the geographic variation of these species and to consider their relationships.

The species have been allotted to several genera at various times, including *Voluta, Scaphella, Cymbiola, Aulica, Aulicina,* and *Cymbiolacca.* There has been a good deal of confusion over the years as to the correct use of a number of generic names in this group (Volutidae), so they are discussed briefly below. Much of the confusion is due to ignorance of the rules of nomenclature and to failure to consult the original literature. After a good deal of searching the following appear to be the correct references to the several genera, together with their type species. (In nearly every case, there are several later, incorrect usages of the generic names based on incorrect type species, but these are not detailed here.)

Voluta Linne, 1758, *Systema Naturae,* Ed. 10, pp. 645 & 729, Gen. No. 287. Type Species: *Voluta musica* Linne, 1758, *Systema Naturae,* Ed. 10, p. 733, Vermes Testacea Sp. No. 370. By Subsequent Designation, Montfort, 1810, *Conch. Syst.,* 2: 551.

Cymbiola Swainson, 1831, *Zoological Illustrations,* 2nd Ser., Vol. 3, pl. 83. (This reference can also be written: 2nd Ser., Vol. 2, Pt. 18, pl. 83, depending on whether the work is bound as issued or as suggested by Swainson.) Type Species: *Voluta cymbiola* Dillwyn, 1817, *Recent Shells,* 1: 576. By Absolute Tautonymy.

Scaphella Swainson, 1832, *Zoological Illustrations,* 2nd Ser., Vol. 3, pl. 87. (Or alternatively, 2nd Ser., Vol. 2, Pt. 19, pl. 87.) Type Species: *Voluta junonia* Shaw, 1808, *Nat. Miscellany,* 19, pl. 815. By Subsequent Designation, Hermannsen, 1848, *Indices Generum Malacozoorum,* 2: 423. (Clench, 1946, attributes to Gray, 1847, *P. Zool. Soc. London,* p. 141, the designation of *V. junonia* as type of *Scaphella,* but it is doubtful whether this is a valid designation. Hermannsen is quite unambiguous, and in either case *V. junonia* emerges as type species of *Scaphella.* The various "Types" of Swainson (1840) cannot be accepted as valid type species designations.)

Aulica Gray, 1847, *P. Zool. Soc. London* 1847: 141. Type Species: *Voluta aulica* Sowerby, 1825, *Cat. Tankerville,* p. 81, Appendix p. 29, pl. 3. By Monotypy.

Scapha Gray, 1847, *P. Zool. Soc. London* 1847: 141. Type Species: *Voluta vespertilio* Linne, 1758, *Systema Naturae,* Ed. 10, p. 733, Vermes Testacea Sp. No. 371. By Original Designation. (This name is preoccupied by *Scapha* Molchulsky, 1845, in Coleoptera. *Aulicina* Rovereto is an available junior synonym.)

Ausoba H. & A. Adams, 1858, *Gen. Recent Moll.,* 1: 160. Type Species: *Voluta cymbiola* Sowerby, 1825 (=*V. cymbiola* Dillwyn 1817) by Monotypy. (This generic name is therefore a junior objective synonym of *Cymbiola* Swainson, 1831.)

Vespertilio Klein, 1753 (often cited in connection with this group), is pre-Linnean, and the name was used by Linne (1758) for a genus of Bats. The name was reintroduced into mollusc nomenclature by Moerch, 1852, for *Voluta vespertilio* Linne, but, of course, is preoccupied. It was apparently replaced by

Aulicina Rovereto, 1899, *Atti Soc. Lingustica Genoa,* 10: 103, a new name for *Vespertilio* Moerch, not *Vespertilio* Linne. This journal is not available in Australia and I have been unable to check it. It is a junior objective synonym of *Scapha* Gray, which is preoccupied.

Cymbiolacca Iredale, 1929, *Rec. Aust. Mus.,* 17: 181. Type Species: *Cymbiola complexa* Iredale, 1924, *P. Linn. Soc. New South Wales,* 49: 183 & 258. By Original Designation.

Volutocorona Pilsbry and Olsson, 1954, *Bull. Amer. Paleont,* 35, No. 152: 25. Type Species: *Voluta imperialis* Lamarck, 1811 (= *V. imperialis* Solander, 1786, *Cat. Portland Mus.,* p. 183.)

The only valid generic names which have been used, therefore, are *Voluta* Linne, *Cymbiola* Swainson, *Scaphella* Swainson, *Aulica* Gray, *Aulicina* Rovereto, *Cymbiolacca* Iredale, and *Volutocorona* Pilsbry and Olsson. Of these, *Voluta* and *Scaphella* are restricted to Atlantic genera, which are quite distinctive from the species considered here. Examination of the several species of Indo-Pacific volutes which are usually listed as *Aulica* or *Cymbiola* and comparison with the *complexa-pulchra-wisemani-perryi* series reveals that at least three groups are separable.

Cymbiola cymbiola (Dillwyn) (together with *C. coronata* Sowerby and possibly *C. sophiae* Brazier) differs from all other species in shape, in its low spire, and in the nature of the spines, which are high up on the whorls and rather delicate. The protoconch is large, almost planate, and in this it resembles the species related to *Aulica aulica.* It seems best to restrict *Cymbiola* to these species and to retain the group as generically distinct from *Aulica.*

Aulica aulica (Sowerby) appears to be a member of a complex of forms which have received many names and are all fairly closely related. These forms are nearly all rather heavy-shelled, without sharp spines, but sometimes with knobs or blunt spines, growing to a fairly large size and with heavy planate apices. Some of the named forms included in this complex are as follows: *aulica* Sowerby 1825; *rutila* Broderip 1826; *norissi* Gray 1838; *piperita* Sowerby 1844; *innexa* Reeve 1849; *cathcartiae* Reeve 1856; *ruckeri* Crosse 1867; *macgillivrayi* Cox 1873; *ceraunia* Crosse 1880; and related to these are such species as *rossiniana, flavicans, tissotiana, mariaemma, quaesita,* and *kellneri.* The generic name *Aulica* can be applied to all the forms listed above. *Aulicina* proposed for *vespertilio* Linne probably represents a subgenus of *Aulica* and would include *nivosa, oblita, irvinae* and other spinose species.

Cymbiolacca Iredale was introduced as a subgenus of *Cymbiola* on the grounds that the type species (*C. complexa* Iredale) did not possess the planate protoconch which true *Cymbiola* has. Iredale did not include *pulchra* and *wisemani* in *Cymbiolacca,* but there is no doubt that the three species are closely related, and they are sufficiently distinct in form from *Cymbiola* and *Aulica* to be regarded as a distinct genus. These species all possess a comparatively small conical apex, consisting of three or four whorls bearing white radial ridges or nodules, spaced about one mm. apart. The apical whorls of *Aulica* are similarly ridged, but in that genus the protoconch is planate or nearly so, and the shells are mostly heavy, with large knob-like spines. The shells of *Cymbiolacca* are small and light, and the spines are quite sharp, or developed only as small knobs, or lacking altogether.

The three species here included in *Cymbiolacca* have a basically similar colour pattern. This pattern takes the form of white triangular markings and brown spots of varying size on an orange, yellow, pink, or red background. The variation in this pattern, particularly in the distribution of the brown spots, serves for the separation of the species.

The radula of *Cymbiolacca* has not previously been examined. It has now been studied in two species (*C. complexa* and *C. pulchra*) and proves to be rather similar to that previously described for *Aulica vespertilio* (Linne) and *Cymbiola* (?) *sophiae* (Brazier) (Cooke 1922, Pace 1902). It consists of a uniseriate ribbon, the rachidian teeth tricuspid, the cusps nearly equal in length, with the base deeply arched.

The species are treated systematically below.

Family VOLUTIDAE Fleming 1822.

Subfamily CYMBIINAE H. & A. Adams 1853.

Genus CYMBIOLACCA Iredale 1929.

Following the systematic arrangement of the Volutidae as proposed by Pilsbry and Olsson (1954), this genus is placed in the subfamily Cymbiinae, tribe Meloides, next to *Aulica* Gray, from which it differs by its small, conical ribbed protoconch. The radula teeth are similar to those of *Aulica* but the bases of the teeth are more deeply arched in *Cymbiolacca.*

Cymbiolacca complexa (Iredale)

(Pl. xliv, figs. 1-3)

Cymbiola complexa Iredale, 1924, *P. Linn. Soc. New South Wales,* 49: 183 & 258. New name for *Voluta punctata* Swainson 1823, *Zoological Illustrations,* (1), 3: pl. 161; not *Voluta punctata* Allan 1818.
Voluta punctata Sowerby, 1844, *Thes. Conch.,* 1: 198, pl. 53, figs. 89 & 90.
Voluta punctata Reeve, 1849, *Conch. Icon.,* 6: *Voluta,* pl. 21, sp. & fig. 52.
Voluta punctata Cox, 1871, *J. de Conch.,* 19: 77, pl. 5, fig. 2.
Voluta punctata Cox, 1871, *P. Zool. Soc. London 1871:* 324, pl. 34, fig. 6.
Cymbiolacca complexa Iredale, 1929, *Rec. Australian Mus.,* 17: 181.
Cymbiola complexa Allan, 1950, *Australian Shells,* p. 168, pl. 21, fig. 6.

Remarks:

This rare and beautiful species was known for more than a century under the preoccupied name *Voluta punctata.* The species was described by Swainson from an unknown locality and from a single beach-worn specimen. It was many years later that Cox confirmed the locality as New South Wales with the discovery of shells at Broken Bay, and Brazier also found the species about the same time near the Bellenger River. Cox (1871) figured an adult shell, and recently many perfect specimens have been found, while the range of the species is now known to extend from Bulli, south of Sydney, to north of Bundaberg, Queensland. Over this range a series of populations occurs, showing regular clinal variation, with a sharp break at Fraser Island, Queensland. Around Sydney, the shells are fairly small, the body-whorl only slightly shouldered and sometimes without any knobs or spines. Further north, about Coff's Harbour, the shells are still quite small, but nearly always have a series of knobs or short blunt spines running around the top of the body whorl, thus giving the shells a definite shoulder. Shells from south Queensland are larger, definitely shouldered and with a series of short, moderately sharp spines. The proportions are the same as those of the southern shells, but the colouring is richer. Typical specimens from off Noosa Heads and Manning River Heads are figured on Plate xliv, figs. 1 & 2.

Shells of this type occur as far north as the southern shore of Fraser Island, but north of that island in Hervey Bay is found a rather distinct population, with more elongate shells and an overall darker coloration. This population is apparently isolated to some extent in Hervey Bay, and is named below as a new subspecies.

Description:

Shells small to medium sized, the maximum length about 80 mm., though shells about 40 to 50 mm. are commonly found. The maximum width about 46% to 50% of the maximum length. Spire short to moderately long, body whorl large, more or less shouldered, the shoulder sometimes bearing small knobs or short spines, which are fairly closely appressed to the body whorl. Aperture large, gaping; columellar plaits four. Shell yellow to orange-red, covered with numerous small, white, or cream triangular markings about one mm. in height, and also with minute red or brown spots, usually less than one mm. in diameter, which are randomly distributed over the shell surface. In northern populations the spots are a little larger, darker, and more numerous, and there are blotches of reddish-brown forming two incomplete and indistinct bands running around the shell. Below the suture there is a band of vertical, closely spaced, dark-brown lines running to a point half-way between the suture and the spines.

In the most northern population known, from Hervey Bay, the shell is distinctly narrower, the maximum width about 43% to 45% of the maximum length, with the spots larger, up to 3 or 4 mm. in length, elongated vertically, and darker, but still distributed randomly over the shell surface. The blotches of reddish brown have fused into two dark, almost continuous brown bands, and the shells have a much darker appearance in general. This population is here named as a new subspecies, *Cymbiolacca complexa neilseni,* after Mr. Thomas Neilsen, who first brought this form to my notice, and the type is figured on Plate xliv, fig. 3. A specimen agreeing with this race is reported to have been taken at Princess Charlotte Bay, North Queensland, and another from Tweed Heads, N.S.W., but I consider these to be erroneous localities.

The radular teeth are tricuspid, the central cusp longest, blade-like, the lateral cusps slightly shorter, the base deeply arched; the maximum width of each tooth 0.18 mm., the maximum length 0.20 mm. (Text fig. 1A.) The number of teeth 76 plus nascents.

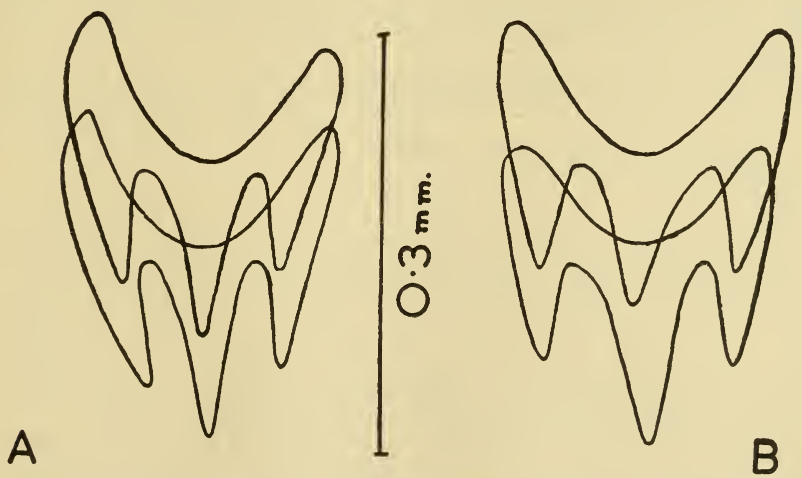


Figure 1.—Radular teeth of (A) *Cymbiolacca complexa neilseni,* and (B) *Cymbiolacca pulchra woolacottae.*

The animal of *C. complexa neilseni* is creamish-white, covered with reddish blotches, formed of numerous wrinkly red lines. The head is small, foot large, siphon elongate.

Types:

The holotype of *Cymbiolacca complexa complexa* Iredale is also the holotype of *Voluta punctata* Swainson, and should be in the British Museum. The type locality of the nominate race may be restricted to Broken Bay, N.S.W. The holotype of *C. complexa neilseni* is in the Australian Museum, No. C.62297, and was presented by Mrs. J. A. Grigg, of Cairns, Queensland. Its dimensions are: Length 71 mm., maximum width 29 mm., apertural height 48 mm. A paratype in the Australian Museum, No. C.62232, was presented by Mr. T. Neilsen. An additional paratype, from which the radula was taken, is in the National Museum of Victoria, No. F.18259. The type locality of *C. complexa neilseni* is 30 miles off Burnett Heads, Hervey Bay, Queensland, 10 fathoms.

Records:

C. complexa complexa: Bulli, N.S.W. (A.M.), Collaroy Beach, N.S.W. (A.M., P. Colman), Broken Bay, N.S.W. (A.M., N.M.V.), off Manning River Heads, N.S.W. (A.M.), Bellenger River, N.S.W. (A.M.), Coff's Harbour, N.S.W. (Mrs. A. R. Bowman), off Wooli, N.S.W. (Mrs. J. A. Grigg), Angowrie, N.S.W. (A.M., Miss G. Thornley), Evan's Head, N.S.W. (T. Garrard), Southport, Qld. (P. Goadby), Stradbroke Island, Qld. (A.M.), Caloundra, Qld. (A.M.), north of Noosa Heads, Qld. (A.M.), Wide Bay, off Fraser Island, Qld. (A.M.), Tin Can Bay, Qld. (T. Garrard, P. Goadby).

C. complexa neilseni: Off Bundaberg, Qld. (A.M., N.M.V.), Elliott Head, near Bundaberg, Qld. (P. Goadby), off Burnett Heads, Hervey Bay, Qld. (P. Goadby, A.M., Mrs. J. A. Grigg), Urangan, Qld. (P. Goadby).

Habitat:

Usually taken by trawling in shallow water (about 5-30 fathoms) along the continental shelf; often washed up dead and broken after storms.

Cymbiolacca pulchra (Sowerby).

(Pl. xliv, figs. 4-6.)

Voluta pulchra Sowerby, 1825, *Cat. Tankerville,* App. p. 28, pl. 4, fig. 2.
Voluta pulchra Reeve, 1849, *Conch. Icon.,* 6: *Voluta,* pl. 21, sp. & figs. 54 a, b.
Voluta (Scapha) pulchra Angas, 1864, *P. Zool. Soc. London* 1864: 51.
Voluta pulchra Tryon, 1882, *Man. of Conch.,* 4: 86, pl. 25, fig. 50.
Aulica pulchra pulchra Maxwell Smith, 1942, *A Review of the Volutidae,* p. 40, pl. 18, fig. 124.
Cymbiola pulchra Allan, 1950, *Australian Shells,* p. 167, pl. 25, fig. 4.
Cymbiolacca pulchra pulchra McMichael, 1958, *P. Roy. Zool. Soc. N.S.W.* 1956-57:149, figs. 3-6.
Cymbiolacca pulchra woolacottae McMichael, 1958, *P. Roy. Zool. Soc. N.S.W.* 1956-57:149-150, figs. 1-2.

Remarks:

I have recently discussed the identity of *Voluta pulchra* Sowerby, and considered it to be a polytypic species, with a race occurring on the coast of Queensland about the Tropic of Capricorn, and an off-shore island race inhabiting the Capricorn and Bunker Groups and Lady Elliott Island. For many years Heron Island was considered to be the type locality of *C. pulchra,* but the type must have been collected by Cook's party at either Bustard Bay or Thirsty Sound. The holotype of *C. pulchra* in the British Museum agrees exactly with the figure given by Sowerby and copied in my recent paper, and represents the coastal form. The nominate race was therefore considered to be the coastal race, and the island race was named *C. pulchra woolacottae* as above.

The study of a series of specimens recently trawled in the waters around the Capricorn Group and the Swains Reefs, Queensland, suggests that the situation is not so straightforward as previously thought. All the deepwater material agrees in form and number of spots with the coastal shells, though many shells are of an overall pinkish coloration; specimens of this type are occasionally washed up as dead shells on the coral cays of the Capricorn Group. Therefore *C. pulchra woolacottae* cannot be considered a simple geographic race of *pulchra* but appears to be a coral cay form. This situation cannot be expressed with much clarity in a trinominal nomenclatural system, but it seems best to retain *woolacottae* as a racial name for the coral cay populations, which should be considered as polytopic or ecological subspecies. Just what the breeding relationship between the two forms is remains in doubt. It seems likely that there would be a certain amount of gene flow between the cay populations and those from deeper water, and, as previously stated, shells from Bustard Head are to some extent intermediate, while North-West Islet shells are in many ways similar to the true *pulchra,* being more elongate and with more numerous spots than Heron Island shells. It may eventually prove necessary to resume the name *pulchra* for all the shells from this area rather than attempt the recognition of geographic races which are in fact ecotypes. It remains possible that secondary hybridisation following initial isolation accounts for some of the problems in this species.

There is a good deal of variation between the populations of coral cay shells from different islands; if Heron Island shells be considered typical, North-West Islet shells are more elongate and lighter coloured, with numerous spots, while Fairfax Island and Lady Elliott Island shells are large, almost white and with few, very large spots. Meanwhile more complete knowledge of dispersal and the distribution of the various populations is necessary. A typical coast specimen from South Keppel Island is figured on Pl. xliv, fig. 4, and a typical Heron Island shell on Pl. xliv, fig. 5. The holotype of *C. pulchra woolacottae* is figured on Pl. xliv, fig. 6.

Description:

Shells small to medium sized, the maximum length about 90 mm., the maximum width from 46% to 52% of the maximum length; the coastal and deepwater forms more elongate than coral cay populations. Spire short to moderately long, body whorl large, distinctly shouldered, and bearing short, sharp, prominent spines which are appressed to the shell in coastal shells but stand out noticeably in island populations. Shell creamish-pink to orange, sometimes blood red or yellowish, covered with numerous white triangular markings, which are small in typical *pulchra,* not exceeding 3 mm. across, but larger in island shells, from 5 to 10 mm. Three more or less distinct pinkish bands circle the shell, one immediately below the spines, one half-way down the body whorl, and one immediately above the columellar callus. The bands marked with dark brown to black spots, small (not exceeding 2 mm. in diameter) and numerous in coastal shells, but larger and elongated vertically (up to 4 mm. long) in the island race. The dark spots are considerably less numerous in the island race, sometimes almost lacking.

The radula teeth of *C. pulchra woolacottae* are tricuspid, the central cusp a little longer than the lateral cusps, broader than those of *C. complexa neilseni,* and the base not so deeply arched; the teeth are similar in size to *C. pulchra neilseni,* the maximum width 0.2 mm., the maximum length 0.2 mm., the number of teeth 73 plus nascents. (Text fig. 1B.)

The animal is very brightly coloured with deep red stripes and patches on a cream background. The foot is broad, the siphon elongate, the proboscis and tentacles quite large.

Types:

The holotype of *Voluta pulchra* Sowerby is in the British Museum, No. 1957.10.10.1. The type locality of the nominate race is here restricted to Bustard Bay, Queensland. The holotype of *C. pulchra woolacottae* McMichael is in the Australian Museum, No. C.62264, from Heron Island, Queensland, collected by Miss E. Pope, June, 1951. Paratypes are from Heron Island (C.62265), Masthead Island (C.18942), North-West Islet (C.62266), and Lady Elliott Island (C.37531). The radula here figured was taken from a specimen in the Australian Museum (C.62303) from Wistari Reef.

Records:

C. pulchra pulchra: Round Hill Head (P. Goadby), Bustard Head (Mrs. A. R. Bowman, Miss G. Thornley, Mrs. J. Kerslake, Mrs. J. A. Grigg, Mrs. W. Rooke, A.M.), Seal Rocks, Port Curtis (A.M.), Facing Island, Port Curtis (A.M.), Yeppoon (Mrs. A. R. Bowman, Mrs. J. Kerslake, P. Goadby, A.M.), Humpy Island, S. end of Keppel Island (Mrs. A. R. Bowman), South Keppel Island (A.M.), North Keppel Island (A.M., P. Goadby, Mrs. J. Kerslake, A. J. Marsh), Pearl Bay, 80 m. N. of Yeppoon (Mrs. A. R. Bowman), off Tryon Is., off Heron Is., off North-West Is., off Swains Reefs, off Masthead Is. (P. Goadby), off Wistari Reef (A.M.), all in Queensland.

C. pulchra woolacottae: Heron Island (A.M., P. Goadby, N.M.V., P. Colman), North-West Islet (A.M., Mrs. M. Bowman, Mrs. J. Kerslake, P. Goadby), Wistari Reef (A.M., P. Goadby), Fairfax Island, Bunker Group (P. Goadby), Lady Elliott Island (A.M., N.M.V.), Queensland.

Habitat:

C. pulchra pulchra apparently lives in depths about 10 to 30 fathoms, though occasional live specimens occur in shallow water along the coast, where they can be found in sand patches, at low tide. *C. pulchra woolacottae* occurs on coral cays; it lives in sand patches, apparently buried or hiding under coral boulders at low tide, but comes out to feed at the turn of the tide, especially towards evening, when it appears with startling suddenness in numbers on sand patches which previously had appeared quite deserted. Young specimens can be found by digging in the sand to a depth of a few inches, but the depth to which the adults burrow is not known. The animals crawl about actively, and because of their bright blotched red coloration are very conspicuous.

Cymbiolacca wisemani (Brazier)

(Pl. xliv, figs. 7 & 8)

Voluta (Aulica) wisemani Brazier, 1870, *P. Zool. Soc. London* 1870: 108.
Voluta (Aulica) wisemani Brazier, 1871, *J. de Conchyl.*, 19: 78-80, pl. 5, fig. 1.
Voluta wisemani Crosse, 1871, *J. de Conchyl.*, 19: 278.
Voluta wisemani Sowerby, 1887, *Thes. Conch.*, 5: 297, pl. 573 (*Voluta* pl. 14), fig. 139.
Cymbiola wisemani Iredale, 1929, *Mem. Queensland Mus.*, 9: 283.
Cymbiola wisemani Allan, 1950, *Australian Shells*, p. 167.

Remarks:

This beautiful species was rarely known until recently. Brazier described the species from "North Queensland," consequently the species was considered to be doubtfully Australian, and Hedley (1909) did not include it in his Queensland List. Iredale (1929) rediscovered the shell at Michaelmas Cay, where it has been found fairly commonly since. Iredale commented that the type was preserved in the Australian Museum, and the specimen here figured in Plate xliv, fig. 7, is marked "Type" in Brazier's handwriting. However, it also bears the locality data Lady Elliott Island in Brazier's script, which does not agree with the original description. Furthermore, the species does not seem to occur at Lady Elliott, so it must be assumed that Brazier added this incorrect locality afterwards. That the specimen is the type is fairly certain on account of Brazier's label and its general agreement with the original figure, which was probably redrawn in France from an original sketch provided by Brazier.

There is a good deal of variation in this species, which has recently attracted the attention of collectors. Michaelmas Cay shells have been accepted as typical, but in fact this population usually lacks the minute dark spots characteristic of the holotype and most other specimens. Specimens from Keeper Reef, near Townsville, Undine and Mackay Reefs, near Cairns, are all more elongate, usually smaller, and with noticeable minute spots, and one of these from Keeper Reef is figured in Plate xliv, fig. 8. These, however, cannot be considered to represent a geographic race, as their range completely overlaps the area of normal reef populations, and the differences appear to be due to colony formation rather than geographic speciation.

Description:

Shells small to medium sized, the maximum length about 80 mm., the maximum width about 45% to 50% of the maximum length. Spire short to moderately elongate, shells more or less shouldered, the spines variable, small and suppressed in some populations, erect and pointed in others, slightly recurved, but in either case not developed on the outer part of the lip, the last few spines reduced. Ground colour creamish white to pinkish orange, sometimes suffused with a bluish tinge; the whole shell covered with large white patches, roughly triangular, which run together so that the ground colour is almost obliterated; these triangular patches ill defined, often greater than 15 mm. across. Shell circled with two fairly definite bands of orange-brown splashes, cut across by large obscure white patches. The shell usually covered with randomly distributed minute dark-brown spots, a little elongated vertically, sometimes obscured by orange patches; the spots not greater than 1 mm. in length and 0.5 mm. in width. These spots sometimes more obvious between the bands of orange splashes, but usually distributed over the whole shell.

Animal and radula unknown.

Types:

The holotype of *Voluta (Aulica) wisemani* is in the Australian Museum, No. C.11497, and is figured on Plate xliv, fig. 9; the type locality is "North Queensland," which can be restricted to between Townsville and Cairns.

Records:

Keeper Reef, near Townsville (A. J. Marsh, P. Goadby, A.M.), Watt Reef, near Townsville (P. Goadby), Michaelmas Cay, near Cairns (A.M., Miss G. Thornley, Mrs. J. A. Grigg, P. Goadby, J. Fearnley), Upolo Banks, near Cairns (A. J. Marsh), Mackay Reef, near Cairns (P. Goadby), Undine Reef, near Cairns (A. J. Marsh), Green Island, near Cairns (T. Garrard, N.M.V.), Outer Barrier Reef, off Cairns (N.M.V.), Euston Reef, near Cairns (P. Goadby), Queensland.

Habitat:

"In one to four feet of water at low spring tides, Michaelmas Cay" (J. Fearnley).

Cymbiolacca perryi (Ostergaard and Summers).

(Pl. xliv, fig. 9)

Aulicina perryi Ostergaard and Summers, 1957, *J. Mal. Soc. Australia,* 1: 30-31, text fig.

Remarks:

This unusual form was found in 1953 at Wistari Reef in the Capricorn Group. The name has been circulated in manuscript for some years but only recently published. Unfortunately the types are all in private collections, but I have been able to examine the two paratypes in Australia, thanks to Messrs. A. Nash and R. Perry, of Gladstone, and have been provided with pictures of the holotype by Mr. Summers. The shells are all juvenile, and the exact taxonomic status of this form cannot be determined until more specimens are available. The locality where they were found is one which abounds in *C. pulchra woolacottae,* so that it is possible that *perryi* is only a colour form of this race. It is also possible that the shells represent a southern occurrence of *C. wisemani,* which resembles *C. perryi* fairly closely in colour pattern, but juvenile shells of *C. wisemani* are not yet available for direct comparison. However, the locality is many miles south of the range of *C. wisemani,* and the shells certainly look distinctive. Finally, it remains possible that *perryi* is a good species, apparently very rare, for intensive collecting has been done in the Capricorn Group for many years. For the time being *C. perryi* is admitted as a full species.

Description:

Shells small, juveniles only known, the maximum length 47 mm., the maximum width about 50-52% of the maximum length. Spire relatively short, body whorl large, shouldered, bearing prominent spines which are erect, outstanding, and extend down the body whorl as short ridges. Shell pinkish-white with two more or less complete bands of orange-brown encircling the shell, one at the base of the spines and one half-way down the body whorl; the shell almost completely lacking in dark spots except for one large spot on the oral surface of the body whorl of one paratype, at the position of the median orange band. The figure of this species (Pl. xliv, fig. 9) is drawn from a Kodachrome transparency of Nash's paratype.

Types:

The holotype is in the collection of Mr. Ray Summers, of Petulama, California, and the paratypes are in the collection of Messrs. Roy Perry and Arthur Nash, of Gladstone, Queensland. The opportunity is here taken of urging the owners of these types to deposit them in some Museum collection at the first opportunity, where they will be preserved for posterity and will not be lost, as has happened so often in the past, leading to yet another insoluble problem of molluscan taxonomy. The type locality is Wistari Reef (not Westaria, as stated in the original description), Capricorn Group, Queensland.

Records: Known only from the types.

Habitat: Unknown.

Origin and Relationships:

These well differentiated species lend themselves to speculation as to their evolutionary origin and relationships with one another. Their precise colour patterns, which though related are fairly clearly defined, may be indicative of their lineage. (The close relationship of the species is exhibited by the changes which take place in the colour patterns after a serious break. Typical *pulchra* often reverts to the *complexa* pattern and to *wisemani* coloration.)

The genus is probably a derivative of the *Aulica* type shell, in view of the similarity in protoconch structure and radular teeth. (However, a similar protoconch to that of *Cymbiolacca* is found in *Notovoluta,* which closely resembles *Cymbiolacca* in form but differs in the development of the columellar plaits and in colour pattern.) It is possible that *Cymbiolacca* arose as a southern isolate of *Aulica* and that *C. complexa complexa,* with its tendency to a simple unornamented shell and randomly distributed spots, may represent the primitive type.

C. wisemani, which retains the randomly distributed spots but has developed an ornate form and background colour, may be a direct derivative from the southern *complexa* through the isolation of a northern stock. *C. pulchra pulchra* suggests itself as a fairly recent derivative of *complexa,* for there is not a great deal of difference between coastal *pulchra* and Queensland *complexa,* the essential difference being the confinement of the dark spots in *pulchra* to definite bands. Just what the past isolating barriers might have been which could have caused these developments cannot be stated. However, it should be remembered that, like all other volutid molluscs, these species probably lay attached egg-capsules, and the young hatch as small versions of the adult in the crawling stage. Thus there is no free swimming larval stage to allow widespread dispersal, so that movement up and down a coastline is probably achieved at a slow rate by the rafting of eggs and young individuals on drifting objects. This means that there is a tendency for colony development with the accumulation of marked differences (well illustrated by the present variation of *C. pulchra woolacottae* in the Capricorn Group) and that any barriers to the free movement of floating objects would act as effective isolating barriers for these molluscs.

From these three basic species the more recently discovered forms have probably arisen in comparatively recent times.

C. complexa nielseni is quite obviously an isolate of the southern *complexa*, confined to Hervey Bay, with Fraser Island preventing much gene flow between the two populations. The coral cay form *C. pulchra woolacottae* today shows much variation, and probably will result in the eventual development of a number of distinct races, some populations already approaching this status. The discovery of true *C. pulchra* in the deeper waters around the Capricorn Group together with a tendency towards the development of intermediate populations as at North-West Islet and Bustard Head suggest that there may have been initial isolation of the island form from the coastal shells, and subsequent re-invasion of the deeper water, with consequent secondary intergradation. On the other hand, it is more likely that *C. p. woolacottae* is an ecological form, adapted to shallow water conditions on coral cays.

C. perryi either represents a recent derivative of *C. wisemani* through southward rafting, or else a colour mutant stock, derived from *C. pulchra*. It may yet prove to be a widespread species.

There does not seem to be any real overlap in range between the three common species, most apparent instances of this proving to be due to misidentifications or inaccurate data. It should be noted that treatment with strong acids of both *C. complexa* and *C. pulchra* produces an orange-brown shell very similar to *C. wisemani*.

Acknowledgements:

I would like to acknowledge the assistance of all those persons who have loaned specimens and provided Kodachromes, in particular Mrs. J. Kerslake, Mr. A. J. Marsh, Mrs. E. Grigg, Mr. A. Nash, Mr. R. Summers, Mr. P. Goadby; and Miss J. Hope Macpherson, of the National Museum of Victoria. I would also like to thank Mr. John Beeman, Artist of the Australian Museum, for the excellent colour plate. Finally, I am indebted to the Royal Zoological Society of New South Wales for making the publication of the paper and colour plate possible.

References:

Clench, W. J., 1946, the Genera *Bathyaurinia, Rehderia,* and *Scaphella* in the Western Atlantic. *Johnsonia,* 2: 41-60, pls. 24-31.

Cooke, A. H., 1922, The Radula of the Volutidae. *P. Mal. Soc. London,* 15: 6-12.

Hedley, C., 1909, The Marine Fauna of Queensland. *Rept. Aust. Assoc. Adv. Sci. Brisbane, 1909* (Vol. 12): 329-372.

McMichael, D. F., 1958, A New Name for the Heron Island Volute. *P. Roy. Zool. Soc. N.S. Wales,* 1956-57: 148-152.

Pace, S., 1902, On the anatomy and relationships of *Voluta musica* Linn., with notes upon certain other supposed members of the Volutidae. *P. Mal. Soc. London,* 5: 21-31.

Pilsbry, H. A., and A. A. Olsson, 1945, Systems of the Volutidae. *Bull. Amer. Paleont.,* 35, No. 152.

Swainson, W., 1840, *A Treatise on Malacology.* London.

EXPLANATION OF PLATE xliv.

(All figures approximately two-thirds natural size.)

Fig. 1. *C. complexa complexa* Iredale. N. of Noosa Heads, Queensland. C.62066.
Fig. 2. *C. complexa complexa.* Off Manning River Heads, N.S.W. C.62308.
Fig. 3. *C. complexa neilseni* McMichael. Holotype. C.62297.
Fig. 4. *C. pulchra pulchra* Sowerby. South Keppel Id., Qld. C.62304.
Fig. 5. *C. pulchra woolacottae* McMichael. Heron Id., Qld. C.62265.
Fig. 6. *C. pulchra woolacottae.* Holotype. C.62264.
Fig. 7. *C. wisemani* Brazier. Holotype. C.11497.
Fig. 8. *C. wisemani* Brazier. Keeper Reef, off Townsville, Qld. C.62310.
Fig. 9. *C. perryi* Ostergaard & Summers. Paratype. A. J. Nash Collection.

Forthcoming Publications

The Royal Zoological Society of New South Wales expects to publish in the near future two more outstanding Handbooks on the Australian fauna.

The *Birds* of the Sydney District are the topic of an illustrated account by Messrs. K. Hindwood and A. McGill, who are both Fellows of the Society.

A Handbook on Australian *Dragonflies,* by Lieut.-Colonel F. C. Fraser (whose Reclassification of the Odonata was published by our Society last year) is in the printer's hands.

Both books can be confidently recommended to naturalists, and enquiries concerning them should be addressed to the Honorary Secretary, Royal Zoological Society of New South Wales, 28 Martin Place, Sydney.

It is also intended to publish a booklet on marlin swordfishes and a paper on stromb shells.

The Zoology of the "Australian Encyclopaedia"

By ANTHONY MUSGRAVE.
(By Permission of the Trustees of the Australian Museum, Sydney.)

The Australian Encyclopaedia[1], Sydney, published by Messrs. Angus & Robertson, Sydney, is a milestone in Australia's literary history, and represents a general survey of all that relates to Australia, and its national economy, as well as to neighbouring territories under Australian jurisdiction.

In 1925 Messrs. Angus and Robertson published the first volume, A to Lys, of the "first" edition of an encyclopaedia entitled *The Illustrated Australian Encyclopaedia,* edited by Arthur Wilberforce Jose and Herbert James Carter, while volume II, M to Z, appeared in the following year; though the work was entitled *The Australian Encyclopaedia.* This two-volume work has proved a valuable source of information, and has served us faithfully, till, with the passing of the years, it has become necessary to produce a new edition.

The "second," or 1958, edition, is now to hand, and far surpasses in appearance and format the earlier work, and *nine* volumes are required to include the vast stores of knowledge which have accumulated in the interim; the tenth volume being an Index to the whole work.

Many subjects are included in the present edition which were undreamed of 33 years ago, advances in all branches of science making this imperative. In addition, World War II, 1939-45, has provided a stimulus to knowledge in many directions.

In his Introduction, the Editor-in-Chief, Alex H. Chisholm, O.B.E., describes the methods adopted in compiling the work, and acknowledges the assistance he has received from many institutions and individuals. The fine illustrations, many in colour (some direct from nature by Frank Hurley), enhance the work, while the half-tone reproductions are particularly rich in detail. Many line drawings, some from the "first" edition, add to the interest and value of the articles. For the benefit of those desirous of learning something of the technical work of printing the *Encyclopaedia,* a page in volume I sets forth all the relevant details, together with the names of the firms responsible for the materials and for the actual printing of the volumes.

The Australian Encyclopaedia, we may confidently assert, will be, like its earlier namesake, a valuable source of reference for years to come. Here we would acknowledge our indebtedness to Messrs. Angus & Robertson for their foresight and courage in the undertaking of a work of such magnitude, to Alec H. Chisholm and his Editorial Staff, and to those firms involved in the printing of the volumes and at the same time extend to all concerned our congratulations on a work well done.

THE AUSTRALIAN FAUNA IN THE *ENCYCLOPAEDIA.*

The main function of this Review, however, is not to draw attention to the obvious merits of the work, but to deal, to the best of our ability, with the Australian Fauna as it is treated throughout the *Encyclopaedia.* From a zoologist's standpoint it soon becomes apparent that the study of the animal life of the Australian Continent has not remained static since the appearance of the earlier edition. Many articles are by contributors unknown to readers of the first edition, and whose names now appear in the list given in volume I. Among these contributors are various members of the *Commonwealth Scientific and Industrial Research Organisation,* Canberra, whose writings are familiar to readers of the journals issued by this great scientific body. At the same time, some of the articles of the "first" edition are reprinted in the new edition, though the names of some of the contributors are now followed by an asterisk to indicate that they have died. Among these lastnamed are such well-known figures in Australian Zoology as Prof. C. Chilton (Crustacea) and Allan R. McCulloch (Pisces).

[1]10 vols., 3 June, 1958, illustrated with plates in colour and black and white, line drawings and maps. Printed by the Halstead Press Pty. Ltd., Sydney. Price: £50.

Some of these articles from the "first" edition have been re-edited and augmented, and we find that Mr. G. P. Whitley (Curator of Fishes in the Australian Museum) has so edited and supplemented some of those by his former chief, A. R. McCulloch, while those of Prof. Chilton have been similarly treated by Mr. H. M. Hale (Director of the South Australian Museum).

Many of the articles about birds which appeared in the "first" edition of the *Encyclopaedia* were from the pen of Mr. W. B. Alexander, and a number of these have been revised by the Editor-in-Chief, who is well known for his interest in ornithology.

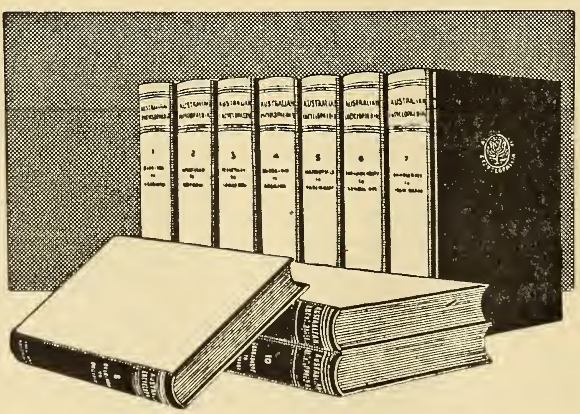
A number of new articles about fishes and birds also appear from Messrs. Whitley and Chisholm, respectively, so that these two animal groups tend to dominate the other zoological contributions. As the members of the Phylum Arthropoda (Crustacea, Insecta, Arachnida, Chilopoda and Dipolopda, &c.) are regarded as constituting about 75% of the Animal Kingdom, one might expect to find an overwhelming preponderance of articles about these animals, which is not the case, and though the articles on birds and fishes are of considerable interest one might wish that more selective articles on other groups of animals had been included so as to maintain a feeling of proportional representation in the groups.

In this nine-volume work a great many articles appear which could quite easily be overlooked by users of the Index (Volume x), so that an attempt is therefore made in this Review to give a supplementary list of all the articles in the *Encyclopaedia* which relate to Australian zoology. This list, or catalogue, is set forth under (1) the heading of the animal groups, and (2) the names of authors (together with the volume and page number). In addition, attention is drawn to such subjects as the "Fauna," Institutions of a scientific nature, and to the "biographies" of those whose work in the past has contributed in any way to study of the Australian fauna, recent or extinct.

On browsing through the volumes so much compels attention that one often feels reluctant to exclude from the almost purely zoological catalogue, as that given below, certain vital information. In particular are those articles on the work of exploring this Continent and mapping its long coast-line. These expeditions by land and sea in the past have contributed so immeasurably to our knowledge of the animal life of Australia and its sea-girt shores that the work of these explorers becomes almost inextricably interwoven with that of the science of biology itself.

THE AUSTRALIAN ENCYCLOPAEDIA

More than 4.500.000 words — 10 Volumes



A CATALOGUE OF THE ARTICLES ON THE AUSTRALIAN FAUNA IN THE AUSTRALIAN ENCYCLOPAEDIA

Amphibians

Anon. Toads. viii: 512. Kinghorn, J. R. Amphibia. i: 171-173.

Arachnids

Anon. Pseudo-scorpions [Chelonethi, Pseudoscorpionida or Chernetidae]. vii: 300.
do. Scrub-itch. viii: 48.
Glauert, L. Scorpions. viii: 31-32.
Musgrave, A. Arachnida. i: 221-222.
do. Spiders [Araneae or Araneida]. viii: 232-240, col. pl. 232A, tfs.
do. Ticks [Acarina-Ixodoidea]. viii: 498-499.
Norris, K. R. Cattle Tick [*Boophilus microplus*]. ii: 300-302.
Womersley, H. Acarina. i: 108-110, tfs.
do. Harvest-men (harvest spiders) [Phalangida or Opiliones]. iv: 440.

Birds

Anon. *Atrichornis*. Scrub-birds. i: 309.
do. Kestrel [*Falco cenchroides*]. v: 181-182, tf.
do. Sandpipers. viii: 3.
Alexander, W. B. Darter [*Anhinga novae-hollandiae*]. iii 201, tf.
do. Dollar-bird [*Eurystomus orientalis*]. iii: 266, tf.
do. Drongo, Spangled [*Chibia bracteata*]. iii: 288, tf.
do. Fig-birds [*Sphecotheres*]. iv: 57.
do. Grebes. iv: 381.
do. Log-runners [*Orthonyx*]. v: 358-359, tf.
do. Pelican [*Pelicanus conspicillatus*]. vii: 49-50, tf.
do. Rails and Crakes [Rallidae]. vii: 357, tf.
do. Sunbird [*Cyrtostomus frenatus*]. viii: 354-355, tf.
do. Tropic-birds. ix: 41-42.
Alexander, W. B. (and Chisholm, A. H.). Bustards [Otididae]. ii: 223, tf.
do. Butcher-birds [*Cracticus*]. ii: 223-224.
do. Cassowary [*Casuarius casuarius*]. ii: 278-279, tf.
do. Chats. ii: 334-335, col. pl. 334A.
do. Chough, White-winged [*Crocorax melanorhampus*]. ii: 356-357.
do. Cockatoos. ii: 439-440, tfs.
do. Crows. iii: 135.
do. Cuckoo-shrikes and Trillers [Campephagidae]. iii: 137-138, tf.
do. Cuckoos [Cuculiformes]. iii: 138-139, tfs.
do. Ducks and Geese (Anatidae). iii: 299-300, tfs.
do. Finches. iv: 63-64, pl. 64A—col.
do. Flycatchers [Muscicapidae]. iv: 120-121, tfs.
do. Friar-birds. iv: 216-217.
do. Gulls, Terns, and Skuas. iv: 400-401, fig.
do. Honeyeaters [Meliphagidae]. iv: 527-529 tfs.
do. Ibis [Ardeiformes]. v: 62.
do. Magpie-Lark [*Grallina cyanoleuca*]. v: 460.
do. Magpies [*Gymnorhina*]. v: 460.
do. Mound-building birds. vi: 182-184, tf.
do. Pigeons. vii: 112, col. pl. 112A.
do. Plain-wanderer [*Pedionomus torquatus*]. vii: 136-137, tf.
do. Quails. vii: 316, tf.
do. Robins. vii: 469-470, tf.
do. Silvereyes [*Zosterops*]. viii: 129, tf.
do. Sittellas [*Neositta*]. viii: 137.

McCulloch, A. R. (and Whitley, G. P.). Anchovy [*Austranchovia australis*]. i: 175.
do. Barramundi. i: 436, tf.
do. Butterfish. ii: 224.
do. Cod [Gadidae]. ii: 444-445.
do. Fishes. iv: 84-87, col. pls. 84A, 86A.
do. Flying-fishes [Exocoetidae]. iv: 124.
do. Hair-tails [*Trichiurus*]. iv: 410.
do. Herrings [Clupeiformes]. iv: 492-493.
do. Leather-jackets. v: 270-272, tf.
do. Mackerels. v: 436.
do. Morwong. vi: 160.
do. Mulloway [*Sciaena antarctica*]. vi: 195, tf.
do. Nannygai [*Centroberyx affinis*]. vi: 240, tf.
do. Old Wife [*Enoplosus armatus*]. vi: 395.
do. Trevallies [Carangidae]. ix: 35, tf.
do. Trout. ix: 50, tf.
do. White Shark [*Carcharodon albimors*]. ix: 297.
do. Whitings [Gadidae & *Sillago*]. ix: 298-299, tf.
Roughley, T. C. Aquaria. i: 220-221.
do. Fisheries. iv: 77-84, col. pl. 82A-82B.
do. Murray Cod [*Maccullochella macquariensis*]. vi: 204-205, fig.
do. Tailor [*Pomatomus pedica*]. viii: 409.
Whitley, G. P. Angler-fishes. i: 180, tf.
do. Archer-fishes [*Toxotes*]. i: 228-229, tf.
do. Bass, Red [*Lutjanus coatesi*]. i: 451.
do. Bellows-fishes. i: 486-487.
do. Blennies. ii: 31.
do. Blind Gudgeon [*Milyeringa veritas*]. ii: 34.
do. Boarfishes. ii: 43.
do. Box-fishes. ii: 81, tf.
do. Bream. ii: 105.
do. Bream, Butterfly [*Nemipterus*]. ii: 105.
do. Butterfly-fishes. ii: 229.
do. Carp. ii: 268-269.
do. Chinaman-fish [*Paradicichthys venenatus*]. ii: 350.
do. Clingfishes [Gobiesocidae]. ii: 419.
do. Cod, Butterfly. ii: 445, tf.
do. Congolli [*Pseudaphritis bursinus*]. ii: 495.
do. Cucumber-fish [*Chlorophthalmus nigripinnis*]. iii: 139.
do. Dolphin [*Coryphaena hippurus*]. iii: 266.
do. Dragonets [Callionymidae]. iii: 280.
do. Drummer [Kyphosidae]. iii: 294, tf.
do. Eels [Apodes]. iii: 361.
do. Fishes, Harmful. iv: 87-88.
do. Fishes, Introduced. iv: 88-89.
do. Flutemouths [*Fistularia*]. iv: 120.
do. Frogfishes [Batrachoididae]. iv: 220.
do. Goblin-fish [*Glyptauchen*]. iv: 390.
do. Grey Nurse [*Carcharias arenarius*]. iv: 390.
do. Gummy [*Emissola antarctica*]. iv: 401.
do. Hussars [Lutjanidae]. v: 38.
do. Jack Mackerel. v: 115.
do. Jawslinger. v: 123.
do. Jewfish. v: 132.
do. Kingfish. v: 192, tf.
do. Knife-jaw [*Oplegnathus woodwardi*]. v: 200.
do. Knight-fish [*Cleidopus gloria-maris*]. v: 200-201.
do. Lampreys. v: 225.
do. Lancelets. v: 225.
do. Lizard-fishes. v: 344.

Fossils

Insects

do. Crickets. iii: 113-114.
do. Diplura. iii: 254.
do. Fireflies. iv: 67.
do. Fleas. iv: 100.
do. Glowworms. iv: 308-309.
do. Hymenoptera. v: 60-61.
do. Insects. v: 89-91, col. pl. 90A.
do. Insects, Inquiline. v: 91-92.
do. Insects, Introduced. v: 92-95.
do. Ladybird Beetles. v: 219-220.
do. Mantids. v: 482.
do. Orthoptera. vi: 419.
do. Scorpion-flies [Mecoptera]. viii: 31.
do. Sheep-ked [*Melophagus ovinus*]. viii: 102.
do. Silverfish [Thysanura]. viii: 129-130.
do. Spring-tails. viii: 253.
do. Stick-insects and Leaf-insects. viii: 294.
do. Stone-flies. viii: 306.
do. Stylops [Strepsiptera]. viii: 339.
do. Wasps [Hymenoptera]. ix: 167-169.
do. Web-spinners [Embioptera]. ix: 222.
McKeown, K. C. (and Calaby, J. H.). Termites [Isoptera]. viii: 462-465.
MacKerras, I. M. Flies, Blood-sucking. iv: 103.
Musgrave, A. Hemiptera. iv: 471-482, tfs.
Nicholson, A. J. Insect Pests. v: 86-89.
Norris, K. R. Blowflies. ii: 36-37.
Rayment, T. Bees. i: 475-476, tfs.
Tillyard, R. J. Dragon-flies. iii: 279-280.
Tillyard, R. J. (and McKeown, K. C.). Neuroptera. vi: 269-270.
Tindale, N. B. Witchety Grub. ix: 339-340, tf.
Zeck, E. H. Butterflies. ii: 225-229, col. pl. 228A.
do. House-flies. v: 7-8.
do. Flies of economic significance. iv: 103-106.
do. Lepidoptera. v: 288-289.
do. Moths. vi: 166-172, tfs.

Institutions

Anon. Gould League of Bird Lovers. vi: 348.
do. Linnean Society of New South Wales. v: 325.
do. Museums. vi: 212-216.
do. National Parks. vi: 245-251.
do. Natural-History Societies. vi: 252-255.
do. Royal Societies. vii: 511-513.
do. Zoological Gardens. ix: 541-545.
do. Zoological Society of N.S. Wales. ix: 542.
Melville, J. Waite Institute. ix: 142-143.

Invertebrates—Marine

Allan, J. Mollusca. vi: 117-135, tfs.
do. Trochus Shell [*Trochus niloticus*]. ix: 39.
Angel, L. M. Endoprocta [Marine and freshwater animals]. iii: 393.
do. Polyzoa or Bryozoa. vii: 186-187.
Briggs, E. A. Bluebottles. ii: 40-41.
do. Hydroid Zoophytes [Hydrozoa]. v: 59-60.
do. Jelly-fish [Coelenterata-Scyphozoa]. v: 126-127.
do. Sea-anemones [Coelenterata-Actinozoa]. viii: 51.
Briggs, E. A. (and Browne, W. R.). Coral [Actinozoa]. iii: 59-61, col. pl. 60A.
Chilton, C. (and Hale, H. M.). Sandhoppers [Crustacea-Amphipoda]. viii: 2-3.
do. Wood-lice and Sea-lice [Crustacea-Isopoda]. ix: 349-350.
Colefax, A. N. Arrow-worms [Chaetognatha]. i: 245-246.
do. Plankton. vii: 138.

Hale, H. M. Cumacea. iii: 142, tf.
Johnson, R. A. Marine Borers. v: 492-494.
Johnson, R. A., and Fry, M. D. Marine Growths on Ships. v: 494-495.
Kott, E., and Pope, E. C. Ascidians. i: 273-274.
McNeill, F. N. Crabs [Decapoda]. iii: 82-93, pl. 92A, tfs.
do. Crustacea. iii: 136-137.
do. Hermit Crabs and Allies [Decapoda-Paguridea]. iv: 489-492, tfs.
do. Prawns and Shrimps [Crustacea-Natantia]. vii: 255-257, tfs.
Pope, E. C. Barnacles. i: 432-433.
do. Bristle-worms [Chaetopoda]. ii: 129.
do. Brittle-stars [Ophiuroidea]. ii: 135-136, tf.
do. Cunjevoi (animal). iii: 145.
do. Echinoderms [Echinodermata]. iii: 330.
do. Feather-stars [Crinoidea]. iv: 22.
do. Holothurians [Holothuroidea]. iv: 521-522, tfs.
do. Sea-urchins [Echinoidea]. viii: 53-54, tf.
do. Sponges. viii: 251-252.
do. Starfishes or Sea-stars [Asteroidea]. viii: 269-270, tfs., col. pl. 268A.
Racek, A. A. Prawning Industry. vii: 254-255.
Roughley, T. C. Crayfish Industry. iii: 93-94, pl. 92A.
do. Oysters and Oyster Culture. vi: 432-434, pl. 434A.
Simpson, C., and Norman, E. de B. Pearls and Pearling. vii: 43-46, pls. 44A-44B; tfs.
Stephenson, N. G. Acorn-worms. i: 113.
do. Mantis Shrimps [Crustacea-Stomatopoda]. v: 482-483.
Thomas, I. M. Brachiopoda [Lamp-shells]. ii: 91-92.
do. Echiurida. iii: 330.
do. Phoronidea. vii: 102.

Invertebrates (other than arachnids, insects and marine).

Anon. Mountain Shrimp [*Anaspides tasmaniae*]. vi: 188.
do. Blood-flukes. ii: 34-36.
do. Flatworms [Platyhelminthes-Turbellaria]. iv: 99.
do. Flukes [Platyhelminthes-Trematoda]. iv: 118-119.
Backhouse, T. C. Hydatid. v: 41.
do. Tapeworms [Platyhelminthes]. viii: 415-417.
Edmonds, S. J. Acanthocephala. i: 108.
Racek, A. A. Water-fleas [Crustacea-Branchiopoda]. ix: 191-192.
Riek, E. F. Rotifera. vii: 500-501.
Steel, T. Leeches. v: 273.
do. Peripatus [Prototracheata or Onychophora]. vii: 66-67, tf.
do. Planarians, Land [Turbellaria]. vii: 137-138, tf.
Steel, T. (and Pope, E. C.). Earthworms [Oligochaeta]. iii: 327-328.
do. Ribbon-worms [Rhyncocoela, Nemertea or Nemertina]. vii: 420-421.
Thomas, I. M. Linguatulida. v: 325.
do. Worms. ix: 506-507.
Thomas, P. M. Roundworms [Nematoda]. vii: 502-503.

Mammals

Anon. Buffalo [*Bubalus buffalus*]. ii: 176.
do. Mole, Marsupial. vi: 115-116.
do. Whaling Industry. ix: 273-279, pls. 272A-B.
Chisholm, A. H. Mammals, Introduced. v: 471-474.
Dunbabin, T. Sealing. viii: 56-58.
Ratcliffe, F. N., and Calaby, J. H. Rabbit. vii: 340-347, pl. 342A.
Troughton, E. Banded Ant-eater or Numbat. i: 408.
do. Bandicoots. i: 409-410, tf.
do. Bats. i: 458-461.
do. Cats, Marsupial. ii: 287-288.
do. Dolphins (Delphinidae) [Cetacea-whales]. iii: 266-267.
do. Dugong [Sirenia]. iii: 307.

do. Kangaroos and Wallabies [Macropodidae]. v: 156-162, tfs.
do. Koala [*Phascolarctos cinereus*]. v: 203-205, pl. 202A; tf.
do. Mammals. v: 471, col. pl. 470A.
do. Marsupials. vi: 1-2, tf.
do. Mice, Marsupial. vi: 67-69.
do. Monotremes. vi: 139-141.
do. Platypus [*Ornithorhynchus anatinus*]. vii: 150-154, pl. 152A; tf.
do. Possums [Phalangeridae]. vii: 233-239, tfs.
do. Rats and Mice [Rodentia]. vii: 389-391.
do. Seals. viii: 54-56.
do. Spiny Ant-eaters [Monotremata]. viii: 241-243, tf.
do. Tasmanian Devil [*Sarcophilus harrisi*]. viii: 437-438, tf.
do. Thylacine [*Thylacinus cyanocephalus*]. viii: 495-496, tf.
do. Water-rats [Muridae-Hydromyinae]. ix: 195.
do. Whales [Cetacea]. ix: 268-273.
do. Wombats [Vombatidae]. ix: 345-346.

Millipedes

Womersley, H. Millipedes. vi: 87-88.

Obituaries

Anon. Arnold, Joseph (1782-1818). i: 245.
do. Bancroft, Joseph (1836-94). i: 407-408.
do. Banks, Sir Joseph (1743-1820). i: 419-422.
do. Blandowski, William. ii: 29.
do. Brazier, John (1842-1930). ii: 101-102.
do. Broinowski, Gracius Joseph (1837-1913). ii: 156-157.
do. Brown, Robert (1773-1858). ii: 165-166.
do. Campbell, Archibald George (1880-1954). ii: 245.
do. Cayley, Neville Thomas (1887-1950). ii: 306-307.
do. Chapman, Frederick (1864-1943). ii: 331.
do. Clark, Hubert Lyman (1870-1947). ii: 394-395.
do. Collie, Alexander (1793-1835). ii: 450.
do. Cook, James (1728-79). iii: 40-47, pl. 44A, tf.
do. Cotton, John (1801-49). iii: 72.
do. Cumpston, John Howard Lidgett (1880-1954). iii: 144-145.
do. Cunningham, Allan (1791-1839). iii: 146-147.
do. Dakin, William John (1883-1950). iii: 176-177.
do. Darwin in Australia. Charles Robert Darwin (1809-82). iii: 203.
do. Davidson, James (1885-1945). iii: 208.
do. D'Entrecasteaux, Antoine Raymond Joseph de Bruni (1739-93). iii: 238-239.
do. De Vis (or Devis), Charles Walter (1829-1915). iii: 243.
do. Dietrich, Amalie (c. 1821-91). iii: 248.
do. Diggles, Silvester (1817-80). iii: 248.
do. Dobson, William Lambert (Sir) (1833-98). iii: 263.
do. Drummond, James (1783-1863). iii: 294-295.
do. Dumont d' Urville, Jules Sébastien César (1790-1842). iii: 309-310.
do. Dun, William Sutherland (1868-1934). iii: 310.
do. Elsey, Joseph Ravescroft (1834-58). iii: 384.
do. Fletcher, Joseph James (1850-1926). iv: 101-102.
do. French, Charles (1842-1933). iv: 213.
do. Freycinet, Louis Claude de Saulces de (1779-1842). iv: 216-217.
do. Froggatt, Walter Wilson (1858-1937). iv: 220.
do. Gilbert, John (-1845). iv: 292.
do. Gould, Elizabeth (1804-41). iv: 345-346.
do. Gould, John (1804-81). iv: 346-347.
do. Grey, Sir George. iv: 388-390.
do. Gunn, Ronald Campbell (1808-81). iv: 403-404.
do. Hall, Robert (1867-1949). iv: 415.
do. Hamilton, Alexander Greenlaw (1852-1941). iv: 419.

do. Harrison, Launcelot (1881-1928). iv: 437.
do. Haswell, William Aitcheson (1854-1925). iv: 442-443.
do. Hedley, Charles (1862-1926). iv: 469-470.
do. Helms, Richard (1842-1914). iv: 471.
do. Hooker, Sir Joseph Dalton (1817-1911). iv: 530.
do. Howitt, Godfrey (1800-1873). v: 21.
do. Hull, Arthur Francis Basset (1862-1945). v: 29.
do. Hunter, John (1737-1821). v: 32-33.
do. Huxley in Australia [Thomas Henry Huxley (1825-95)]. v: 40-41.
do. Jack, Robert Logan (1845-1921). v: 115.
do. Johnston, Robert Mackenzie (1844-1918). v: 140.
do. Johnston, Thomas Harvey (1881-1951). v: 140.
do. Jones, Frederick Wood (1879-1954). v: 142-143.
do. King, Phillip Parker (1791-1856). v: 189-190.
do. Krefft, Johann Ludwig Gerhard (1830-81). v: 213.
do. Lea, Arthur Mills (1868-1932). v: 266-267.
do. Legge, William Vincent (1840-1918). v: 280-281.
do. Lesueur, Charles Alexandre (1778-1846). v: 292.
do. Lewin, John William (1770-1819). v: 293.
do. Lhotsky, John. v: 296-297.
do. Longman, Heber Albert (1880-1954). v: 363.
do. Lord, Clive Errol (1889-1933). v: 366-367.
do. Lucas, Arthur Henry Shakespeare (1853-1936). v: 382-383.
do. Lumholtz, Carl Sofus (1851-1922). v: 385.
do. Lyell, George (1866-1951). v: 388.
do. McCoy, Sir Frederick (1817-99). v: 414.
do. McCulloch, Allan Riverstone (1885-1925). v: 416.
do. Macdonald, Donald (1857-1932). v: 417-418.
do. MacGillivray, John (1821-67). v: 424.
do. Macgillivray, William David Kerr (1867-1933). v: 424.
do. Mackenzie, Sir William Colin (1877-1938). v: 435.
do. Macleay, Alexander (1767-1848). v: 440-441.
do. Macleay, Sir William John (1820-91). v: 442-443.
do. Macleay, William Sharp (1792-1865). v. 443.
do. Mathews, Gregory Macalister (1876-1949). vi: 9-10.
do. May, William Lewis (1861-1925). vi: 14-15.
do. Meredith, Louisa Anne (1812-95). vi: 57.
do. Mitchell, Sir Thomas Livingstone (1792-1855). vi: 110-112.
do. North, Alfred John (1855-1917): vi: 354.
do. Ogilby, James Douglas (1853-1925). vi: 389.
do. Parkinson, Sydney (c.1745-71). vi: 489.
do. Peron, Francois (1775-1810). vii: 67.
do. Pratt, Ambrose (1874-1944). vii: 253.
do. Ramsay, Edward Pearson (1842-1916). vii: 386.
do. Receveur, Louis (-1788). vii: 394-395.
do. Roe, John Septimus (1797-1878). vii: 477-478.
do. Ryan, Sir Charles Snodgrass (1853-1926). vii: 530-531.
do. Scott, Alexander Walker (1800-83). viii: 37.
do. Scott, James (1790-1837). viii: 38-39.
do. Sloane, Thomas Gibson (1858-1932). viii: 143-144.
do. Solander, Daniel Carl (1736-82). viii: 195.
do. Spencer, Sir Walter Baldwin (1860-1929). viii: 230.
do. Steel, Thomas (1858-1925). viii: 279.
do. Stokes, John Lort (1812-85). viii:- 300.
do. Strange, Frederick (-1854). viii: 315.
do. Stuart, James (1802-1842). viii: 331.
do. Stutchbury, Samuel (1797-1859). viii: 338-339.
do. Tate, Ralph (1840-1901). viii: 439-440.
do. Tenison-Woods, Julian Edmund (1832-89). viii: 454-455.
do. Tillyard, Robin (Robert) John (1881-1937). viii: 502-503.

do. Tryon, Henry (1856-1943). ix: 54.
do. Verco, Sir Joseph Cooke (1851-1933). ix: 105-106.
do. Waite, Edgar Ravenswood (1866-1928). ix: 141.
do. Waterhouse, Gustavus Athol (1877-1950). ix: 213.
do. Watling, Thomas (1762-). ix: 214.
do. Wheelwright, Horace William (1815-1865). ix: 289.
do. White, Henry Luke (1860-1927). ix: 294.
do. White, John (c.1750-1832). ix: 295.
do. White, Samuel (1835-1880). ix: 295-296.
do. White, Samuel Albert (1870-1954). ix: 296.
do. Whitelegge, Thomas (1850-1927). ix: 297-298.
do. Whittell, Hubert Massey (1883-1954). ix: 299.
do. Wickham, John Clements (1798-1864). ix: 300-301.
do. Wilson, Herbert Ward (1877-1955). ix: 321-322.
do. Wilson, James Thomas (1861-1945). ix: 322-323.

Reptiles

Anon. Crocodiles. iii: 130-131.
do. Lizards. v: 344-348, tfs.
do. Perentie [*Varanus giganteus*]. vii: 54-55.
do. Sea-serpents. viii: 52.
do. Snakes. viii: 161-169, col. pls. 162A, 166B, and pl. 166A.
Brazenor, C. W. Reptiles. vii: 411.
do. Tortoises and Turtles [Chelonia]. viii: 527-528.

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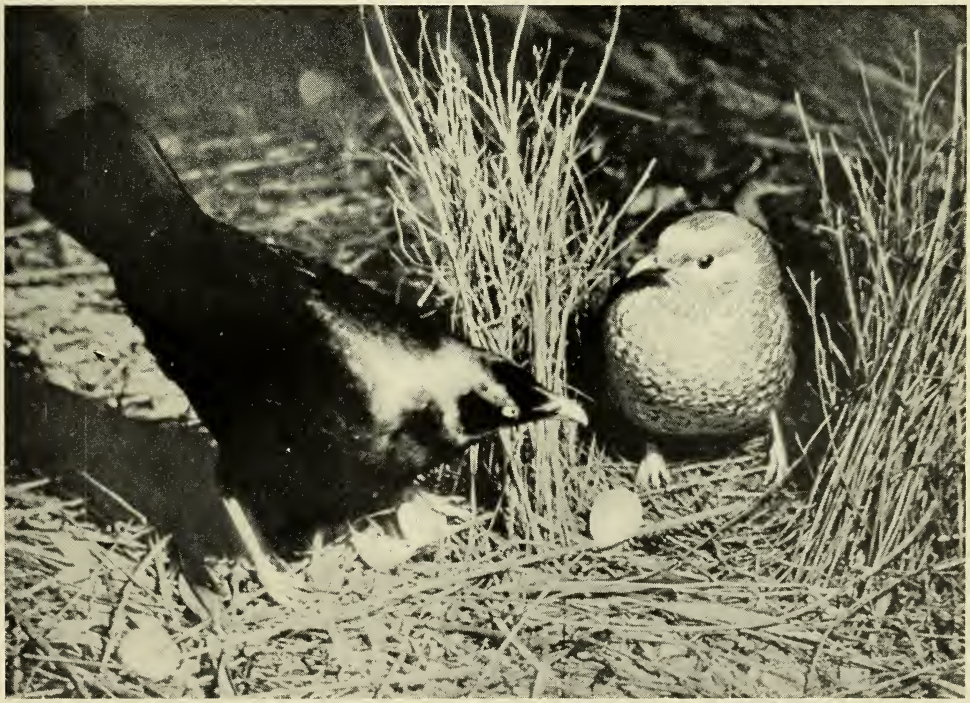

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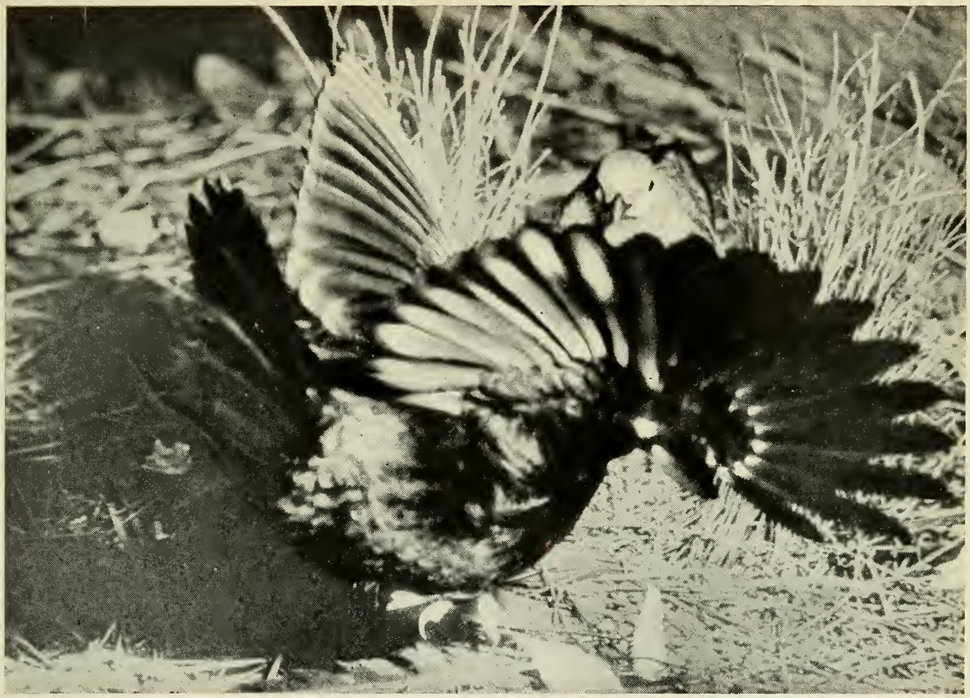

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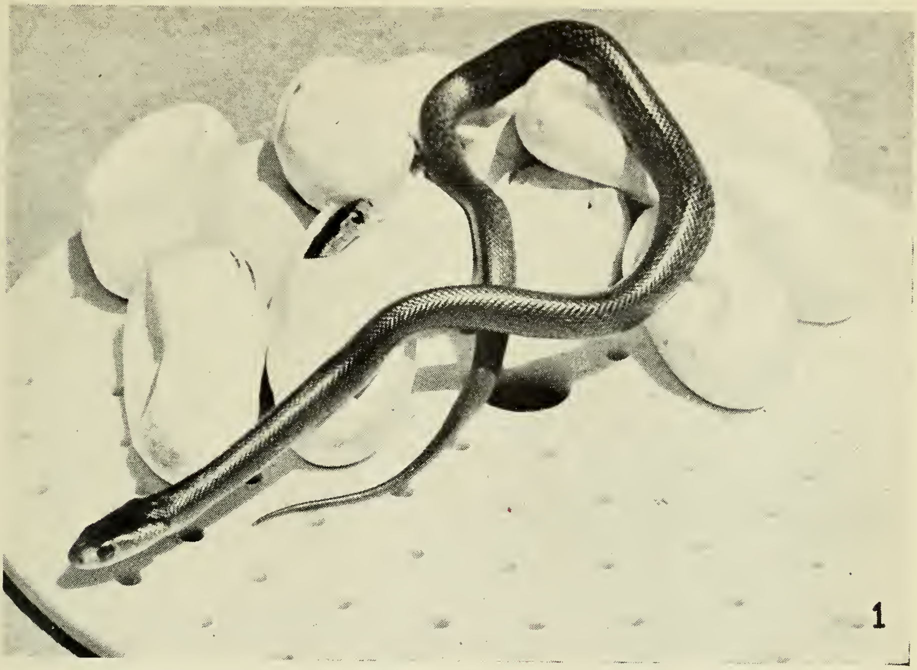

New Guinea Taipan eggs and young.

Photos—K. R. Slater.

Lace Monitor, Lion Island, New South Wales.

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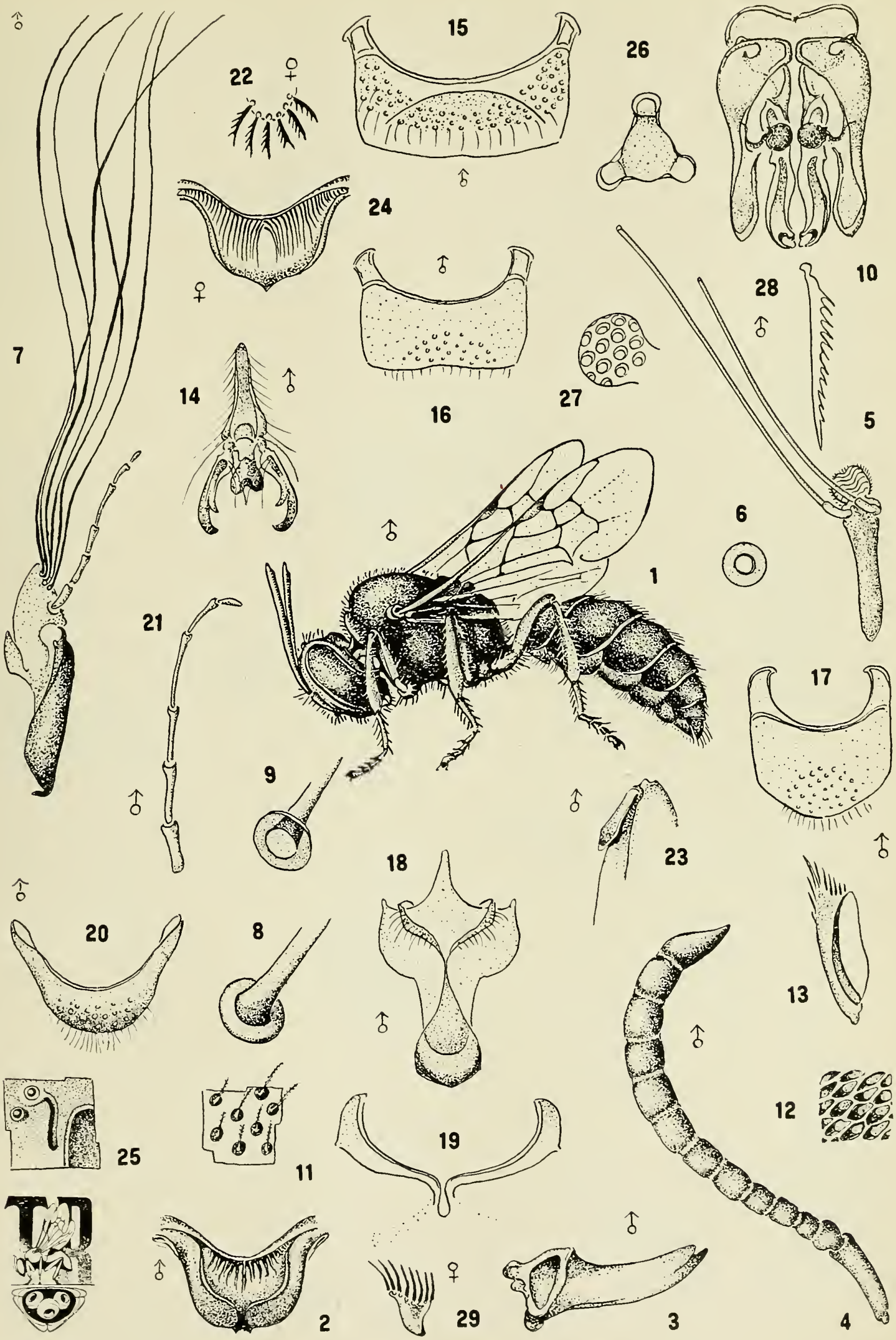

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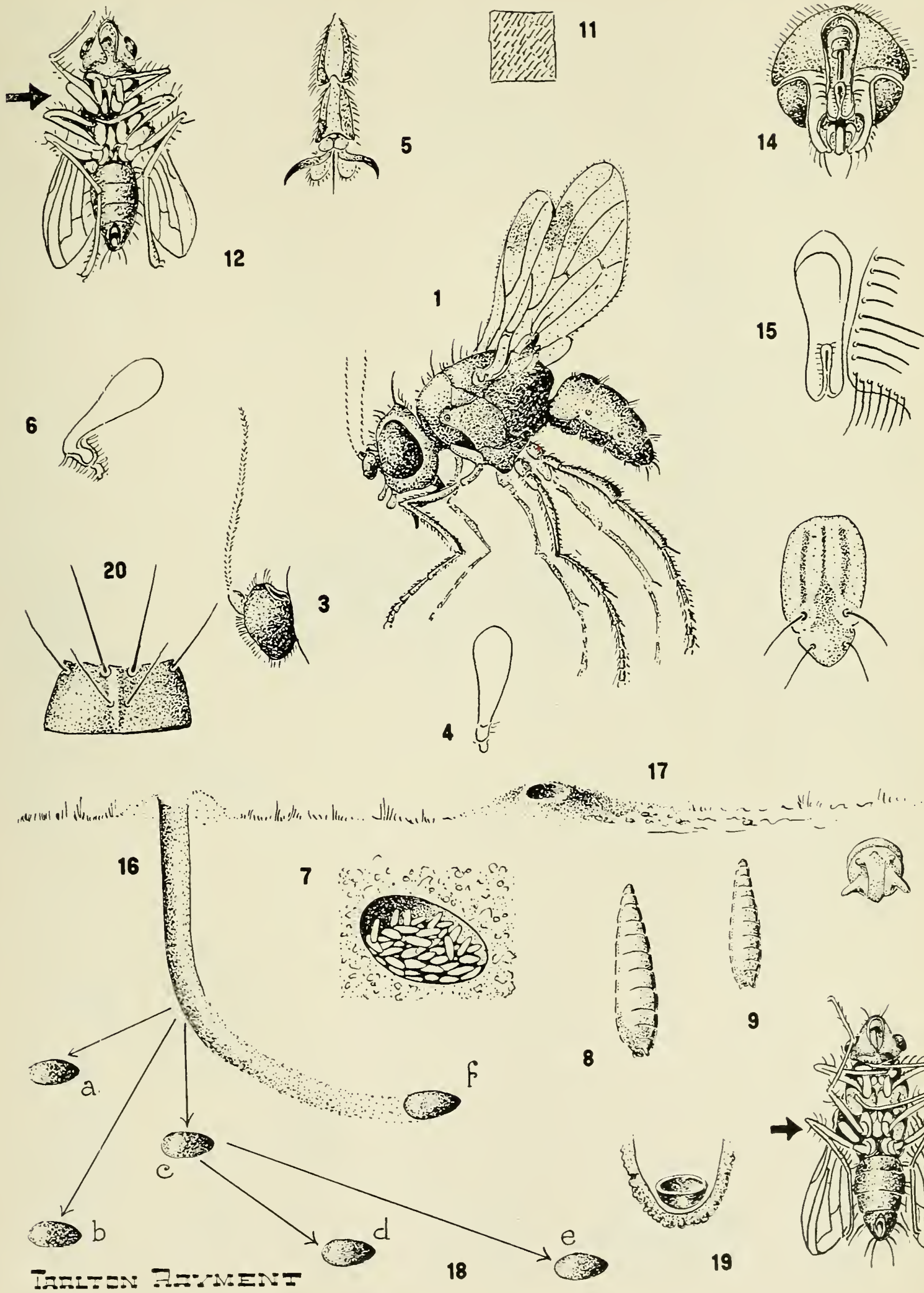

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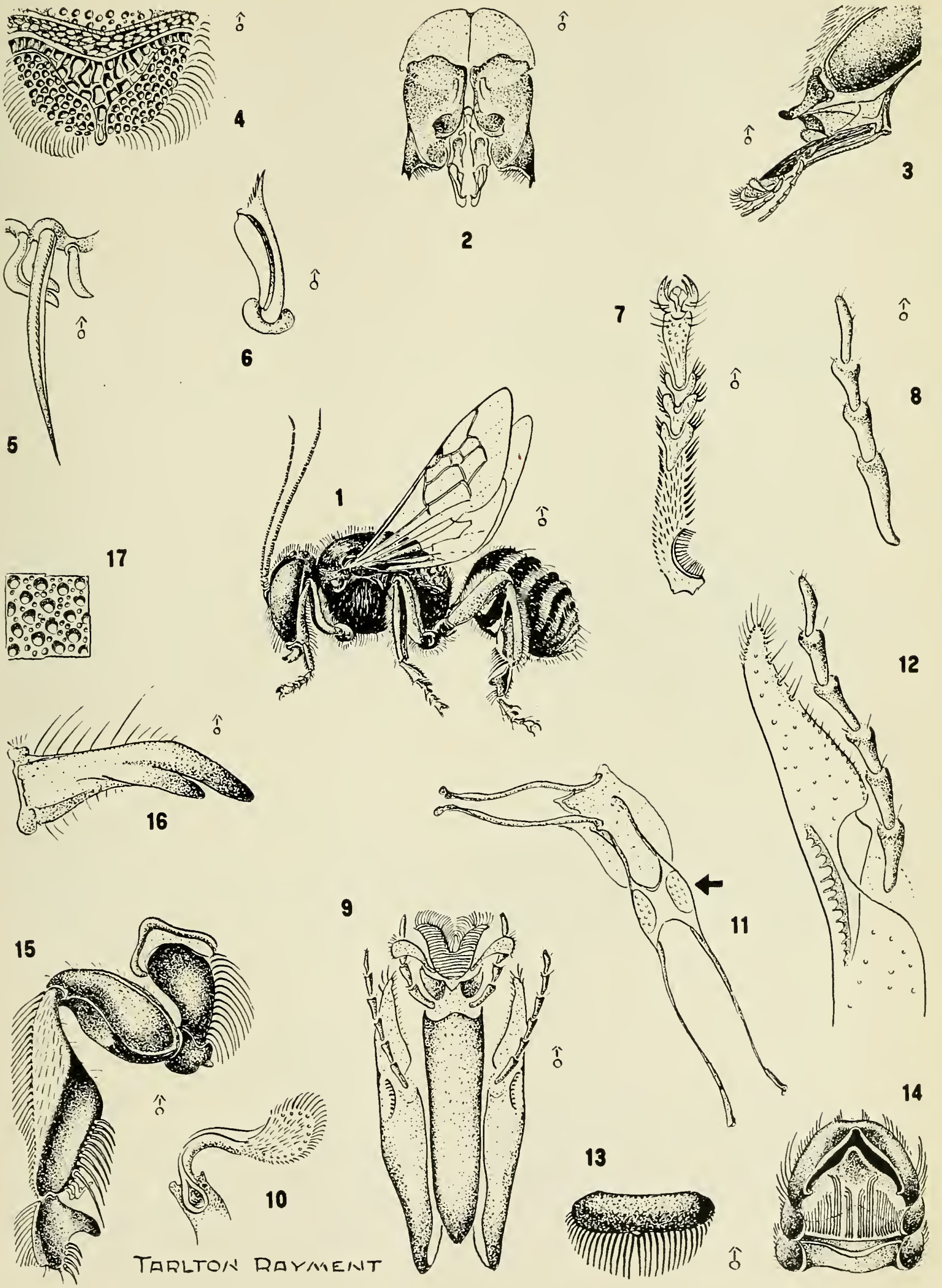

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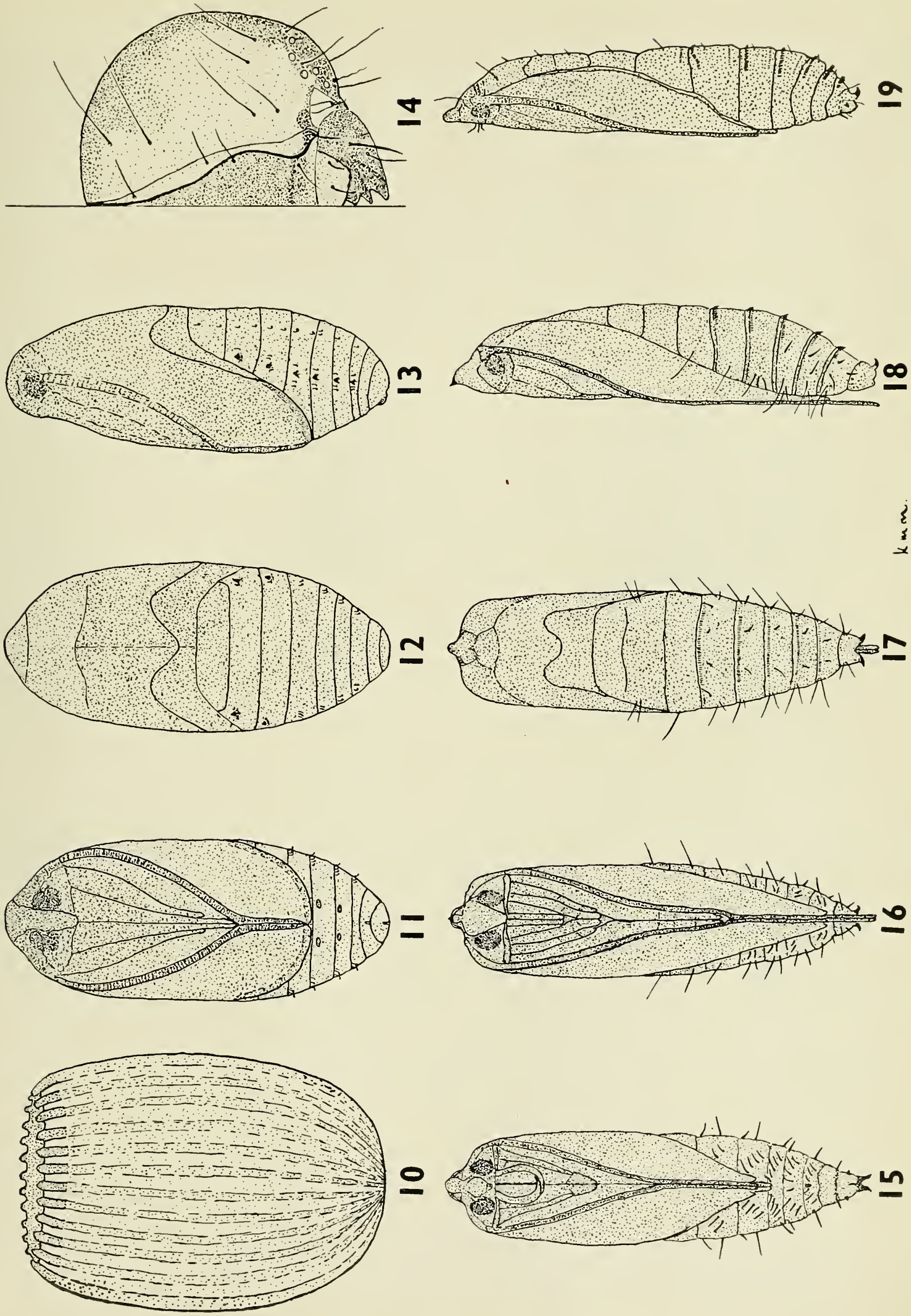

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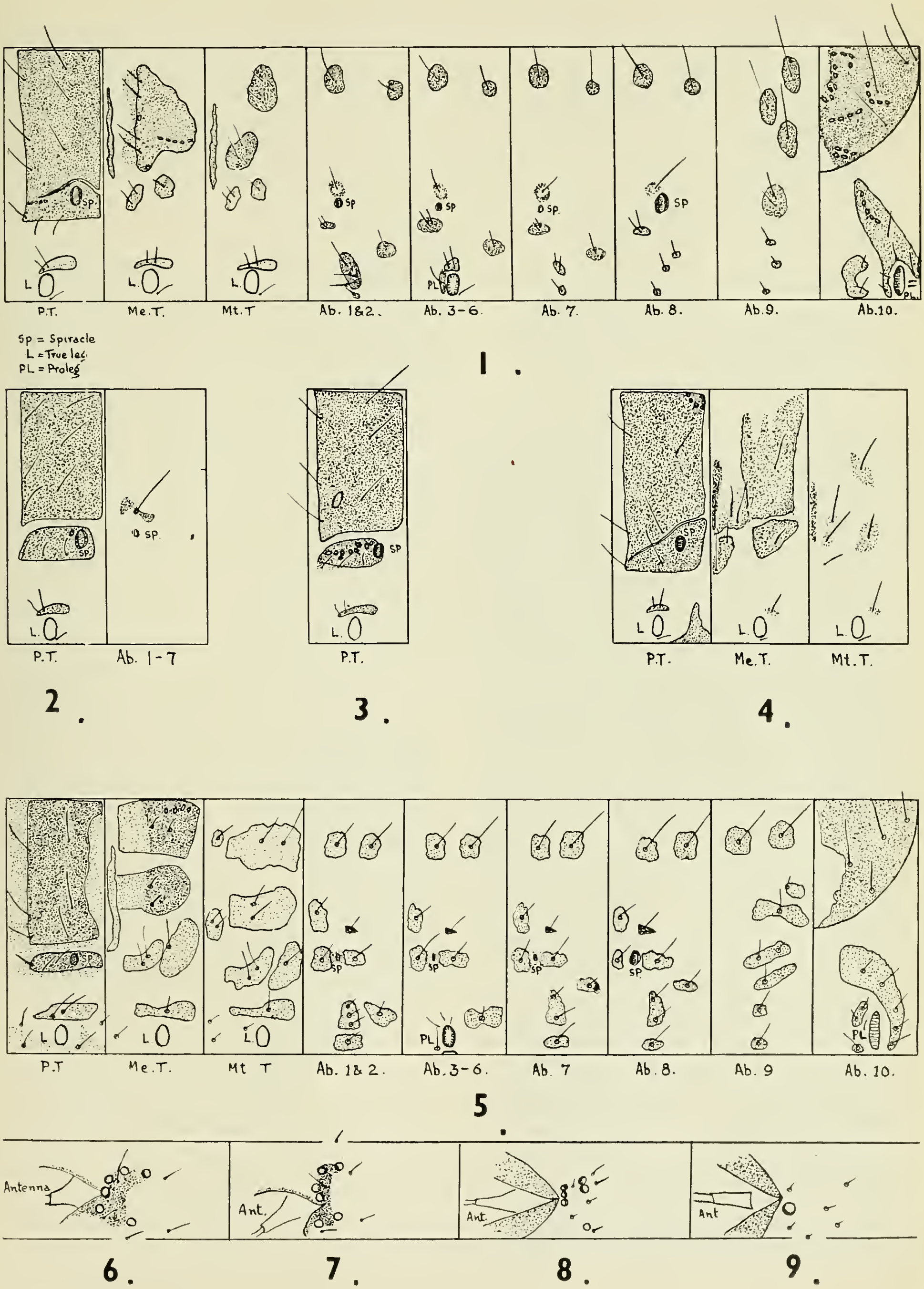

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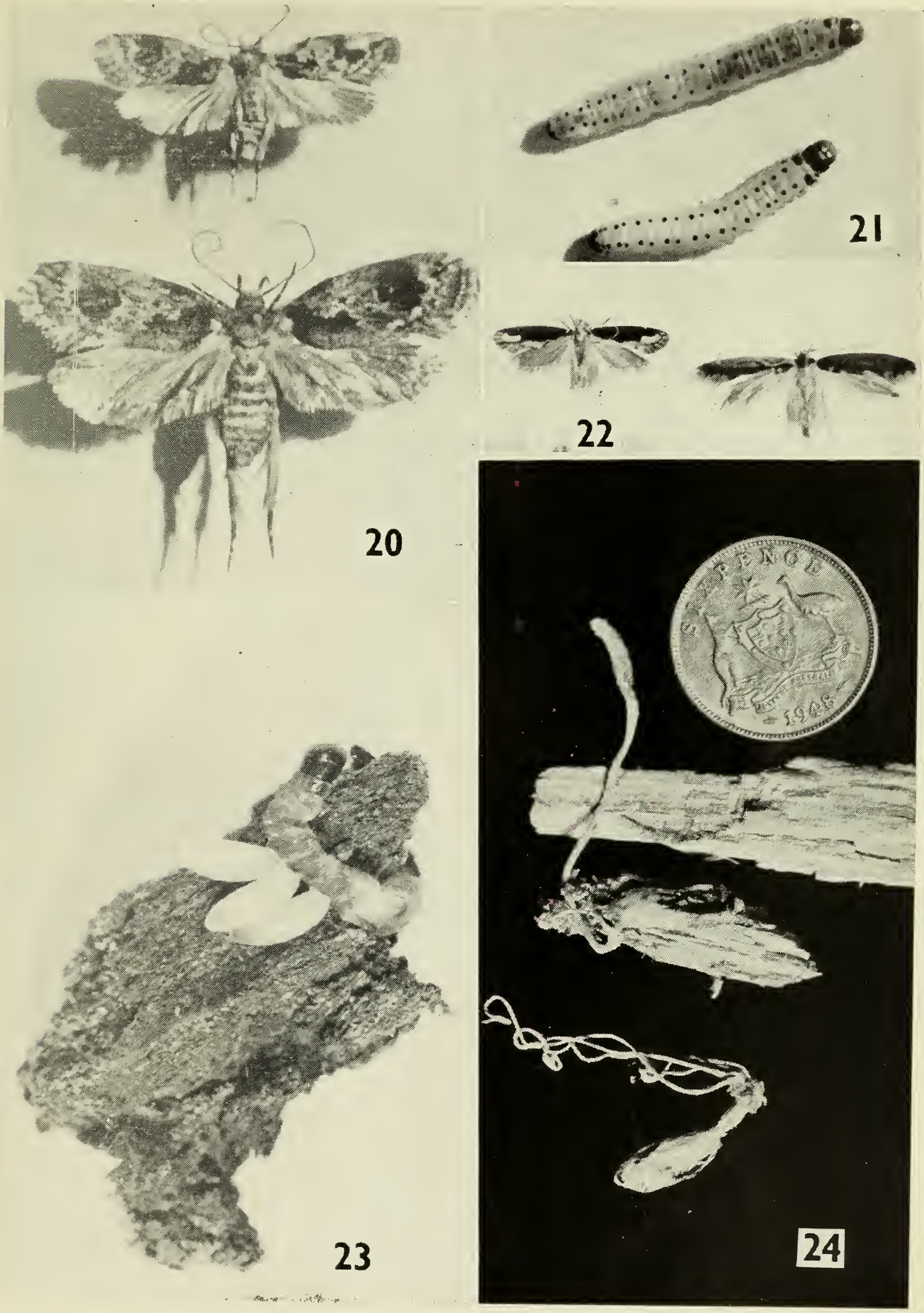

Lepidoptera attacking trees and timber.

Photos—R. Moulton (23,24) and K. M. Moore.

Volute Shells of the genus *Cymbiolacca.*

John Beeman pinx.

(Block donated in memory of the late Leone Woolacott.)

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