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Western Australia.

Vol. XXI.

1934-35.

The Authors of Papers are alone responsible for the statements
and
the opinions expressed therein.

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THE ROYAL SOCIETY OF WESTERN AUSTRALIA.

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T. H. Wilson.

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VOLUME XXI.

ROYAL SOCIETY OF WESTERN AUSTRALIA.

ANNUAL REPORT OF THE COUNCIL FOR YEAR ENDED 30th JUNE, 1935.

Ladies and Gentlemen,

Your Council begs to submit the following report for the year ended 30th June, 1935:—

There are 92 ordinary members and 56 associate members, as compared with 95 ordinary members and 54 associates, on 30th June, 1934. In addition there are nine honorary members and six corresponding members as well as eight student members. During the year three ordinary members and nine associates have been elected, while three students have been transferred to full membership of the Society. On the other hand four ordinary members and three associates have resigned.

We regret to report the loss by death of two very valued members of the Society, Mr. Hugh Plaistowe and Mr. G. F. Pitchford.

Council.—Eleven ordinary meetings and one special meeting of the Council were held during the year.

Finance.—The grant received from the Treasury during the year was at the rate of £80 per annum, and the Council wishes to express its thanks to the Government for the subsidy. Without the aid of the Government grant, the publication of papers in the Journal would have to be even more seriously curtailed than at present. The satisfactory financial position of the Society is due in a very large measure to the management of the finances of the Society by the Hon. Treasurer, Mr. H. Bowley, and the effective co-operation afforded him by the Editor, Mr. B. L. Southern.

Publications Committee.—Volume XX. of the Society's Journal, together with the revised list of members and exchanges, has been published and forwarded to members. All eleven papers for publication in Volume XXI. have either been completed or are in the hands of the printers. It is anticipated that the completion of this volume will require a further expenditure of £70 chargeable against the credit balance showing in the Hon. Treasurer's statement.

The Committee deferred publishing papers communicated by members on behalf of scientific workers, not resident in Western Australia, until the end of the financial year to avoid the possibility of excluding, for financial reasons, work by ordinary members.

A pleasing feature of the new volume is the large number of new authors.

The Government Printer and his staff have again been of great assistance to the Editor. Their willing co-operation is much appreciated by the Committee.

Mr. B. L. Southern again carried out the duties of Editor, and the Council desires to express its appreciation of his work in that capacity.

Library.—The Society is in regular exchange with 144 institutions, 47 of which are in Australia, 17 in the United Kingdom, 17 in the Dominions of the Empire, 31 in the United States of America, 29 in Europe, and three in Asia.

Hector Medal of the Royal Society of New Zealand.—The recipient for 1934 of this Award, made by the Royal Society of New Zealand, was Professor C. E. Weatherburn, of the University of this State, and the Royal Society of Western Australia was asked to act on behalf of the New Zealand Society in arranging for its public presentation. Owing to a change in design of the medal there was considerable delay in its preparation and, as Professor Weatherburn was leaving the State on study leave, it was decided to arrange for the public presentation of the medal to be made during his stay in England—probably at Cambridge. The accompanying money prize was handed to Professor Weatherburn privately.

H. W. BENNETTS,
President.

L. W. PHILLIPS,
D. L. SERVENTY,
Joint Hon. Secretaries.

ROYAL SOCIETY OF WESTERN AUSTRALIA.

Statement of Receipts and Expenditure for the Year ended 20th June, 1935.

General Fund

Receipts.	£	s.	d.
General Fund—			
Balance, 1st July, 1934 ...	96	16	2
Subscriptions ...	134	8	9
Government Grant, July, 1934, to May, 1935 ...	73	6	8
Authors Reprints, and Refunds for Half Cost of Blocks ...	15	18	5
	£320	10	0

Payments.	£	s.	d.	£	s.	d.
Petty Expenses, including Postage, etc. ...				14	5	11
Clerical Assistance ...				9	2	6
Stationery ...				5	2	8
Annual Meeting, Catering ...				6	0	0
,, ,, Rent ...				3	3	0
Ordinary Meetings, Catering ...				7	10	0
Museum Trustees, Rent ...				12	0	0
,, ,, Attendant's Fee ...				7	3	0
Editor, Honorarium ...				15	15	0
Excursion Expenses ...				1	3	11
Transfer to Medal Fund ...				7	10	0
Refunds ...				0	11	0
Post Office Box Rent ...				3	0	0
Government Printer—						
Journal XX., completing ...	66	7	9			
Journal XXI., part cost ...	39	18	10			
Notices of Meetings ...	2	12	6			
Miscellaneous Printing ...	2	9	11			
				111	9	0
Balance, 20th June, 1935 ...				116	14	0
				£320	10	0

Medal Fund

Receipts.	£	s.	d.
Medal Fund—			
Balance, 1st July, 1934 ...	7	13	3
Transfer from General Account, 7th August, 1934 ...	7	10	0
	£15	3	3

Payments.	£	s.	d.
Balance, 20th June, 1935 ...	15	3	3
	£15	3	3

Endowment Fund

Receipts	£	s.	d.
Endowment Fund—			
Balance, 1st July, 1934 ...	167	1	3
	£167	1	3

Payments	£	s.	d.
Balance, 20th June, 1935 ...	167	1	3
	£167	1	3

Note.—£167 1s. 3d. placed on fixed deposit at Commonwealth Bank, Perth, on 12th June, 1934, for 24 months at $2\frac{3}{4}$ per cent. interest per annum.

Summary of Funds at 20th June, 1935.

	£	s.	d.
Credit Balance, General Fund ...	116	14	0
,, ,, Medal Fund ...	15	3	3
,, ,, Endowment Fund ...	167	1	3
	£298	18	6

Perth, 5th July, 1935.

H. BOWLEY, Hon. Treasurer.

Audited and found correct, with books, receipts and vouchers produced, and we consider this a true statement of the Royal Society's Accounts.

R. E. GATHERER,
THOS. H. WILSON,
Hon. Auditors.

ABSTRACT OF PROCEEDINGS, 1934-1935.

10TH JULY, 1934—

Annual General Meeting held at Karrakatta Club. Presidential Address: "The Problem of Correlation in Stratigraphical Geology," Mr. L. Glauert.

14TH AUGUST, 1934—

Papers—Professor E. de C. Clarke communicated a paper by Miss K. Prendergast: "Revision of some Western Australian Permian Fossils."

Dr. Serventy communicated a paper by Messrs. F. Chapman and W. J. Parr: "Foraminifera and Ostracoda from Soundings made by the Trawler 'Bonthorpe' in the Great Australian Bight."

11TH SEPTEMBER, 1934—

Lecture—"Some Western Australian Snakes," Mr. L. Glauert.

9TH OCTOBER, 1934—

Papers—"Note on an Australite observed to fall in Western Australia," Dr. E. S. Simpson.

"A Survey of the Genus Phalloniscus (Oniscoidea) with Descriptions of Several New Species," Miss E. A. Bowley.

"Earthworms from South-Western Australia," Dr. W. L. Michaelsen, communicated by Mr. L. Glauert.

Lecture—"Recent Investigations of the Blow-fly and Buffalo-fly Problems in Western Australia," Dr. I. M. Mackerras.

13TH NOVEMBER, 1934—

Lecture—"The Soils of Western Australia in Relation to Climate and Agriculture," Dr. L. J. H. Teakle.

11TH DECEMBER, 1934—

Paper—"The Genus Cheilea in Australian Waters," B. C. Cotton, communicated by L. Glauert.

Exhibits—"The Pelshenke Test as a Measure of Flour Quality," Mr. G. E. M. Dean.

"Colour Variation in Brown Snakes," Mr. L. Glauert.

"Soil Texture," Mr. B. L. Southern and Miss H. T. Cole.

"Hook-worm and other Parasites of the Small Bowel of Sheep," Dr. H. W. Bennetts.

"Diseases of Wheat with Special Reference to Rust," Mr. H. A. Pittman.

"Variolitic Rocks from near Meekatharra," Mr. R. T. Prider.

"Local Laterites," Mr. S. E. Terrill.

12TH MARCH, 1935—

Lecture—"Aerial Surveys in Northern Australia," Mr. F. G. Forman.

9TH APRIL, 1935—

Papers—"A New Genus and Two New Species of Western Australian Aleyrodidae," Mr. M. E. Solomon.

"Thrip Census," L. J. Newman, paper tabled.

Lecture—"Manufacture of Flour and Bread," Mr. G. E. M. Dean.

14TH MAY, 1935—

Papers—"Essential Oils of some Western Australian Eucalypts," Dr. E. M. Watson and Mr. G. Marshall.

Lecture—"The Plague Thrips," Mr. L. J. Newman.

11TH JUNE, 1935—

Lecture—"The Rothamsted Experimental Station," Dr. L. W. Samuel.

EXHIBITS.

14th August—A live female specimen of the Numbat (*Myremecobius fasciatus*) which had been kept in captivity for eight weeks, being fed entirely on termites; Mr. L. Glauert.

9th October—Cobalt arsenate from Ravensthorpe; Dr. E. S. Simpson.

12th March—Palaeolithic stone axe from West Africa belonging to the same cultural type still in use among Australian aboriginals; Mr. L. Glauert.

14th May—*Dactyloptera orientalis* (Flying gurnard) a species new to Western Australia, caught at Geraldton by Mr. C. Newman; Mr. L. Glauert.

11th June—Two new but as yet unnamed species of eucalypts from Ravensthorpe; Mr. C. A. Gardner.

PROCEEDINGS—BIOLOGICAL SECTION.

OFFICE BEARERS:

Chairman	..	Mr. L. Glauert.
Secretary	..	Mr. K. R. Norris.

Nine general meetings of the section were held during the year.

24TH JULY, 1934—

Lecture—"The Importance and Relationships of the Organisms of the Bacillus Welchii Group," Dr. H. W. Bennetts.

21ST AUGUST, 1934—

Discussion—"Flight in Nature," led by Mr. H. M. Wilson.

18TH SEPTEMBER, 1934—

Discussion—"Burrowing Modifications in Animals," led by Mr. L. Glauert.

Dr. Serventy exhibited some specimens of *Priapulus cordatus* from England.

16TH OCTOBER, 1934—

Exhibit evening.

Mrs. M. B. Johnson exhibited the bladderworts *Polypompholyx multifida, Polypompholyx tenella, Utricularia Hookeri* and *Utricularia violacea.*

Colonel Goadby an orchid, *Microtis parviflora,* about 100 of which he had grown from seed. Also a specimen of *Acianthus hügelii.*

Mr. V. Cooper fresh-water sponge, *Ephydatia multiformis.*

20TH NOVEMBER, 1934—

Exhibit evening.

Mr. K. R. Norris exhibited the rather rare Homopteran *Alleloplasis darwini Waterhouse.*

26TH MARCH, 1935—

Lecture—"Cambridge Personalities and their Work," Dr. D. L. Serventy.

18TH APRIL, 1935—

Lecture—"A Visit to Great Britain in 1934," Miss A. Baird.

21ST MAY, 1935—

Discussion—"Animal Psychology," led by Mr. A. J. Marshall.

25TH JUNE, 1935—

Lecture—"Natural History in Tasmania," Miss D. Spargo.

The average attendance for the year was nine.

PLANTS POISONOUS TO LIVE-STOCK IN WESTERN AUSTRALIA.

PRESIDENTIAL ADDRESS.

By H. W. BENNETTS, D.V.Sc.

Read 10th July, 1935; Published 18th December, 1935.

1.—INTRODUCTION.

Poisonous plants are of considerable interest to workers in more than one branch of science represented here this evening. The native flora of this State, renowned for its botanical and aesthetic appeal, includes also a large number of toxic plants. These are of special local interest as the majority belong to two related genera, Oxylobium and Gastrolobium, which are almost entirely restricted to Western Australia.

Let it be stated at the outset that a poisonous plant is regarded as being any plant which detrimentally affects the health of stock when eaten in such quantities as would be taken normally.

Poisonous plants may be considered from different points of view—according to their botanical relationships, according to the chemical composition of their toxic principles, or according to their effect on animals. I propose to consider these essentially from my own professional standpoint, that is, according to their effect on live stock. Wherever possible I will use native toxic plants for the purpose of illustration.

I shall endeavour to trace briefly the history of poisonous plants in this State, and to review broadly the information accumulated as a result of field experience and scientific investigation from the inception of settlement in Western Australia up to the present time.

Despite the fact that we have more than our fair share of toxic plants in this State, accurate knowledge of the effects on animals, particularly of our native plants, is very incomplete. In most instances the chemical nature of the toxic principles is entirely unknown. The study of our toxic plants offers an almost unlimited field of research for the chemist and pathologist. It has not been so neglected by the systematic botanist, and his co-operation is naturally a *sine qua non* of such investigations.

2.—HISTORICAL.

Losses in stock resulting from the ingestion of toxic plants were experienced in the earliest days of settlement in Western Australia, and coincided with the introduction of stock to the districts first settled. As early as 1837 sheep, cattle, and goats were lost in the Guildford, York, and Williams districts. The first recorded instance of plant poisoning was at Guildford, where a severe mortality in sheep and goats was sustained by Mr. Jones, in, according to the Press account, "animals imprudently depastured on land which had been found by previous experience to have produced the same effect . . . . . Mr. Tanner and Mr. Bland were great sufferers from similar losses some years back. The cause of the disorder remains unexplained, although many gentlemen have carefully inquired into the facts. The animals were attacked with staggering fits, and were found dead shortly afterwards." James Drummond attributed these losses to *Isotoma hypocrateriformis,* but the symptoms described, as well as subsequent history, indicate that a species of Gastrolobium (or Oxylobium) was probably responsible. Later in the same year, 1837, a further mortality occurred in the vicinity of Chidlow, which can be definitely attributed to one of these plants. "Another accident has occurred to some sheep and goats on the York Road. A slight detention of the carts which accompanied the flock on their way down to Perth market was the occasion of the animals getting astray into the bush. It is supposed that from their eating some of the scrubby herbage which borders the road they were attacked with a disorder which has already been so fatal, and both sheep and goats to the value of about £70 were lost . . . . Notwithstanding the great pains taken to arrive at the origin of this disorder or to discover the noxious herb by which the animals are said to have been poisoned, little information has been obtained, and the conclusions hitherto arrived at are very unsatisfactory. Mr. Drummond, our talented botanist, has determined, we hear, to visit the spot for the purpose of examining the various shrubs in the neighbourhood, and, if possible, to solve this question of so much importance to the Colony at large."

These Press extracts quoted indicate one of the many difficulties which faced the early settlers in this State. They had to determine by bitter experience and keen observation which plants were unsafe for grazing. The number of toxic species and the lack of any botanical knowledge of these plants constituted a very real difficulty in the early settlement of many areas.

An account of the effects of Gastrolobium poisoning was given by Thomas Carter, of Gwambygine, in March, 1838: "The sheep hold their heads and necks stretched out, apparently suffering from a difficulty of breathing; a convulsive motion may also be noted at intervals in the different parts of their frames. If the sheep are disturbed when under the influence of these symptoms, the disease generally assumes its worst features, and the slightest motion or cause of excitement increases its operations. The effects never continue long, the animals are either relieved from their suffering by death or recover in a few hours, often in a very short time unless excessively weakened by bleeding or medicines. I have opened many after death, and never observed any appearance of inflammation of the stomach, which generally contained a great quantity of mixed scrub, and appeared in a frothy or fermented state; and this I believe to have been the proximate cause of death from the consequent distention of the stomach or the pressure thus given the lungs, causing a difficulty and finally a stoppage in the circulation of the blood . . . . . I am inclined to believe that, whatever the cause of the disease may be, it does not operate as a poison, from the speedy recovery of the affected sheep, as those are aware who have witnessed the complaint. In many cases where the worst symptoms have occurred, the animals have, after bleeding and frequently without the aid of any remedy, immediately recovered and joined the flock without any further inconvenience." I have quoted this extract practicaly *in extenso*, as it does illustrate the keen powers of observation possessed by some of the early settlers. The deductions are not altogether correct, but the observations are excellent.

In the year 1840 feeding tests were carried out by Mr. Drummond and Mr. Harris (Colonial Surgeon), at Belgarup, near Kojonup, with a plant which, from its description, was almost certainly *Gastrolobium calycinum*. This and further experiments carried out in 1841 proved that this plant was toxic to sheep and goats; the symptoms observed in the experimental animals being similar to those noted previously. Drummond considered that it was this same plant which had been responsible for the stock losses experienced at the half-way house (Chidlow) in 1837, hence its name "York Road Poison."

In 1842 Drummond recorded that four toxic plants were recognised. They were not specifically named, but the Government Botanist, Mr. Gardner, from Drummond's descriptions, is of the opinion that the plants referred to were *Gastrolobium calycinum, Gastrolobium oxylobioides, Gastrolobium callistachys, and Oxylobium parviflorum.*

I have dealt at some length with the early records of plant poisoning in this State, the subsequent literature has been reviewed elsewhere. The first comprehensive account of "Poison Plants of Western Australia" was published in 1921 as Bulletin No. 96 of the Department of Agriculture of Western Australia. This was written by D. A. Herbert, who was at that time occupying the position of Botanist and Plant Pathologist. The Bulletin contained the collected accounts of various authors and correspondents published at different times, together with original information resulting from his field experience and laboratory experiments. The publication proved of inestimable value to stock owners, and a second revised edition was issued in 1926. The results of some further experimental work were recorded in 1927 in the Journal of this Society.

In all the literature referred to, the data concerning the effects on live stock of native toxic plants is based almost entirely on the observations of stock owners, and on the results of feeding tests with laboratory animals. It has been recognised, for a long time, that such information is far from satisfactory.

An accurate definition of the symptoms and *post mortem* appearances induced by a known toxic plant can be determined only by experiments carried out on the species of animals poisoned.

In order to obtain definite information regarding the effects of plants known to be poisonous, and the toxicity of others suspected, a systematic investigation was commenced last year. The Government Botanist collected plant material from type localities, and forwarded it to the Avondale State Farm, Beverley, where I carried out feeding tests with sheep.

In all 51 individual plant species, including seven *Oxylobium spp.* and 30 *Gastrolobium spp.* were tested. It is proposed to include the results of these and subsequent investigations in a departmental bulletin which will be issued at a later date. Much of the newly acquired information is used in this address.

It is apparent, from what has been said previously, that poisonous plants have been responsible for serious economic loss to this State. In 1905 Morrison estimated this at from £15,000 to £20,000 annually. With increasing knowledge of the plants responsible and their eradication from large areas the position has steadily improved, but serious losses still occur and poisonous plants must always be borne in mind as a possible cause of any unusual stock mortality.

3.—FACTORS INFLUENCING THE TOXICITY OF PLANTS.

The effects produced by poisonous plants vary considerably under the influence of a number of factors operating on both plant and animal. Let us briefly consider some of these.

(a) *Locality.*—It is well known that the toxicity of a species varies with the locality, probably as a result of the influence of different soil and climatic conditions. It has been found that even individual plants of the same species, growing together, may differ considerably in toxicity. White wood (*Atalaya hemiglauca*) shown by Murnane and Ewart (5) to be toxic for horses in the Kimberleys is considered to be non-toxic in New South Wales and South Queensland (Seddon) (6) The Milk Bush (*Sarcostemma Australe*), a proved poisonous plant in the Eastern States (Gilruth and Murnane), is (3) regarded as being a good fodder plant in this State.

(b) *Season and Stage of Growth.*—Seasonal variations in toxicity seems to depend generally on variations in the concentration of toxic principles according to the stage of growth of the plant. Most species belonging to the genera Oxylobium and Gastrolobium, of which "Box Poison" (*Oxylobium parviflorum*) and "Champion Bay Poison" (*Gastrolobium oxylobioides*) are well known examples, are most highly toxic when young or when flowering or seeding. It is interesting to note that it is during these stages of growth that they are most palatable, the highly toxic seedlings, flowers and seeds being readily eaten whereas the non-poisonous or relatively non-poisonous harsh foliage is not attractive to stock. Further, the state of the plant, that is whether fresh, dry, or wilted, may have a bearing on its toxicity. The poisonous property is frequently lost on drying. "Lamb Poison" (*Isotropis spp.*) appears to be much more highly toxic when fresh than when tested some days after picking. The same is true of many Oxylobia and Gastrolobia, which rapidly lose toxicity when the plants commence to dry. On the other hand "Rock Poison" (*Gastrolobium callistachys*), as recognised by Drummond as early as 1842, remains poisonous—we have found the leaves to be still highly toxic two years after collection.

(c) *Species of Animal.*—It is well known that species of animals vary in their susceptibility to poisons, which variation may depend on physiological and anatomical differences. This must be taken into account when suspected poisonous plants are being investigated—they should be fed to the same species of animal as those allegedly poisoned. Two plants, *Gompholobium marginatum* and *Cassia pleuracarpa* were found to be toxic for guinea pigs, but recent feeding experiments with sheep have given negative results. Box Poison (*Oxylobium parviflorum*) is not regarded as being particularly dangerous to horses, but is highly toxic for sheep and cattle.

An ex-President of this Society, the late Mr. Catton Grasby, collected a large amount of field evidence indicating that native animals and bronze-winged pigeons eat the highly toxic flowers and seeds of *Oxylobium spp.* and *Gastrolobium spp.* without ill effects, whereas dogs and cats eating their entrails show typical signs of poisoning.

(d) *Age, Sex, Breed, etc.*—Such considerations as age, sex, breed, and the physiological state of the animal may influence the susceptibility to poison plants. The recent experiments carried out at Avondale indicate that a starved sheep is somewhat more susceptible to the effects of Gastrolobium and Oxylobium. It is probable that the fluidity of the contents of the rumen, which is characteristic of this physiological state, facilitates the solution and subsequent absorption of the toxic principles contained in the plant material. It is, of course, well known that travelling stock are particularly prone to poisoning, and it may be that hunger, apart from causing them to eat greedily plants which otherwise would be avoided, in this way renders them more susceptible.

(e) *Colour.*—The colour of an animal is important in the phenomenon known as photosensitization. Certain plants contain fluorescent substances which, following ingestion and absorption, sensitize the skin, rendering the un-pigmented portions sensitive to the action of direct sunlight. A dermatitis affecting portions of skin covered with white hair has been observed frequently in cattle in the South-West. This condition has been ascribed to photosensitization, following the ingestion of *Trifolium spp.*

(f) *Environment.*—The effect of environment is well illustrated in the case of poisoning with *Oxylobium spp.* and *Gastrolobium spp.* The ingestion of these plants, in even small amounts, renders animals hyper-sensitive to external stimuli. It is amply borne out by field and experimental evidence that such animals if left quiet may never show any obvious signs of poisoning. If, however, they are disturbed in any way an almost immediate fatal result is commonly produced. Sheep can be used to eradicate Box Poison seedlings, provided the paddock is heavily stocked and the sheep are left entirely undisturbed. If sheep which have had access to poison are driven, and particularly if startled by dogs, etc., a heavy mortality may be experienced in a short time.

There are many other factors which may influence the susceptibility of animals to toxic plants. It is, for example, known that stock may become immune to certain plant poisons of a protein nature as a result of the development of specific antibodies in the animal body, or that the tissue may acquire a tolerance to plant poisons which are of a non-albuminoid nature. It has been claimed that animals continuously running on poison country become immune to the effects of *Oxylobium spp.* and *Gastrolobium spp.*, but the evidence is inconclusive, and experimental proof is necessary on this point. It does appear that brumbies are somewhat resistant to, notably, Box Poison, but whether their survival is due to an acquired tolerance or to an active immunity is unknown. It may even be due to acclimatisation, *i.e.*, the development of a sense of discrimination between edible and poisonous plants. We have frequently seen evidence of acclimatisation in connection with poisoning by an introduced plant, *Homeria collina.* Cattle running on infested country do not eat it, whereas newly introduced cattle unfamiliar with the plant eat it readily with fatal results.

4.—THE PHYSIOLOGICAL SIGNIFICANCE OF THE TOXIC PRINCIPLES OF PLANTS.

A number of theories have been advanced concerning the physiological significance of the toxic principles of plants. It has been variously held that they are excretory products, normal stages in the building up of plant tissue, or that they are produced in order to protect plants from destruction by man and animals. The genera Oxylobium and Gastrolobium afford some interesting evidence in favour of the latter hypothesis. It has already been pointed out that the poisonous species are much more highly toxic when attractive to stock, and that the poisonous principles are concentrated in the parts of the plant which are most readily eaten. Further, the genus Gastrolobium is divided into two sections, one the Racemosae, in which the flowers are terminal, and one Axillares, in which the flowers occur in the axils of the leaves. The buds, flowers and seeds of the former being on the tips of the branches are attractive and readily available to stock, whereas those occurring in the axils of the leaves are protected by harsh vegetation. The recent observations and experiments carried out by us indicate that all species belonging to the section Racemosae are toxic, whereas only one of the Axillares, viz. *Gastrolobium obovatum*, is even suspected of being toxic, and feeding tests with this species so far have given negative results.

It would appear, therefore, that in the two genera Gastrolobium and Oxylobium the toxic principles may have a protective function.

5.—A REVIEW OF THE EFFECTS OF TOXIC PLANTS.

(i) PLANTS, NORMALLY GOOD FODDER PLANTS, BUT WHICH MAY PRODUCE HARMFUL EFFECTS.

Plants which are normally good fodder may exert a harmful effect if consumed in excessive amounts; or may develop toxic properties under certain circumstances. The shed seeds of the lupin (*Lupinus varius*), used largely for fattening sheep in certain districts, may induce signs of intoxication if eaten without adequate roughage. This condition is transient and not fatal, but is somewhat disconcerting to any who are not familiar with the effects of driving sheep under these conditions.

Kochia sedifolia is regarded as an excellent feed, but apparently may become toxic after rain. The classical example of a fodder plant which becomes toxic under certain conditions is Sorghum. The plant is a cyanogenetic one, which becomes dangerous during periods of very active growth, as after wilting.

(ii) PLANTS WHICH IMPAIR BODILY FUNCTION, AND WHICH MAY LEAD TO SUPERIMPOSED MALADIES.

Some plants may damage a particular organ with the result that normal bodily function can no longer be maintained. Whitewood (*Atalaya hemiglauca*) causes a cirrhosis of the liver in horses. The damaged organ is no longer able to perform its important detoxifying function, with the result that intoxication and death is a frequent sequel. Certain species of Senecio have the same selective action on the liver, and there is some evidence that the native species *Senecio lautus* is toxic. Other plants again may cause injuries which predispose to bacterial diseases. Of particular interest in this regard is Stinkwort (*Inula graveolens*). This plant was considered to be poisonous when flowering or when fruiting—many sheep mortalities in the Eastern States, notably in South Australia, being ascribed to the ingestion of the plant in this stage of growth. Of recent years in this State a number of severe losses have occurred in flocks depastured on fruiting Stinkwort, and we have shown the true mode of action of this plant. The barbed pappus hairs penetrate the lining of the bowel, and remain embedded in the wall. The resultant injury provides conditions which are favourable to the rapid multiplication and toxin production of a specific bacterium (*C. ovitoxicum*). It is the absorption of this bacterial toxin which is the cause of death. The ingestion of the plant, in effect, predisposes to entero-toxaemia or braxy-like disease.

Seddon and McGrath (7) have shown that the continued ingestion of Bracken Fern leads to the development of ulcers in the alimentary tract. These act as portals of entry for certain bacteria, death being due to the resultant septicaemia. Similar mortalities are not uncommon in the South-West of this State.

(iii) Plants which cause Death by virtue of their Toxic Principles.

Reference has already been made to the enormous stock losses which have been experienced in this State as a result of poisonous plants. Most of these have been due to those now to be considered. The plants concerned belong to several genera with diverse actions on animals. I propose to consider these in order of relative importance, grouping plants which have a similar effect on the animals poisoned. Our present knowledge of the toxicology of many of these plants is, however, very limited.

(a) *Oxylobium spp. and Gastrolobium spp.*

These two genera, of which there are many toxic species, contain the largest number of our poisonous plants, and have undoubtedly been responsible for the greatest economic loss. They are almost State-wide in distribution, although species tend to be localised. A number of these are familiar to many of you under the vernacular names of York Road, Champion Bay, Rock, Narrow Leaved, Hook Point, Runner, Berry, Crinkly Leaved, Heart Leaved, Prickly, White Gum, Granite, Box and Brother Brother "poisons."

I will not weary you with an enumeration of the botanical names of these and other toxic species, and I am not qualified to discuss their systematic relationships. Suffice it to say that the two genera are very closely related. Both belong to the pea-flowered family of the pod-bearing Leguminosae. The species are generally small shrubs with harsh fibrous leaves which, as we have seen, are not as a rule attractive to stock, except when young or when flowering or fruiting.

As previously indicated an experimental investigation of seven species of Oxylobium and 30 species of Gastrolobium was carried out last year. Four species of the former and 16 species of the later genus tested were found to be toxic for sheep. In every instance the material tested comprised only flowers or young seed pods. This investigation has led to an accurate definition of the symptoms and post mortem appearances induced in sheep, and has greatly clarified the position regarding the toxicology of these plants. All toxic species tested had essentially the same effects on sheep, and it appears reasonable to assume that the same is true for all the toxic species in both genera. There is, however, a considerable variation in the degree of toxicity of different species, although it may be stated that all are highly toxic. Varying with the species, amounts of from half an ounce to about one and one-quarter pounds of flowers will produce death within three hours to three days of ingestion.

Generally speaking the effect produced is very rapid, particularly, as pointed out previously, if the animal is disturbed.

A weak accelerated heart beat is one of the earliest signs of poisoning. The rate may exceed 200 per minute, and frequently the heart becomes almost imperceptible. The rate of respiration is usually increased. It may exceed 200 per minute, and is frequently distressed owing to congestion, oedema, and haemorrhage in the lungs. Haemoptysis is common. Depending on the amount of plant eaten and on the degree of toxicity of the species, somewhat different phenomena are observed. Generally the pupils are dilated, and there are signs of nervous excitement, the animal being hyper-sensitive to external stimuli of sight, sound, or touch. These precipitate mania characterised by violent galloping associated with general violent clonic spasms of muscles. Death is violent, and may occur within a few minutes. With a somewhat smaller dose mania is absent, hyper-sensitiveness is moderate or absent, and clonic muscular spasms are marked. Death occurs within two or three hours of signs being first noticed, and may be violent or quiet. With a still smaller dose of toxic material the clinical appearances are those of depression and partial paralysis. The sheep appears dull, and will only drive for a short distance. It soon stands in a "sulky" attitude, and lies down when approached. Partial recovery occurs after a short rest, but further driving reproduces the same signs of muscular weakness. Death may occur within several hours, or be delayed for from one to four days. Frequently practically all the phenomena described may be seen in the one animal. The general progress is from hyper-excitability to depression and muscular weakness with possible recovery, but occasionally peculiar alternations between depression and stimulation are observed. Recovery is not unusual, but is more frequent in animals showing the dull type of syndrome.

Prior to last year's experiments certain species, for example, *Gastrolobium calycinum*, *Gastrolobium oxylobioides*, *Oxylobium parviflorum* were described as producing madness, trembling, and convulsions, whereas other species, *e.g. Gastrolobium ovalifolium*, were said to produce drowsiness and paralysis. The latter plant is one of the less toxic species which would tend to produce the type of syndrome indicated. In a series of experiments, designed to prove that the effects produced by all toxic species were identical, it was shown that relatively large doses of *Gastrolobium ovalifolium* and of other of the less toxic species produced the typical syndrome characterised by convulsions and mania, and that small doses of the more highly toxic species, such as *Gastrolobium calycinum and Gastrolobium callistachys* produced the dullness, etc., supposed to be characteristic of *Gastrolobium ovalifolium*. It is evident, therefore, that the variation in syndrome depends rather on the amount than on the species of plant which is ingested.

In addition, the post mortem appearance observed in poisoned sheep are essentially the same throughout, irrespective of the species of plant which has been consumed. These will be given in detail elsewhere. The typical pathological changes are very marked general congestion of the carcase, delayed clotting of blood, intestinal inflammation (frequently of a haemorrhagic character), and characteristic lung haemorrhages.

It is curious that all reference to the clinical and pathological signs of lung involvement, which are such a feature of poisoning by *Oxylobium spp.* and *Gastrolobium spp.* should have been omitted from recent literature on poisonous plants, although some references appear in the earlier accounts.

The mode of action of the toxic principle, or principles, concerned is complicated, and is still open to speculation. The dilation of pupils and rapid heart rate are suggestive of stimulation of the sympathetic nervous system. There is evidence of stimulation of cerebro-spinal nervous system which may be followed by depression. The weak heart, and resultant venous congestion, appears to indicate a direct toxic effect on the heart muscle. The increase in respiration has been found to occur independently of any lung lesions, and is probably due to an increase in the carbon dioxide content of the blood resulting from the sluggish circulation.

Toxic Principles.—The identical effects produced in experimental animals by the large number of toxic species tested suggest that the toxic principles are identical throughout both genera. Mann (4) isolated two different alkaloids, cygnine and lobine, from *G. calycinum* and *O. parviflorum* respectively. These alkaloids, when inoculated, induced in experimental animals effects similar to those produced by the plants themselves. Other workers, however, using the same chemical methods have been unable to confirm Mann's work, and it has been suggested that the toxic substances isolated by him were degradation products.

Mr. L. W. Phillips carried out a considerable amount of chemical work with several species, but was, unfortunately, unable to finalise his investigation owing to pressure of administrative duties. As the result of his work, which has not been published, he developed a conception that the toxic principles are protein derivatives which, as the result of the action of enzymes, break down into other toxic derivatives, and finally into simpler compounds which are non-toxic. It is postulated that the enzyme is present in some species at certain stages of growth, and is entirely absent from other species. This view has much to commend it, and would explain why some species, *e.g. G. calycinum* readily lose their toxicity, whereas others, notably *G. callistachys* may retain it unchanged for years.

A further chemical investigation is being pursued at the present time.

The determination of the nature of toxic principles contained in species of Oxylobium and Gastrolobium is undoubtedly a tedious and arduous task. It is, however, one of paramount importance. Success in this direction might not only lead to the discovery of an antidote, but would possibly lead to the development of a simple chemical test, whereby the degree of toxicity of the various species at different stages of growth could be determined. Such a test would be of very great value.

The very rapid action of toxic species and the hyper-excitability of poisoned animals would limit the usefulness of any antidote, however effective. The most satisfactory method of preventing mortality, obviously, is to prevent stock from having access to poisonous species. This pre-supposes a still more comprehensive knowledge of the toxic species and their eradication. Complete knowledge regarding the stages of growth, during which the plants are dangerous to stock, could be used to minimise losses. If it were possible to determine this by simple chemical means instead of solely by extensive feeding trials a considerable saving in time and expense would result.

(b) *Dubosia Hopwoodii and Nicotiana suaveolens.*

The toxicity of both *D. Hopwoodii* (Pituri) and *N. suaveolens* (Native Tobacco) is due to the alkaloid nicotine. The toxicology is, therefore, similar. Both plants are widely distributed in this State. The former is highly toxic, and is responsible for very large losses of stock (sheep, horses, and cattle), but the latter is not so dangerous, and is apparently not relished by animals. "Pituri is made use of by the natives to great extent. They use it for chewing, and the leaves are mixed with ashes for this purpose. Natives come from long distances for the leaves, and some tribes use them as an article of commerce. In South Australia they are said to be traded for hundreds of miles.

They are also used for throwing into gnamma holes; kangaroos drinking the water become stupefied, and fall easy victims to the spear. It is said that the natives were accustomed to use the smoke from the burning leaves as an anaesthetic for such crude operations as they performed."

Feeding tests were carried out recently with Pituri. Experimental sheep could not be induced to eat the plant readily. An aqueous extract prepared from three ounces of leaves caused death within two hours; a sheep drenched with a similar extract, prepared from 10 ounces of leaves, died almost instantaneously.

The symptoms observed were dullness, trembling, muscular weakness—particularly of the forelegs and neck—and a marked inco-ordination of gait. The most marked lesion was an inflammation of the small intestine.

(c) *Isotropis spp.*

There are a number of species of Isotropis occurring in this State. They have been given the vernacular name of "Lamb Poison," although there appears to be little foundation for the belief that they are particularly dangerous to lambs. The northern species, *Isotropis atropurpurea*, which also occurs in the Northern Territory and New South Wales, is known to be toxic for cattle; and this has been verified experimentally (9). There is definite field evidence that *Isotropis cuneifolia* is very highly toxic for sheep and cattle in some of our coastal districts.

In the past a number of feeding experiments with several species (*Isotropis cuneifolia, Isotropis juncea, Isotropis Drummondii*) gave consistently negative results. Recently, however, a successful feeding experiment was carried out with *Isotropis cuneifolia* (Sm), *Domin., var. parviflora,* Benth. The amounts of flowering plant necessary to produce a positive result were much greater than one would expect from field observations. It seems evident that the toxicity of the plant rapidly diminishes after plucking, and it is quite possible that the previous negative results obtained with *Isotropis spp.* were due to the plant material used not being in a sufficiently fresh condition. Further investigation is necessary.

In the successful experiment referred to two sheep consumed 2¾ lbs. of fresh flowering plant collected from the Hill River district. One sheep died seven days after the commencement of the experiment, and the other one three days later. The clinical appearances were similar to those described for cattle poisoned with *Isotropis atropurpurea.* The sheep showed dullness, weakness, loss of appetite and diarrhoea followed by dysentery. The subjects had a very "tucked up" appearance, and were unable to completely extend the hind limbs. Similar symptoms are seen in cattle which eat very small quantities of *Isotropis cuneifolia* under field conditions, but a much smaller amount than that fed experimentally to sheep is said to cause death within 24 hours in the field.

Numerous lesions were seen on post mortem examination including oedema, nephritis, gastro-intestinal inflammation, and in one case pneumonia.

On the evidence at present available it may be stated that two species of Isotropis are highly toxic, and it appears probable that other species may also be toxic. Field evidence also incriminates *Isotropis juncea.*

(iv) CYANOGENETIC PLANTS.

A cyanogenetic plant is one which may contain a cyanogenetic glucoside. This in the presence of a suitable enzyme yields prussic acid. The necessary enzyme and the glucoside do not always occur together in the same plant. Finnemore (2) for example, has found that the native Fuchsia (*Eremophila maculata*) does not always contain the ferment. "It has been found on the Georgina River that stock may eat the leaves of the native Fuchsia, but may not become poisoned until they eat other plants or Gidgea pods." (*Acacia Georiana*). These pods contain the ferment necessary to liberate the prussic acid.

The toxicity of a cyanogenetic plant depends on its cyanogenetic glucoside or prussic acid content, which varies considerably according to climatic and soil conditions, and upon the rate at which plants are ingested.

Prussic acid is rapidly eliminated by the animal body and unless the rate of absorption exceeds that of excretion no detrimental effects will be produced. It will be obvious that the investigation of the toxicology of a cyanogenetic plant is fraught with many difficulties. In this State such plants are not as important economically as the Oxylobia and Gastrolobia. Nevertheless they have been responsible for severe losses, particularly in travelling stock, which are more prone to eat large quantities in a short period of time, thus absorbing prussic acid more rapidly than they are able to eliminate it. The chief offenders are Balsam (*Euphorbia Drummondii*) and the native Fuchsia. "Gascoyne Poison" (*Euphorbia eremophila*) has been suspected for a number of years on strong field evidence which has now been confirmed. In June, 1935, severe losses were experienced in travelling stock at Meekatharra, the losses being 150 head of cattle in a mob of 250, and 300 sheep in a flock of 2,000. An investigation by officers of the Department of Agriculture incriminated *E. eremophila.* Further experiments carried out at the Perth laboratory confirmed this, the plant being found to be definitely toxic. The observations made indicate that the plant is probably cyanogenetic, but no chemical investigation was undertaken. The Government Botanist is of the opinion that losses in travelling stock at Jimba Jimba, and on the Mt. Gould stock route and north-west of Cue are also due to this plant.

(v) MACROZAMIA REIDLEI.

Although Zamia Palm has been responsible, directly or indirectly, for the loss of large numbers of cattle in this State our knowledge of the toxicology of the plant is still in a very unsatisfactory state. For these reasons I have devoted a separate section to Macrozamia although I do not propose to consider it in any detail.

The palm is held to be responsible for a locomotory disturbance in cattle, characterised by ataxia, and popularly termed "wobbles" or "rickets" although quite unrelated to the disease rickets or rachitis. There has been much debate locally concerning the part of the plant which causes this condition, the gum, wool, nuts and young leaves all being regarded with suspicion. It is generally considered, however, that the "wobbles" results from the ingestion of the young leaves. Feeding tests with Macrozamia carried out by workers in this State and in other parts of Australia, have given very conflicting results and the pathogenesis of the disease is unknown. In this State Edwards (1) claimed to have reproduced the condition by feeding the young leaves of *M. Reidlei* to calves at the rate of 4 lbs. a day for 11 days, or 6 lbs. a day for 7 days. In 1926 Mr. Filmer and I fed the young leaves to a calf at the rate of 2 lbs. daily for 28 days and 4 lbs. daily for the succeeding 28 days. The results of this experiment were entirely negative.

The nuts of Macrozamia are undoubtedly poisonous, containing a violent gastro-intestinal irritant, as found by Vlaming's hungry men in 1697 and more recently by Filmer and myself, when we fed nuts to another calf with fatal results but without inducing "wobbles." A series of feeding tests carried out by Filmer, also in 1926, showed that the nuts were toxic for guinea-pigs and rabbits. All experimental animals showed severe gastro-enteritis. Seddon and Belchner (8) have recorded a very serious sheep mortality in New South Wales which resulted from the ingestion of the nuts of *Macrozamia spiralis* by a travelling flock. The lesions found were those of acute enteritis and toxic haemoglobinuria.

The case against the nuts of Macrozamia is, therefore, perfectly clear but we are still in the dark regarding the nature of the relationship of Macrozamia to "wobbles" in cattle. The pathology of this condition has not yet been studied in detail. One would expect to find some degeneration in the spinal cord or nerves of the hind limbs.* A further study of the pathology of "wobbles" in cattle is undoubtedly warranted.

(vi) POISONOUS PLANTS OF THE NORTH-WEST.

I have left the consideration of these till the last, not because they are of minor importance but on account of the fact that not much is known regarding the toxicology of the species which are restricted to the North. The following toxic plants which have been referred to in other connections occur also in the North-West:—*Duboisia Hopwoodii*, *Eremophila maculata* and *Atalaya hemiglauca*—the latter occurs only in the North in this State. The genus Gastrolobium is represented by one toxic species, *G. grandiflorum*; this incidentally appears to be the only poisonous species which extends beyond the borders of this State.

*The clinical appearances are very similar to those observed in Enzootic ataxia of lambs—a disease characterised by degeneration of sensory tracts in the cord and of certain fibres in the nerves of the hind limbs. This disease is in no way associated with Macrozamia.

Of the remaining poisonous plants of the North-West there are only two which are at all well known. The Black Bean Tree *Erythrophleum chloristachys* is undoubtedly toxic. It is said to be particularly dangerous to camels which apparently eat it more readily than do other stock. This accounts for the vernacular name "Camel Poison" by which it is known in the Kimberleys. We have no definite information regarding the symptoms and post mortem appearances of poisoned animals.

Indigophera boviperda, which occurs in the North-West and in Northern Territory, has been proved toxic for cattle—it appears probable that sheep also are susceptible. The Poison Plants Committee of the Council for Scientific and Industrial Research give the following symptoms for cattle—"general dullness, weakness, increased breathing and heart beats, with constipation, off feed and death in a day or two." There are no characteristic post mortem appearances.

The following plants are suspected of being poisonous:—*Strychnos lucida*, *Tephrosia rosea*, *Tephrosia purpurea*, *Tinospora smilacina* and *Velleia panduriformis*.

In the brief review, this evening, I have indicated the vast hiati in our knowledge of native poisonous plants. We have no definite knowledge regarding the toxicity of a very large number of suspected plants, and even in the case of plants which are known to be poisonous our information is often incomplete, indefinite, or even inaccurate. Recent work has considerably improved the position with regard to species of two important genera, Oxylobium and Gastrolobium. As already pointed out, however, this experimental work is far from complete and needs to be supplemented with intensive chemical investigation. In fact, our knowledge of the toxic principles of almost all of the native poisonous plants is very inadequate. The field for future work is almost unlimited and the requisite investigations should prove a source of perennial interest to the scientist and of profit to the State.

ACKNOWLEDGMENT.

I desire to thank the Government Botanist (Mr. C. A. Gardner) for his courtesy in making available the results of his researches into the early accounts of plant poisoning in this State and for the helpful advice in connection with the preparation of this address.

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JOURNAL OF THE ROYAL SOCIETY OF WESTERN AUSTRALIA.

VOLUME XXI.

1. FORAMINIFERA AND OSTRACODA FROM SOUNDINGS MADE BY THE TRAWLER "BONTHORPE" IN THE GREAT AUSTRALIAN BIGHT.

By FREDERICK CHAPMAN, A.L.S., and WALTER J. PARR, F.R.M.S.

Read 14th August, 1934; *Published 25th March*, 1935.

Communicated by D. L. Serventy.

We are indebted to Mr. D. L. Serventy, B.Sc., for the opportunity of examining the bottom soundings collected by him in the Great Australian Bight while on the trawler "Bonthorpe" in February, 1930. The amount of material is very small as the samples were taken with grease by means of the sounding lead. Only one exceeds 0.5 cc. They consist almost entirely of foraminifera and polyzoa, with an occasional ostracodal valve. The number of species and varieties of foraminifera identified is 112, of which one is described as new and another species is renamed. Eleven species of ostracoda were met with, several of which are probably new to science, but insufficient specimens are available for their description.

The senior author has previously, in 1915, published a list of species from the same faunal area as the present soundings. This will be found in *Biol. Results "Endeavour,"* vol. iii, pt. 1 (pp. 1-51, pls. i-iii), the material being from an "Endeavour" dredging made 40 miles south of Cape Wiles, South Australia, in lat. 35° 35′ S., long. 135° 15′ E., in 100 fms. Many of the "Endeavour" species occur in the "Bonthorpe" material and for purposes of comparison are shown in the first column of the subjoined table. Recent work has resulted in the alteration of the names of several species recorded from 40 miles S. of Cape Wiles and they are here listed under their amended names. The absence of others from the "Bonthorpe" samples may be explained by the limited amount of material available for examination.

In the list of species several manuscript names will be found. The descriptions of these species will shortly be published, several in a report by us on the foraminifera dredged by the Australasian Antarctic Expedition 1911-14, under the leadership of Sir Douglas Mawson, and the remainder in a paper, by the junior author, on Victorian and South Australian shallow-water foraminifera.*

* Since published, see *Proc. Roy. Soc. Vic.* 44, p. 1, pl. I. (1931).

B 6778/35

DETAILS OF SOUNDINGS.

Feb. 23rd, 1930. Lat. 33° 14′ S., long. 126° 16′ E.

Sample 2, taken at 10.40 a.m. in 89 fms.
„ 3, „ 11.50 a.m. in 75 fms.
„ 4, „ 12.30 p.m. in 100 fms.

Same day, in Lat. 33° 15′ S., long. 126° 10′ E.

Sample 5, taken at 1.55 p.m. in 62 fms.
„ 6, „ 2.5 p.m. in 70 fms.

Feb. 26th, 1930. Lat. 33° 50′ S., long. 125° 17′ E.

Sample 7, taken at 6.0 a.m. in 40 fms.
„ 8, „ 9.0 a.m. in 39 fms.

Feb. 27th, 1930. Lat. 34° 0′ S., long. 124° 56′ E.

Sample 9, taken at 3.0 a.m. in 39 fms.
„ 10, „ 6.0 a.m. in 36 fms.

Feb. 28th, 1930. Lat. 33° 50′ S., long. 124° 40′ E.

Sample 11, taken at 6.0 a.m. in 41 fms.
„ 12, „ 4.50 p.m. in 39 fms.

LIST OF SPECIES.

(v.c., *very common;* c., *common;* f., *frequent;* r., *rare.*)

FORAMINIFERA.

No.	Species.	S. of C. Wiles.	Sample No.										
			2	3	4	5	6	7	8	9	10	11	12
1	*Spirillina inaequalis* Brady ...	...	...	1	...	...	...	...	...	...	...	...	...
2	*Lenticulina orbicularis* (d'Orbigny)	x	...	...	...	1	...	...	...	...	...	...	...
3	*L. rotulata* (Lamarck) ...	x	...	1	...	1	...	...	...	...	...	...	...
4	*Nodosaria proxima* O. Silvestri	...	...	...	...	r.	1	...	...	...	...	...	...
5	*N. scalaris* (Batsch)	x	...	...	...	...	1	...	...	...	...	...	...
6	*Lagena globosa* (Montagu) ...	...	...	...	...	1	...	...	...	...	...	...	...
7	*L. hexagona* (Williamson) ...	...	...	...	...	1	...	...	...	...	...	...	...
8	*L. orbignyana* (Seguenza) ...	x	...	...	...	1	...	...	...	...	...	...	...
9	*L. lacunata* Burrows and Holland	...	...	...	...	1	...	...	...	...	...	...	...
10	*L. sulcata* (Walker and Jacob)	x	...	...	...	1	...	...	...	...	...	...	...
11	*Guttulina regina* (Brady, Parker, and Jones)	...	1	1	...	...	1	...	...	...	...	...	1
12	*Sigmoidella kagaensis* Cushman and Ozawa	...	1	1	1	...	...	r.	...	...	1	...	...
13	*S. elegantissima* (Parker and Jones)	x	1	...	...	1	r.	...	...	...	1	1	1
14	*Buliminella elegantissima* (d'Orb.)	x	...	...	...	r.	1	...	...	...	...	...	...
15	*B. seminuda* (Terquem) ...	x	...	...	...	r.	..	...	...	...	...	...	...
16	*Bulimoides williamsoniana* (Brady)	...	...	...	...	1	...	...	...	...	...	...	...
17	*Cassidulina laevigata* d'Orb ...	...	r.	1	c.	r.	...	...	...	...	...	...	...
18	*C. subglobosa* Brady	x	c.	r.	c.	c.	c.	f.	...	...	...	...	...
19	*Bolivina abbreviata* Heron-Allen and Earland	...	...	...	...	r.	...	...	...	1	...	...	...
20	*B. robusta* Brady	x	...	...	...	1	...	...	...	...	...	...	...
21	*Loxostomum limbatum* (Brady), var. *costulatum* (Cushman) ...	...	...	c.	...	f.	...	...	...	...	...	...	...
22	*Reussia armata* Parr MS. ...	...	...	...	...	1	...	...	...	...	...	...	...
23	*R. ensiformis* (Chapman) ...	...	...	...	...	...	...	...	1	...	...	...	...
24	*R. spinulosa* (Reuss)	x	...	...	...	1	...	...	...	...	...	...	...
25	*Uvigerina pigmea* d'Orb. ...	x	c.	c.	c.	v.c.	v.c.	...	1	...	...	...	...
26	*Siphogenerina raphanus* (Parker and Jones)	...	...	1	...	...	...	...	...	...	...	...	...
27	*Melonis stelligerus* (d'Orb.) ...	...	...	1	...	1	...	...	...	...	...	...	...
28	*Elphidium crispum* (Ninné) ...	x	r.	f.	f.	c.	1	r.	c.	...	c.	c.	c.
29	*E. craticulatum* (Fichtel and Moll)	...	...	...	...	...	...	...	...	...	...1	...	...
30	*Bolivinita rhomboidalis* (Millett)	...	...	...	...	1	...	...	...	...	...	...	...
31	*Bolivinella folium* (Parker and Jones)	x	...	...	...	1	...	...	...	...	...	...	...
32	*Spirolina cylindracea* (Lamarck)	...	1	...	r.	1	..	...	...	...	...	...	f.

LIST OF SPECIES—*continued.*

No.	Species.	S. of C. Wiles.	Sample No. 2	3	4	5	6	7	8	9	10	11	12
33	*Peneroplis planatus* (F. & M.)...	...	...	...	...	1	...	f.	c.	1	f.	f.	f.
34	*Marginopora vertebralis* (Quoy and Gaimard	...	...	...	...	...	...	1	r.	r.	f.	f.	1
35	*Discorbis australis* (Parr MS.)	...	1	1	...	...	...	...	...	1	...	...	...
36	*D. dimidiata* (Jones and Parker)	...	...	1	f.	r.	1	c.	c.	c.	c.	r.	c.
37	*D. dimidiata*, var. *acervulinoides* (Parr MS.)	...	...	...	1	...	...	r.	...	...	c.	...	r.
38	*D. mira* (Cushman)	...	r.	...	...	...	...	1	...	...	...	...	...
39	*D. opercularis* (d'Orb,)	...	...	...	...	r.	...	...	...	...	...	...	...
40	*D. patelliformis* (Brady) ...	...	...	...	...	...	...	...	...	...	...	...	1
41	*D. pulvinata* (Brady)	...	...	...	...	1	...	...	...	...	...	...	...
42	*Eponides repandus* (F. & M.)	x	f.	...	...	f.	f.	...	...	...	...	...	...
43	*E. concentricus* (Parker and Jones)	x	...	...	...	f.	r.	...	...	...	...	...	...
44	*Rotalia beccarii* (Linné) ...	...	...	...	...	...	r.	...	...	...	...	...	...
45	*R. clathrata* (Brady)	x	1	1	1	c.	c.	r.	f.	...	c.	...	c.
46	*Cancris auricula* (F. & M.) ...	...	...	...	...	...	1	1	r.	...	1	...	1
47	*Amphistegina radiata* (F. & M.)	...	...	...	1	...	...	...	...	...	...	...	...
48	*Sphaeroidina bulloides* (d'Orb.)	...	...	...	1	...	...	...	...	...	...	...	...
49	*Globigerina bulloides* (d'Orb.) ...	x	...	1	...	1	r.	...	...	...	...	...	...
50	*G. conglomerata* (Schwager) ...	...	r.	f.	...	r.	r.	...	...	...	...	...	...
51	*G. inflata* (d'Orb.)	x	c.	c.	c.	v.c.	r.	r.	1	1	...	r.	...
52	*Globigerinoides rubra* (d'Orb.), colorless var.	x	1	1	...	c.	f.	...	...	...	1	...	...
53	*G. triloba* (Reuss)	x	1	...	...	f.	...	...	...	...	...	...	1
54	*Globigerinella aequilateralis* (Brady)	...	r.	1	...	1	...	..	...	...	...	...	...
55	*Orbulina universa* (d'Orb.) ...	x	...	...	1	...	...	...	...	...	...	...	...
56	*Globorotalia menardii* (d'Orb.) ...	...	1	1	...	1	...	...	...	...	...	...	1
57	*G. truncatulinoides* (Brady) ...	...	...	1	...	...	...	...	...	...	...	...	...
58	*Anomalina coronata* (P. & J.)...	x	1	1	...	1	...	...	...	..	...	...	...
59	*A. colligera* (Chapman and Parr MS.)	x	...	1	...	1	r.	...	...	...	...	...	...
60	*A. glabrata* (Cushman)	...	f.	c.	1	c.	c.	...	...	...	...	...	...
61	*Planulina biconcava* (Jones and Parker)	x	...	...	...	r.	...	...	...	...	...	...	...
62	*Cibicides refulgens* (Montfort) ...	...	1	f.	r.	r.	r.	...	c.	1	f.	r.	c.
63	*C. lobatulus* (Walker and Jacob)	x	r.	...	r.	?	r.	...	...	...	...	...	r.
64	*C. ungerianus* (d'Orb.)	x	c.	...	...	f.	f.	r.	...	...	...	...	...
65	*C. haidingeri* (d'Orb.)	...	...	...	...	f.	...	r.	...	r.	f.	r.	...
66	*Gypsina globulus* (Reuss) ...	...	...	...	...	...	...	...	...	...	...	1	...
67	*G. vesicularis* (P. & J.) ...	...	...	...	...	1	...	...	...	...	r.	...	...
68	*Polytrema miniaceum* (Pallas) ...	...	r.	...	...	r.	1	...	1	...	c.	c.	r.
69	*Hyperammina friabilis* (Brady)	...	1	...	...	...	1	...	...	...	...	...	...
70	*Cornuspira involvens* (Reuss) ...	x	1	...	...	...	...	...	...	...	...	...	...
71	*Planispirina bucculenta* (Brady)	...	f.	c.	...	c.	...	...	...	...	...	...	...
72	*Nubecularia lucifuga* (Defrance)	...	...	...	...	...	...	...	...	...	1	...	1
73	*Quinqueloculina ammophila* (Parr MS.)	x	1	1	...	...	r.	...	...	1	...	...	...
74	*Q. australis* (Parr MS.) ...	...	...	...	...	1	r.	...	...	1	...	...	...
75	*Q. lamarckiana* (d'Orb.) ...	x	c.	r.	c.	f.	f.	r.	r.	1	1	...	...
76	*Q. poeyana* (d'Orb.)	...	...	...	...	1	...	...	...	...	...	...	1
77	*Q. reticulata* (d'Orb.)	...	...	...	...	f.	...	...	...	...	...	...	...
78	*Q. vulgaris* (d'Orb.)	x	...	r.	...	1	...	...	...	...	...	...	r.
79	*Q. polygona* (d'Orb.)	.	1	...	1	...	r.	...	...	1	1	...	...
80	*Q. crassa* (d'Orb.)	...	...	...	1	1	...	r.	c.	1	f.	r.	1
81	*Spiroloculina canaliculata* (d'Orb.)	x	...	r.	r.	f.	1	...	1	...	...	...	...
82	*S. antillarum* (d'Orb.), var. *reticosa* (Chapman)	x	1	...	...	...	...	...	...	...	...	...	...
83	*S. milletti* (Wiesner)	...	...	...	...	...	...	...	...	...	...	1	...
84	*Sigmoilina celata* (Costa) ...	x	...	r.	...	f.	r.	...	...	...	...	...	...
85	*S. schlumbergeri* (A. Silvestri) ...	...	...	...	...	...	1	...	...	...	...	...	...
86	*Triloculina circularis* (Bornemann)	x	1	c.	...	...	1	...	...	...	...	...	...
87	*T. insignis* (Brady)	x	f.	1	r.	...	r.	1	r.	...	r.	...	...
88	*T. tricarinata* (d'Orb.)	x	...	1	...	...	...	...	...	...	1	...	...
89	*T. trigonula* (Lamarck) ...	x	f.	...	f.	...	...	...	...	1	r.	...	...
90	*Flintina triquetra* (Brady) ...	...	...	...	1	...	r.	...	...	...	...	...	...
91	*Ptychomiliola separans* (Brady)	...	f.	1	1	r.	1	...	...	...	...	...	...
92	*Pyrgo fornasinii*, nom. mut. ...	x	..	1	...	...	1	...	...	...	...	...	...
93	*Haplophragmoides grandiformis* (Cushman)	...	...	...	...	...	1	...	...	...	...	...	...
94	*Ammobaculites reophaciformis* (Cushman)	...	c.	...	c.	1	f.	...	...	...	1	...	...
95	*Reophax eunata* (Jensen) ...	...	...	...	...	1	...	...	...	...	...	...	...
96	*R. scorpiurus* (Montfort) ...	x	c.	r.	...	c.	...	r.	1	1	1	...	1
97	*Textularia candiana* (d'Orb.) ...	...	...	...	...	...	1	...	1	...	...	...	...
98	*T. conica* (d'Orb.)	...	...	...	r.	r.	...	...	...	?	1	...	...
99	*T. foliacea* (Heron-Allen and Earland)	...	...	f.	...	f.	f.	...	...	...	...	...	...
100	*T. heterostoma* (Fornasini) ...	...	...	1	...	r.	f.	...	...	...	...	...	...
101	*T. pseudogramen* (Chapman and Parr MS.)	x	f.	c.	f.	c.	f.	r.	r.	r.	1	1	f.
102	*T. porrecta* (Brady)	x	c.	c.	c.	c.	c.	...	...	...	...	...	...
103	*T. rugosa* (Reuss)	...	...	...	...	...	...	...	...	...	r.	...	...

LIST OF SPECIES *continued.*

No.	Species.	S. of C. Wiles.	Sample No. 2	3	4	5	6	7	8	9	10	11	12
104	*T. concava* (Karrer)	...	...	...	...	1	...	...	...	...	...	...	...
105	*T. sagittula* (Defrance)	x	1	c.	r.	v.c.	f.	...	...	...	...	...	...
106	*Bigenerina textularioidea* (Goës)..	x	r.	f.	1	f.	c.	...	...	1	..	..	...
107	*Gaudryina triangularis* (Cushman)	...	v.c.	c.	c.	c.	c.	...	...	...	...	...	...
108	*G. quadrangularis* (Bagg) ...	...	...	...	...	1	...	...	...	...	..	...	...
109	*G. hastata* (Parr MS.)	...	r.	c.	c.	c.	c.	r.	...	1	f.	1	1
110	*Clavulina serventyi* sp. nov. ...	...	f.	f.	c.	c.	c.	r.	...	...	...	...	...
111	*C. difformis* (Brady)	...	...	1	1	...	...	.	1	...	1	...	...
112	*Cribrobulimina polystoma* (Parker and Jones)	...	1	...	...	...	1	...	1	f.	f.	...	1

OSTRACODA.

No.	Species.	S. of C. Wiles.	2	3	4	5	6	7	8	9	10	11	12
1	*Bairdia* sp. aff. *foveolata* (G. S. Brady)	...	...	...	...	...	1	...	...	...	...	...	...
2	*B. amygdaloides* (G.S.B.) ...	x	...	...	...	r.	...	...	...	...	...	...	...
3	*Cythere polytrema* (G.S.B.) ...	...	1	...	...	...	..	...	...	...	...	...	...
4	*C.* sp. aff. *moseleyi* (G.S.B.) ...	...	...	...	...	1	...	...	...	...	...	...	...
5	*C.* sp. aff. *reticulata* (G.S.B.) ...	...	...	1	...	...	...	...	...	...	...	...	...
6	*Loxoconcha australis* (G.S.B.) ...	...	...	...	...	...	...	...	r.	...	...	...	...
7	*Xestoleberis variegata* (G.S.B.) ...	x	1	...	...	...	...	...	...	...	...	...	..
8	*Cytheropteron wellingtoniense* (G. S.B.)	...	...	...	...	1	...	. .	...	...	...	...	...
9	*Bythocythere* sp. aff. *pumilio* (G. S.B.)	...	...	...	...	1	...	...	...	...	...	...	...
10	*Cytherella ovalis* (G.S.B.) ...	...	...	...	...	...	...	...	...	...	...	...	r.
11	*C. punctata* (G.S.B.)	...	...	r.	...	...	...	..	...	...	...	...	...

NOTES ON THE MORE INTERESTING FORAMINIFERA.

Reussia ensiformis (Chapman). Plate I., fig. 1.

Verneuilina ensiformis Chapman, 1910, Proc. Roy. Soc. Vic., vol. xxi (n.s.), pt. 2 (for 1909), p. 271, pl. ii, figs. 1*a*, *b*. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 138, pl. vii, figs. 5, 6. Parr, 1926, Vic. Nat., vol. xliii, p. 18.

One typical example was met with in the "Bonthorpe" soundings. The occurrence of this rare species as a Recent form is noteworthy, as all previous records, which are given above, are from the Oligocene and Miocene of Victoria.

Flintina triquetra (Brady). Plate I., figs. 2*a*, *b*.

Miliolina triquetra Brady, 1879, Quart. Journ. Micr. Sci., vol. xix, p. 268; 1884, "Challenger" Rept. Zool., vol. ix, p. 181, pl. viii, figs. 8-10.

There are several small but otherwise characteristic specimens. This species is extremely rare and is confined to moderately shallow water in the Indo-Pacific region. Brady's figured examples were from Bass Strait.

Ptychomiliola separans (Brady). Plate I., fig. 3.

Miliolina separans Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi, p. 45; 1884, "Chall." Rept. Zool., vol. ix, p. 175, pl. vii, figs. 1-4.

Ptychomiliola separans (Brady): Eimer and Fickert, 1899, Zeitschr. Wiss. Zool., vol. lxv, p. 687.

This is represented by one adult specimen and several examples of the early, involute stages, when this species is very much like *Triloculina linneiana* d'Orb. Although seldom recorded, *P. separans* is a common form on the east coast of Australia and in Bass Strait, in water of moderate depth.

Pyrgo fornasinii, nom. mut.

Biloculina ringens Brady (*non Miliolites ringens* Lamarck, 1884, "Chall." Rep. Zool., vol. ix, p. 142, pl. ii, fig. 7.

B. bradyi Schlumberger (*non* Fornasini), 1891, Mem. Soc. Zool. France, vol. iv, p. 170, text-figs. 15-19; pl. x, figs. 63-71 (and later authors).

There are two typical examples of the form figured by Brady as *Biloculina ringens.* This was subsequently renamed *B. bradyi* by Schlumberger who, however, overlooked that this name had already been used by Fornasini[1] for another species.

Ammobaculites rheophaciformis Cushman. Plate I., figs. 5, 6.

Ammobaculites rheophaciformis Cushman, 1910, Proc. U.S.Nat. Mus., vol. xxxviii, p. 440, text-figs. 12-14; 1920, Bull. 104, U.S.Nat. Mus., pt. 2, p. 67, pl. xiii, fig. 6; 1922, Publ. 311, Carn. Inst. Wash., p. 20, pl. i, fig. 1.

Typical examples are fairly common. This is the first record of the species from Australian waters. The type-specimens were from the Philippines where it occurred abundantly as a shallow-water coral reef species. Cushman's records are from the West Indies and from the tropical Pacific.

Rheophax cuneta Jensen. Plate I., fig. 4.

Rheophax cuneta Jensen, 1905, Proc. Linn. Soc. N.S.W. for 1904, pt. 4, p. 821, pl. xxiii, figs. 5-7*a*, *b*.

Rheophax cuneta Jensen: Heron-Allen and Earland, 1922, Brit. Ant. ("Terra Nova") Exped. Nat. Hist. Rept. Foram., p. 96, pl. iii, figs. 13, 14.

One good example of this species was met with. The only records of its occurrence are those given above. These are from Byron Bay, N.S.W., 111 fms., and 7 miles E. of North Cape, N.Z., 70 fms. We have nothing to add to Heron-Allen and Earland's observations on the structure of the test.

Clavulina serventyi, sp. nov. Plate I, figs. 7*a*, *b*.

Description:—Test elongate, triserial portion trihedral, bluntly pointed; uniserial portion subcylindrical, often slightly tapering, apertural end rounded; chambers broader than high, in the uniserial portion separated by depressed sutures; wall thick, coarsely arenaceous, the surface rough; aperture small, circular, with a valvular tooth; occasionally consisting of two or three pores; colour creamy white.

Length up to 4 mm.

Holotype (Chapman Coll.) from "Bonthorpe" Sample 6.

Observations:—This is a common form on the Australian coast in dredgings from depths of from 100 to 300 fms. and is probably the species recorded by Brady and later authors from the Indo-Pacific region as *C. parisiensis* d'Orb. Our specimens of *C. parisiensis*, from the Eocene of Grignon, show it to be a much smaller, irregularly-formed species, with fewer chambers, and usually with a smoothly finished test, although this may occasionally be roughened. Cushman's *C. humilis*, var. *mexicana* (*vide Bull.* 104, U.S.Nat. Mus., pt. 3, 1922, p. 83, pl. xvi, figs. 1-3) bears some resemblance

(1) 1886, Bull. Soc. Geol. Ital., vol. v, p. 261.

to the present species, but differs in the subglobular shape of the later chambers which are separated by deeply constricted sutures, and in its produced apertural end. *C. parisiensis*, var. *multicamerata* Chapman, described (Journ. Quek. Micr. Club, ser. 2, vol. x (for 1907), 1909, p. 127, pl. ix, fig. 5) from the coast of Victoria has a smooth shell, with the first few chambers of the uniserial portion triangular in section, while the apertural end is depressed, with the conspicuous, often cribrate aperture surrounded by a raised border.

The specific name is given in honour of Mr. D. L. Serventy, B.Sc., who has so kindly given us the opportunity of examining these interesting soundings.

EXPLANATION OF PLATE I.

Fig. 1.—*Reussia ensiformis* (Chapman). "Bonthorpe" Sample 8, from lat. 33° 50′ S., long. 125° 17′ E., 39 fms. × 46.

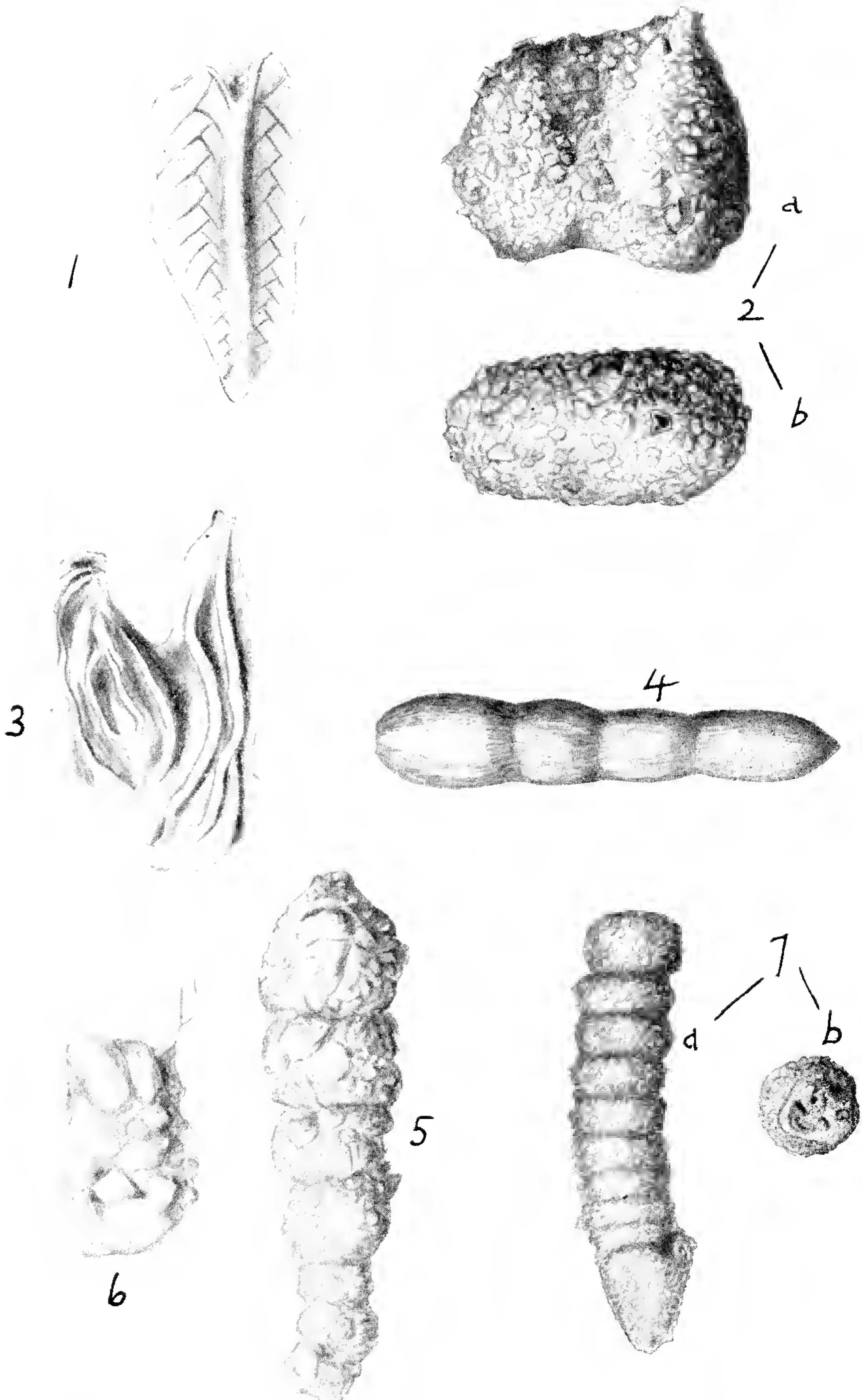
Fig. 2.—*Flintina triquetra* (Brady).—*a*, side view; *b*, apertural view. "Bonthorpe" Sample 6, from lat. 33° 15′ S., long. 126° 10′ E., 70 fms. × 46.

Fig. 3.—*Ptychomiliola separans* (Brady).—"Bonthorpe" Sample 5, from lat. 33° 15′ S., long. 126° 10′ E., 62 fms. × 23.

Fig. 4.—*Rheophax eunceta* (Jensen).—"Bonthorpe" Sample 5, from lat. 33° 15′ S., long. 126° 10′ E., 62 fms. × 23.

Figs. 5, 6.—*Ammobaculites reophaciformis* (Cushman).—5, "Bonthorpe" Sample 2, from lat. 33° 14′ S., long. 126° 16′ E., 89 fms. × 34. 6, Early chambers of another specimen, showing initial coiled series. Sample 6, from lat. 33° 15′ S., long. 126° 10′ E., 70 fms. × 46.

Fig. 7.—*Clavulina serventyi*, sp. nov. Holotype. *a*, side view; *b*, apertural view. "Bonthorpe" Sample 6, from lat. 33° 14′ S., long. 126° 10′ E., 70 fms. × 23.



W.J.P. ad nat. del.

PLATE I.

Reproduced nat. size.

2.—SOME WESTERN AUSTRALIAN UPPER PALAEOZOIC FOSSILS.

By K. L. PRENDERGAST, B.Sc. (Hons.).

Read 14th August, 1934; Published 31st May, 1935.

CONTENTS.

INTRODUCTION.

The correlation of beds in geographically distant localities must be based, in the main, on published lists of fossils. In some cases these lists have been copied from paper to paper without examination of the specimens, with consequent faulty correlation. An examination of some Western Australian fossils with partial revision of lists was commenced by Miss L. F. V. Hosking in 1931. All the shells described in this paper have been previously listed, but owing to recent changes in palaeontological nomenclature now require renaming.

The history of the palaeontology of the Permo-Carboniferous of Western Australia is divisable into three schools governed respectively by the English, the Eastern Australian, and the Western Australian workers in the subject.

Of the earliest, the English, apparently the first published descriptions were those of Hudleston in 1883. The paper was confined to a collection made by the late Sir John Forrest. Among the specimens listed are Echinoderms, Brachiopods, and Lamellibranchs, but the only descriptions are of Corals and Polyzoans.

Mr. E. T. Hardman, of the Geological Survey of Ireland, was the pioneer geologist of the Kimberley, and his researches laid the foundation of our knowledge of the geology of that district. In the course of his investigations Hardman made an extensive collection. A part of this collection was presented to the British Museum in 1886, and additional specimens were forwarded after Hardman's death. Dr. Henry Woodward edited a series of papers on the description of the specimens contributed by A. H. Foord (Brachiopoda, Mollusca, Pteropoda, and Crustacea), R. Kidston (Plants), H. A. Nicholson (Stromatoporoids), and G. J. Hinde (Corals). Foord's descriptions included notes made on the collection by R. E. Etheridge. Hardman's field determinations, as contained in his report, are, therefore, replaced by the series of papers listed above.

In 1886 Dr. Henry Woodward published a description of a fish (*Edestus davisii*) from the Gascoyne River. The exact generic position of this species has been a matter of controversy for some years, the age of the containing rock being dependent upon the genus. As the specimen was found in a boulder, and no further specimens have been found, it seems that the importance of the specimen has been over-rated.

From 1886 onwards the major portion of the Palaeozoic Palaeontology of Western Australia was done by Australian geologists. The greatest worker in this field was R. Etheridge, junior, of the Australian Museum, Sydney, whose work must form the basis for future work. In 1889 appeared an article in the Proceedings of the Linnean Society of New South Wales, being a description of some Western Australian fossils in the Macleay Museum, Sydney. The report of the Department of Mines of New South Wales for 1889 contained a short note on some fossils from the Irwin River. The work as official palaeontologist to the Geological Survey of Western Australia began in 1903 (Bull. 10). This Bulletin contains descriptions of Carboniferous fossils from the Gascoyne District, and was the first recognition of the importance of palaeontology in the unravelling of the stratigraphy of the Carboniferous rocks. Etheridge's second contribution was a description of plant and animal remains from the Irwin River, published as a Bulletin of the Geological Survey (No. 27 of 1910). This was followed in 1914 by Bulletin 58 on more Carboniferous fossils from Mount Marmion and other localities in the North-West Division of the State. The last work of this writer on Western Australian Palaeontology is a description of the fossils collected by the Basedow Expedition in 1916.

F. Chapman, now Commonwealth Palaeontologist, has contributed many papers on this subject. In Bulletin 27, G.S.W.A., the Carboniferous fossils in the collection of the National Museum, Melbourne, which has been sent from the Collie District, are described. Since his appointment as Commonwealth Palaeontologist, Chapman has published several lists of Western Australian fossils.

The third Eastern geologist was Rex. W. Bretnall, who in 1926 compiled a complete description of Western Australian Polyzoa with the aid of some of Etheridge's notes. This was published in Bulletin 88, G.S.W.A.

A very useful work on Western Australian Palaeontology is contained in Bulletin 36 of the Geological Survey of Western Australia, with a supplement in Bulletin 88. This is a list of Western Australian fossils systematically arranged by L. Glauert, giving a complete bibliography of the subject to the date 1925. Prior to this, in 1912, Glauert completed a description of a new Brachiopod from the Byro Plains, together with a list of fossils from that locality.

Since 1926 no further contributions have been published by the Geological Survey, the Royal Society of Western Australia now publishing the majority of papers on this subject. The latest contributions are those of Miss L. Hosking. Two of her papers—The Specific Naming of Aulosteges from Western Australia and Western Australian Orthotetinae—deal with individual problems, while the later ones give full descriptions of new species with records and further figures of those previously described.

The inaccessibility of the fossiliferous horizons explains the relatively small amount of work that has been done. These localities are separated by enormous distances in almost uninhabited country. Zoning, under such circumstances, is an impossibility, so that advances of Western Australia Palaeontology must depend for some time upon the recording and description of specimens.

The author is indebted to Miss L. F. V. Hosking (now Mrs. N. Hanrahan) for advice and assistance in the preparation of this paper; to Mr. H. J. Smith for the photographic work; the Mining Museum, Sydney, and the Australian Museum for the loan of specimens; and Mr. T. Blatchford, the Government Geologist, for access to literature and the generous loan of specimens.

NOMENCLATURE.

In Palaeontological papers the same terms are used in a different sense by different authors. In order to avoid misinterpretation the terms used in this paper are defined below. The usage is in accordance with that of Thomson.[1]

DEFINITION OF TERMS.

Apical Plates: used as a substitute for crural plates. A neutral term not indicating a specific function, and therefore useful in cases where the function of the plates is unknown.

Biramous Spines: Spines arranged with a longitudinal partition, hence the spine has two circular or oval cavities.[2]

Chilidium: A plate similar to the deltidium developed in the brachial valve.

Crumples: Sub-concentric ribs without regular arrangement.

Crural Cavity: The cavity enclosed between the apical plates.

Crural Plates or Crura: Processes diverging from the cardinalia, and generally curved towards the ventral valve.

Curvature of the Umbo: Thomson[3] says "The curvature of the ventral beak towards the dorsal valve is usually expressed by such terms as 'suberect,' 'erect,' 'slightly incurved,' etc., the sense varying with the author . . . To ensure precision it is recommended that the terms should be used in the sense indicated in the accompanying diagram." (Fig. 33.)

Thomson's figures have been interpreted as follows:—

A Straight: the axis of the umbo is parallel to the plane of the commissures, in the opposite sense.

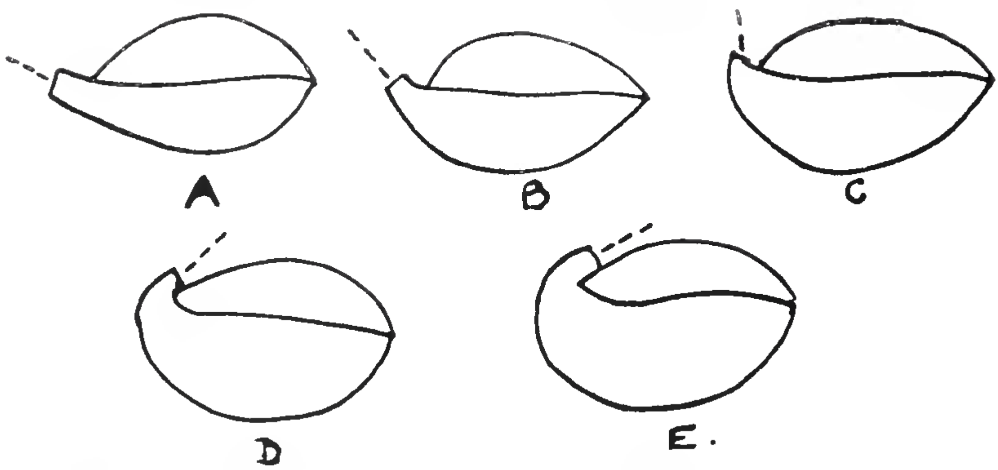
B. Suberect: the axis of the umbo lying between the straight and erect positions.

C. Erect: the axis of the umbo is perpendicular to the commissural plane.

1 1927. 2 George, 1932. 3 Thomson, 1927, p. 30.

D. Slightly-incurved: the inclination of the umbonal axis and the plane of the commissures is between 90° and 45°.

E. Strongly-incurved: the inclination is less than 45°.



Text Figure 1. Diagram showing the terminology of the curvature of the umbo.

Deltidium: an impunctate triangular plate present on the cardinal area of the pedicle valve, only in the Protremata.

Dental Lamellae or Dental Plates: plates supporting the teeth, usually free though sometimes joined to the bottom of the valve.

Hinge-plate: a horizontal plate separated anteriorly from the floor of the valve by a cavity.

Parasulcate: a shell in which the uniplica is present with a sulcus formed on each side of it.

Pectinated Ridges: growth lamellae continued forward as a fringe of closely set spines.

Plications: coarse radial markings.

Rectimarginate: a shell in which each valve is regularly convex, though not necessarily equal in convexity; the front margin is straight.

Sinus: the term sinus should be restricted to a ventrally directed curve in the course of the commissure.

Striae: fine radial markings.

Sulcus: decrease in convexity along lines running from the umbo to the margin.

Uniplica: a shell in which a single fold in the brachial valve is opposed to a sulcus in the pedicle valve.

All measurements are taken in millimetres, and where the sign + appears following a figure it indicates measurement along a broken shell.

The name of a species where included in inverted commas, indicates a wrong indentification.

Genus **Spanodonta**[1] n. gen.

Shells concave-convex dorso-ventrally. Shell substance impunctate and ornamented with fine plications which increase by bifurcation. The area of the pedicle valve is inclined and flat; it has a well-developed deltidium. In the brachial valve the area is very narrow.

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1 σπανις, scarcity, from the lack of denticulations along the hinge-line.

The crural plates of the brachial valve are united to the cardinal process, the whole forming a vertical sub-crescentric process. The crural plates diverge and curl forward to form a spoon-shaped cavity with the concavity facing backwards and outwards. The muscle marks are flabellate and separated by a median ridge. Visceral cavity defined by marginal elevations. In the pedicle valve the dental plates are short, not reaching to the bottom of the valve.

Geno-type: Spanodonta hoskingiae sp. nov.

These shells are closely allied to Stropheodonta, from which they may be distinguished by the impunctate character of the shell, the absence of denticulations along the hinge-line and the presence of marginal elevations.

The internal and external characters remind strongly of the Orthotetinae but in that group the shells are convexo-concave dorso-ventrally.

Spanodonta hoskingiae[1] n. sp.

Pl. III., fig. 1-3.

1923. "*Productus tenuistriatus* var. *foordi*" Eth. fil.

"*Productus* sp." in Chapman, List of Fossils from the West Kimberley: G.S.W.A. Ann. Prog. Rept. 1923, p. 35-36.

Shells small, the hinge-line less than the greatest width of the shell. The maximum width is at about the mid-length of the valve.

In the young stages the pedicle valve is slightly convex, the convexity increasing with age. The umbo is not prominent, being hardly elevated above the general level of the cardinal area. This is wide and is divided medially by a deltidium. The deltidium is broad, the angle of divergence of its sides in some cases as great as 90°.

The brachial valve is regularly concave and has a well-developed area and chilidium. The valve becomes thickened with age, so that the interior appears geniculate in the later stages. The smallness of the shells is shown by the table.

Length of the pedicle valve.	Width.	Length of the hinge-line.	Depth.
15.0	17.5	12.0	3.3
15.0	13.0	12.0	—
15.0	13.3	13.0	—
13.0	13.0	11.5	—

Syntypes Nos. 2530, 3052, 2750, University of W.A. Geol. Dept.

Localities: Price's Creek, Rough Range. 2½ miles NNE of bore at Price's Creek, Kimberley.

North-West portion of Price's Creek, Kimberley.

Genus LINOPRODUCTUS Chao.[2]

1927. Chao, Y. T., Productidae of China, Pt. 1, Pal Sinica. Peking. Ser. B, Vol. V., fasc. 2, p. 128.

1 The species is named after Miss L. F. V. Hosking.

2 Synonyms. Cora Fredericks 1928, and Cancrinella Fredericks 1928, vide Muir-Wood, H.M., 1930, p. 105.

Linoproductus cancriniformis (Tschernyschew).

Pl. II., fig. 7-12.

1889. *P. cancriniformis* Tschern. Mem. Com. Geol. Russia, St. Peterbourg, 111, No. 4, p. 373, Pl. VII., fig. 32 and 33.

1907. "*P. undatus*" Defrance, Eth. fil., Palaeontological Contributions to the Geology of Western Australia: Pt. 1, G.S.W.A. Bull. 27, p. 30.

1908. *P. cancriniformis* Tschern., Diener, Himalayan Fossils: Pal. Ind. Ser. XV., Vol. 1, Pt. 4, p. 31, Pl. 1, fig. 7-10.

1908. *P. cancriniformis* Tschern., Diener, op. cit.: Pt. 3, p. 25, Pl. IV., fig. 6 a-b, 7 a-d.

1918. "*P. bellus*" Eth. fil., in Basedow, H., Narrative of an Expedition in North-Western Australia: Trans. Roy. Geog. Soc. Aust. S.A. Branch, Vol. XVIII., p. 254, Pl. XXXIX., fig. 4 and 5, Pl. XL., fig. 6.

In 1907, Etheridge, recording *Productus undatus* from the Irwin River, pointed out that the specimens agreed with only one of Davidson's[2] figures (Pl. XXXIV., fig. 7).

Again, in 1908, Diener[3] questioned the identification of these shells. Writing of *P. undatus*, he said, "The Australian species differs from the typical shape of *P. undatus*, as it is described by deKoninck, by the larger number of spines, and reminds strongly of *Productus cancriniformis* . . . . . This variety of *P. undatus* can barely be distinguished from *P. cancriniformis*, if one has to deal with ventral valves only, the chief difference consisting in the shape of the dorsal valve, which is regularly concave in *P. undatus*, but distinctly geniculate in Tschernyschew's species."

The brachial valve of the Irwin shells are strongly geniculate, hence they must be referred to *P. cancriniformis* rather than to *P. undatus*. The fossils occur in a grey limestone near Fossil Cliff, and in the same limestone are numerous slightly convex impressions, which show the same ornamentation of concentric crumples, radial striae and spine bases, but without a geniculate margin. Their length is not so great as that at which the larger specimens become sharply bent over, hence they are probably impressions of brachial valves of younger individuals.

Describing fossils from Balmaningarra, Mt. Marmion, in 1918, Etheridge includes a new Productus—*P. bellus*. Etheridge's types of this species (Australian Museum, Sydney, Nos. F. 16731, 16734, 16735, 16736, 16742) include one flattened and three fairly convex pedicle valves and a geniculate brachial valve, which show no characters distinguishing them from *Linoproductus cancriniformis*. Etheridge, in his descriptions of *P. bellus*, says that it approximates in shape to *P. carbonarius* de Kon, but on comparing Davidson's descriptions and figures of *P. carbonarius*[4] with *P. undatus*, and with Diener's figures of *P. cancriniformis*, there appears to be no distinct difference in shape between the three. Again, Etheridge says that *P. bellus* is distinct from all other Productidae in having two rows of alternating spines on the cardinal margin. This is a character of *P. cancriniformis*.[5] On these grounds, therefore, *P. bellus* and *P. cancriniformis* cannot be separated.

2 Davidson, T., 1861, p. 161, Pl. XXXIV., figs. 7-13.

3 Diener, C., 1908, p. 24.

4 Davidson, 1861, p. 160, Pl. XXXIV., fig. 6.

5 Diener, op. cit. Pt. 4, p. 32, Pl. 1, fig. 8, 1908.

Among the collection are specimens in which the concentric crumples are strongly marked. On this account they have been placed in *P. canciniformis* rather than in *P. cancrini*, Verneuil; although Diener thinks that *P. canciniformis* is not distinct from *P. cancrini*.

It must be noted that some of the specimens differ in their proportions from those of the Productus shales, as the commonest forms of the latter are longer than broad. Diener says, however, that his specimens are very variable in shape, and some have been found broader than long. The majority of the Irwin shells, as with those from the Productus shales, are longer than broad.

Smaller specimens of this species have been collected at Oscar Range Station. From the smallness of the shells it is thought that the physical conditions must have been unfavourable to their growth.

Specimen Nos.:

2511, 10822, 10823, University of Western Australia, Geology Department.

A 371, A 379, Geological Department, University of Western Australia.

1/4970, Geological Survey of Western Australia.

F. 16731, 16734, 16735, 16736, 16742, Australian Museum, Sydney.

Localities:

Fossil Cliff, Irwin River District.
Balmaningarra, Mount Marmion.

Genus WAAGENOCONCHA Chao.[1]

1927. Chao, Y. T., The Productidae of China: Pt. 1, Pal. Sinica, Ser. B, Vol. V., fasc. 2, Pt. 1, p. 85.

Waagenoconcha imperfecta sp. nov.[2]

Pl. IV., fig. 1-3.

1923. "*Productus subquadratus*" Morris. Chapman, List of Fossils from the West Kimberley: G.S.W.A. Ann. Prog. Rept., p. 36.

In the adult the shell is longitudinally oval, the hinge-line being always less than the greatest width of the shell. The shell has its maximum width at a distance of two-thirds of the length from the umbo. There is no cardinal area.

The pedicle valve is moderately convex and is regularly curved longitudinally; transversely the sides slope steeply. The beak is strongly incurved and overhangs the hinge-line. The valve is divided into parts by a sinus which extends from the umbo to the anterior margin; as it approaches the margin the sinus flattens out and in the largest specimens the margin is entire. The umbonal cavity is smooth but a pair of large longitudinally striated, flabellate muscle scars arise about a fourth of the length from the umbo and extend to a point half the length from the umbo.

1 Synonym, Ruthenia Fredericks 1928, fide Muir-Wood, H.M., 1930, p. 104.

2 The species is called "imperfecta" since it agrees imperfectly with the generic description.

The brachial valve is almost flat, but a median fold, arising in the centre of the valve and widening towards the margin, gives to the anterior portion a concave appearance. A median septum is present in the brachial valve and is joined to a triangular hinge-plate, which is continued posteriorly as a strong cardinal process. Where the shells are weathered, the median septum, hinge-plate and the cardinal process stand out as a cruciform projection. The median septum continues forward to within a fifth of the length from the margin.

The ornamentation is not preserved on the majority of the specimens. Where preserved the whole surface of the shell is covered by fine tubercles, regularly arranged in quincunx. Each tubercle gives rise to a spine. The spines are small, inclined obliquely forward and distributed over both valves.

As the figures given in the table indicate, the shell outline changes with growth. In the younger shells the width is equal to or greater than the height, while in the adult the height always exceeds the width.

A syn-type of this species has been previously listed by Chapman[3] as *Productus subquadratus*. In his original description of that species, Morris[4] states that the surface of the valves is covered with coarse longitudinal plications and that the hinge-line is the greatest width of the shell. Later, Etheridge[5] describing *P. subquadratus* from Queensland, says that the umbo does not overhang the hinge-line. This species *W. imperfecta* is, therefore, distinct from *P. subquadratus*.

Specimen No.	1	2	3	4	5
Length	60	65	70	74	90
Height	31	38	43	43	49
Width	37	39	41	38	42
Length of the hinge-line	23	24	30	22	24
Depth	13	14	17	21	24
Length of the brachial valve ..	26	30	33	35	37

Dimensions of specimens of *Waagenoconcha imperfecta*.

The species is most closely related to *P. purdoni*[6], from which it may be distinguished by the texture of the spines. The spines are much closer and finer in this species than as described for *P. purdoni*.

In the diagnosis of the genus Waagenoconcha as given by King[7], he says, "the surface is marked by quincunxially arranged tubular spines in the youthful and adult stages, which become smaller and more closely packed together in old age." It must be noted that the present specimens do not agree with King's diagnosis, since the spines become more widely spaced towards the margin. Thus in a shell where the length of the pedicle valve is 74mm., at a distance of 25mm. from the umbo there are 14, at 44mm. 11, and at 68mm. 10 spines per cm. In spite of this discrepancy the species is referred without hesitation to the genus Waagenoconcha.

Locality: Luluigui Station, Kimberley Division.

Holotype: University of Western Australia, Dept. of Geology, No. 3044.

Allotypes: University of Western Australia, Dept. of Geology, Nos. 2768,

3 Chapman, 1923, p. 36.

4 Morris, 1845, p. 284.

5 Etheridge and Jack, 1892, p. 253, Pl. 38, figs. 7-10.

6 Davidson, 1862, p. 31, Pl. 11, fig. 5; Reed, F. R. C., 1931 (a), p. 10, Pl. 111, fig. 2.

7 King, R. E., 1930, p. 80.

Genus PRODUCTUS, J. Sowerby.

1814. Sowerby, J., Mineral Conchology, Vol. 1., p. 153.

Productus subquadratus,[1] Morris.

1845. Morris in Strzelecki's Physical Description of New South Wales and Van Dieman's Land: p. 284.

For further references see—

1909. Etheridge and Dun, Records of the Geological Survey of New South Wales: Vol. 8, Pt. 4, p. 300, Pl. XLI., fig. 1-5.

A figure of this species is included in the plates. The specimen is a limonitic cast, and the muscle marks are clearly shown.

Locality: 2 miles North of Ballythanna Hill, Wooramel River.

Genus SEMINULA McCoy (not Hall and Clarke, 1894).

Genotype figured by McCoy, Carboniferous Limestone Fossils of Ireland: p. 150, fig. 31, 1844.

Seminula globulina Phillips.

Pl. 11, fig. 16-18.

1836. *Terebratula globulina* Phillips, Encyc. Met. Geol. in Mixed Sciences, Vol. IV., Pl. 111, fig. 3.

1850. *Camarophoria globulina* Phillips, King, Mon. Perm. Fossils: p. 120, Pl. VII., fig. 22-25.

1858. *Camarophoria globulina* Phillips, Davidson, Brit. Perm. Brachiopoda: p. 27, Pl. 11, fig. 28-31.

1883. *Camarophoria globulina* Phillips, Waagen, Salt Range Fossils, Productus-Limestone Group, Brachiopoda: Pal. Ind. Ser. XIII., Vol. 1, Pt. 4, p. 443, Pl. XXXIII., fig. 13-14.

The specimens agree in all essential features with those figured by Waagen, but differ slightly from those of King and Davidson, since the plications are more strongly marked on the English shells.

The smaller shells are smooth, and even on the larger the plications are marked only on the anterior margins. Several of the shells show marginal expansions of the valves.

Waagen distinguishes between *C. rhomboidea* Phillips, and *C. globulina* on the relative convexity of the ventral valves. On this criterion the specimens from the Irwin River must be placed in *C. globulina*. Sections of the shells show that the internal structure is in complete agreement with Camarophoria, as shown by Weller.[2]

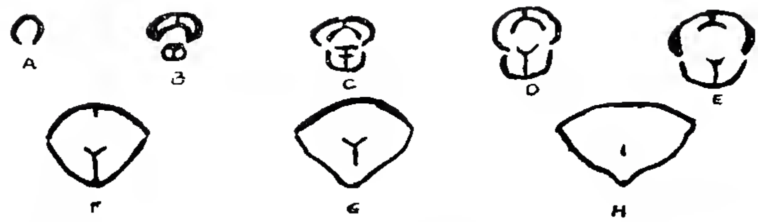
1 This species has been made the genotype for a new genus, Taeniothaerus Whitehouse. Since no description of the genus has been published it must be regarded as a nom. nudum.

The examination of a large series of specimens reveals that this species cannot be included in any of the recognised genera formerly grouped as Productus (s.l.).

2 Weller, 1914, p. 169, fig. 1.

In the pedicle valve is a strong median septum. The dental lamellae are continued anteriorly as a well-developed spondylium supported for the whole of its length by a median septum.

The hinge-plate of the brachial valve is continuous, and is supported by a median septum.



Text. Fig. 2. Sections through the rostral portion of *Seminula globulina* showing the internal structure.

This species has formerly been referred to the genus *Camarophoria*, King, but as Buckman[2] has pointed out, it really belongs to the genus *Seminula*, McCoy, of which *Camarophoria* King, may be regarded as a sub-genus, in which the shells are more transverse and plicate.

Localities: Holmwood, Irwin River District; Fossil Cliff, Irwin River District.

Specimens: No. 10370, 10371, Geol. Dept., University of Western Australia.

Genus COMPOSITA Brown.

1849. Brown, T., Illustr. Foss. Conch. Great Britain and Ireland, p. 131, Pl. LIV.*, fig. 6, 7.

1906. Buckman, S. S., Brachiopod Nomenclature: Ann. & Mag. Nat. Hist. Series 7, Vol. XVIII., p. 325.

Composita subtilita Hall.

Pl. III., fig. 4 & 5.

1852. *Terebratula subtilita* Hall, Stanbury's Expl. and Survey Great Salt Lake: p. 409, Pl. IV., fig. 1a-2c.

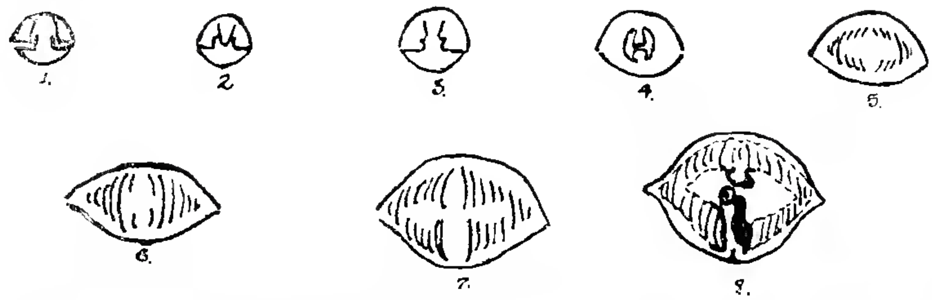
1923. *Seminula sp. nov.* (near *S. subtilita* Hall). Chapman, List of Fossils from the West Kimberley: G.S.W.A. Ann. Rept. 1923, p. 35.

Shell sub-oval to pentagonal in outline with the greatest width about half the length of the pedicle valve from the umbo. The shell is marked by concentric growth lines, there being no sign of secondary plications among these specimens. The pedicle valve is indented by a narrow sulcus which widens towards the margin. The valves are biconvex, the pedicle more convex than the brachial. The pedicle umbo overhangs the hinge-line and is perforated by an oval foramen.

Internally the shells exhibit the characteristic structures of Composita Brown.

2 Buckman, 1906, p. 325.

These shells have been previously listed as *Seminula* sp. nov. (near *S. subtilita* Hall) by Chapman, but I can see no reason for separating them from that species.



Text Fig. 3.—Series of sections through the umbo of *Composita subtilita* Hall, to show the internal structure.

The dimensions of the shells are shown by the following table:—

	Valve Length— Pedicle.	Valve Length— Brachial.	Breadth.	Depth.
1.	21.5	16.0	12.4	8.5
2.	21.0	17.0	15.7	9.7
3.	28.0	18.0	16.3	12.3
4.	30.0	20.0	17.4	12.2
5.	30.5	21.0	17.6	12.5

This species has been formerly referred to Seminula McCoy, but Buckman has shown that this name should be replaced by Composita Brown since that has right of priority.

An excellent description of this species is given by Dunbar and Condra.[2]

Locality: 12 miles West of Oscar Range Homestead, about 120 miles E.S.E. of Derby, Kimberley.

Specimens Nos. 2507, 2510, University of W.A., Geol. Dept.

Genus CAMAROTOECHIA Hall and Clarke.

1894. Hall and Clarke, Palaeontology of New York, Vol. VIII., Pt. 2, p. 189.

Camarotoechia pleurodon (*Phillips*).

1836. *Rhynchonella pleurodon* Phillips, Geol. Yorks, Vol. II., Pl. 12, figs. 25-30, p. 222.

1858. *Rhynchonella pleurodon* Phillips, Davidson, Mon. Brit. Carb. Brach.: Vol. II., p. 101, Pl. XXIII., fig. 1-22.

1863. *Rhynchonella pleurodon*, Davidson, Mon. Brit. Dev. Brach.: p. 62, Pl. XIII., fig. 12-13.

1923. *Pugnax pleurodon*, Chapman, List of Fossils from the West Kimberley: G.S.W.A. Ann. Prog. Rept. 1923, p. 36.

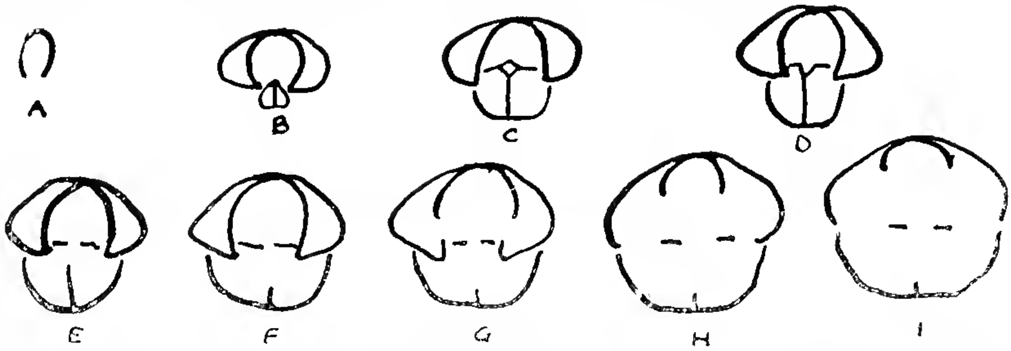
Sections through the umbo prove the specimens to belong to the genus Camarotoechia Hall and Clarke.

In the restral portion of the brachial valve the median septum is divided to form a V-shaped crural cavity, the walls of this cavity support a divided hinge-plate.

The dental lamellae of the pedicle valve are long, slender and diverging.

2 Dunbar and Condra, 1932, p. 363.

The shells agree with the figures and descriptions of *C. pleurodon* as given by Davidson. The umbo is pointed, slightly incurved and overhanging the hinge-line. The surface of both valves is covered with well-defined plications, of which there are from 15-18 on each valve.



Text Fig. 4. A series of sections through the rostral portion of Camarotoechia pleurodon, to show the internal characters.

The dimensions of the shells are shown by the table.

Specimen No.	Length.	Width.	Depth.	No. of plications on the fold.
A	12.5	18.0	9.0	5
B	11.4	16.3	6.9	5
C	12.5	16.6	4.7	4
D	9.0	13.7	8.4	4
E	11.1	13.7	6.3	4

The specimens show one difference from those of Davidson's, the plications of these shells are not grooved longitudinally.

Locality: Fossils Downs Station, Margaret River, Kimberley.

Specimens No. 2771, University of W.A., Department of Geology.

Camarotoechia pleurodon Phillips, var. tripla. var. nov.

Pl. II., fig. 1A-6.

1923 "Pugnax pleurodon," Chapman, List of Fossils from the West Kimberley: G.S. W.A. Ann. Prog. Rept., 1923, p. 35.

A large number of plicated Rhynchonellids from the Kimberley Division show a gradual variation from a small flat shell with no sinus to a much larger shell with a well-developed fold and sinus resembling *Camarotoechia pleurodon* in general outline.

On sectioning, both the larger and smaller shells show the internal characters of Camarotoechia as given by Weller.

In *C. pleurodon* the number of plications on the fold of the brachial valve is usually four, varying from three to nine according to the age of the shell. The number of plications on the fold in the Kimberley shells is always three, being independent of the size of the shell.

Again, while in *C. pleurodon* the plications are grooved longitudinally, not one of these specimens shows that condition.

These differences, constant in so many specimens (138) appear sufficiently well-marked to constitute a variation.

Locality: 12 miles S.W. of Oscar Range Homestead, about 120 miles E.S.E. of Derby, Kimberley.

Specimen Nos. 2512, 2513, 2514, University of Western Australia, Department of Geology.

Genus SPIRIFER Sowerby.

1816. Sowerby, J. Mineral Conchology of Great Britain, Vol. 2, p. 41.

Spirifer fasciger Keyserling.

1843. Keyserling, Reise in das Petschoraland, p. 229, t.8, f.3, 3a,b. For reference and synonomy see—

1930. *Spirifer musakheylensis* Dav. Hosking, Fossils from the Wooramel District, Western Australia: Journ. Roy. Soc., W.A., Vol. XVII, p. 23, Pl. VII, fig. 1-2.

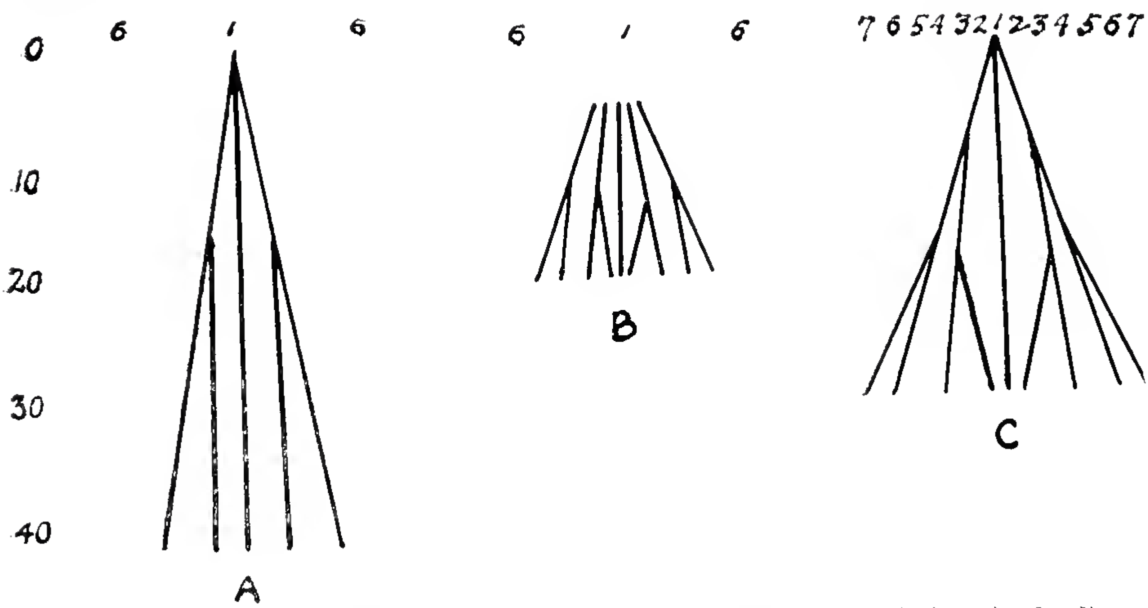
The specimens of this species from Western Australian beds are not preserved at all well. There is no record of a complete specimen, and the majority of single valves are crushed and broken. A few small valves are almost entire, and it is from these specimens that the notes have been compiled .

In all the specimens examined there is evidence of a median sinal plication. In tracing the development of the plications the younger specimens were the only ones found satisfactory. The concentric lamellar expansions of the shell surface tend to obscure the nature of the radial markings, and it was found easier to trace the plications on plasticine casts of the exterior of the shell. The hollows of the cast appeared more clearly defined than the ridges of the shell.

The smallest shell (A) of this species is an almost perfect valve. Both the bounding and laterial plications have each divided twice to give an external and an internal branch.

In the next stage (B) the first sinal plication has bifurcated and a second branch of the bounding plication has appeared.

The next increase is due to bifurcation of the second sinal plication. Beyond this stage the development cannot be traced without better specimens.



Text Fig. 5. Diagrams illustrating the development of the sinal plications in *Spirifer fasciger* Keyserling. (Not to scale.)

1 These specimens show a constant difference from the Mongolian species
1 in the possession of a median sinal plication.

1 Grabau, A. W., 1931, pp. 163-178, Pl. XXIII.

The Australian species has been referred to *Spirifer fasciger.* Grabau, following Waagen, states that the differences between the two species is shown by the character of the primary plications. In *S. fasciger* they are angular, whereas in *S. musakheylensis* the outline is rounded. This criterion cannot be applied to the Western Australian shells since every gradation from sharply angular to almost flat and rounded plications may be seen.

Locality: Creek, ½ mile West of Callytharra Springs, Wooramel; Waltharrie Pools, Wooramel; Fossil Cliff, Irwin River District.

Specimens: No. 8490a, 6327, 10961, 10962, 10963, Geology Department, University of Western Australia. 1/4963, Geological Survey of Western Ausstralia.

Genus SPIRIFERELLA Tschernyschew.

1902. Tschernyschew, Mem. Comite. Geol., Russia, 1902, Vol. XVI., No. 2, pp. 121 and 522, Pl. XII., fig. 4, Pl. XI., fig. 7.

Spiriferella australasica Eth. Fil.

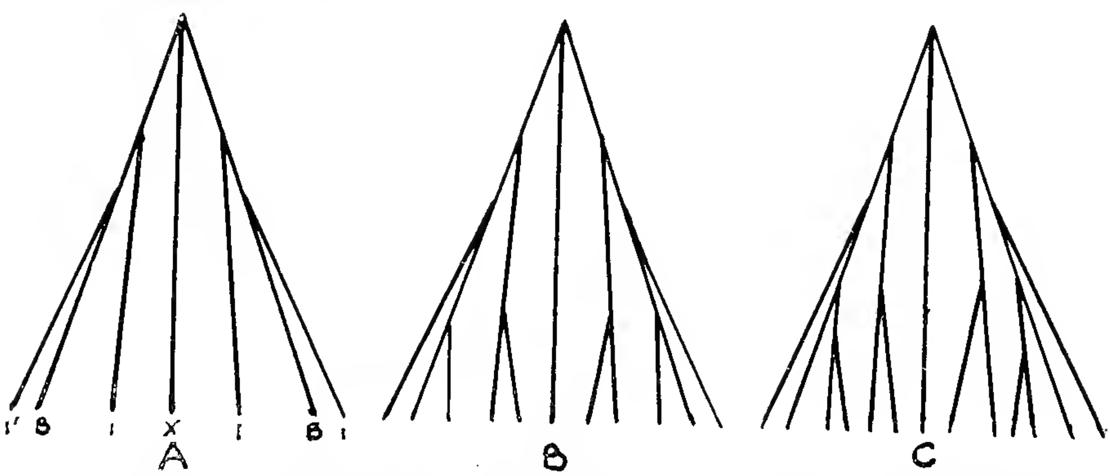
1915. *Spiriferella australasica* Eth. Fil., Western Australian Carboniferous Fossils, chiefly from the Mount Marmion, Lennard River, West Kimberley: G.S.W.A. Bull. 58, p. 30, Pl. V., fig. 6-13.

1931. *Spiriferella australasica* Eth. Fil, Hosking, Fossils from the Wooramel District: Journ. Roy. Soc., W.A., Vol. XVII., p. 29.

For further synonomy, see this paper.

The species may be divided into three mutations[2] according to the arrangement of the sinal plications. It has been said[3] that this species approximates closely to *S. saranae* Tschern, but examination of the sinal plications shows that it differs radically, since these is not a median plication in *S. saranae*, while in this species the sinus is always medially folded.

A diagram shows the difference between the mutations most clearly.



Text Fig. 6. The Western Australian mutations of *Spiriferella australasica.*

2 The term "mutation" may be wrongly used here. The time sequence of the "mutations" is not known, but from the development of the forms it is thought that a, b, c, follow chronologically.

3 Etheridge, 1914, p. 31.

In *mutation a* the bounding plications have each divided once, while the lateral plications are simple.

Mutation b is a second stage in the development of *mutation a,* in which the bounding plication has divided twice, and the first branch has bifurcated.

A much greater development is shown by *mutation c,* for here the lateral plications have each an internal branch, and the second branch of the bounding plication is an internal one.

Both mutations b. and c. have arisen from mutation a. by multiplication of the plicae. In Western Australian beds mutation a. is by far the most common form. The distribution of the mutations is shown by the table.

	Number of specimens		
Locality.	Mutation a.	Mutation b.	Mutation c.
Creek ½-mile W. of Callytharra Spring, Wooramel	14	4	2
S. bank of Wooramel, ¼-mile above Callytharra Spring	1	—	1
S. bank of Wooramel, below Callytharra Spring	1	—	—
Waltharrie Pools, Wooramel	4	—	—
Callytharra Spring, Wooramel	6	3	—
Irwin River	2	1	—
Bogadi Outcamp, Wooramel	3	—	—
Mt. Marmion, Kimberley	2	1	—

Although at this stage no conclusions may be drawn from this table, it is hoped that when accurate zoning of the beds is commenced the distribution of the mutations will be of some use.

Specimens:

Nos. 8497, 9369, 10941, 10942, 10939, 10940, 10965, Dept. of Geology, University of W.A.

Nos. 1/4658, 1/4636, 1/4681, 1/4691, 1/4964, Geological Survey of W.A.

Genus PHRICIDOTHYRIS George.

1932. George, N. T., The Carboniferous Reticulate Spiriferidae: Q.J.G.S. 1932. p. 524, Pl. XXXV., fig. 2a-2d.

Phricidothyris lineata (Martin).

Pl. III., fig. 6-8.

1931. *Reticularia lineata,* Hosking, Fossils from the Wooramel District, W.A.: Roy. Soc. W.A., Vol. XVII., p. 22.

1932. *Reticularia lineata,* George, N. T., The British Carboniferous Reticulae Spiriferidae: Q.J.G.S. 1932, p. 543.

Shells transverse, hinge-line about half the maximum width. Ornamentation of two series of spines, the larger biramous in character, arranged on concentric lamellae. Beak prominent and slightly incurved over a triangular delthyrium. The shell substance is impunctate and fibrous.

Internally the apical plates are well-developed and the shells possess a median septum.

When the shells are exfoliated they are seen to be covered with sharp plications. The spines are the elongations of these plications on the growth lamellae.

This series of shells is a particularly interesting one, since of the 60 specimens examined, 15 were rectimarginate, 40 had uniplicate, and 5 parasulcate margines.

The classification of these shells thus becomes difficult. They have the external characters of Phricidothyris with the internal characters of Reticularia McCoy, s.s., that is, with a strong development of apical plates. But George[1] says, "The double-baralled spines of Phricidothyris . . . are so specialised that it is unlikely that they should have evolved homoeomorphically in two separate stocks and they occur in such a self-contained group, obviously closely similar in other respects, that they almost constitute a truly differential character for the recognition of the genus."

The dimensions of the shells are shown by the following table:—

	Length.	Width.	Depth.
1.—Ventral Valves—			
(a) parasulcate	40	35	9
(b) uniplicate	39	34	13
(c) rectimarginate . .	32	27	7
2.—Dorsal Valves—			
(a)	30	32	7
(b) both uniplicate . .	36	37	8

Although the marginal characters of the specimens does not remain constant throughout the whole range of specimens, the internal structures and the ornamentation of the valves is the same; thus they have been placed in *P. lineata*.

Specimens Nos. 10927, 10928, 10929, 10930, University of W.A.

Localities: Fossil Cliff, Irwin River.

Waltharrie Pools, Wooramel River District.

Genus CLEIOTHYRIDINA Buckman.

1906. Buckman, S. S. Brachiopod Nomenclature: Ann. & Mag. Nat. Hist. Ser. 7, Vol. XVIII., p. 324.

Cleiothyridina roysii var. **penta** var. nov.

Pl. II., fig. 13-15.

1923. *Athyris sp.* aff. *A. lamellosa* l'Ev.

Athyris aff. *A. roysii* l'Ev. Chapman, List of Fossils from the West Kimberley; G.S.W.A. Ann. Prog. Rept., 1923, p. 36.

Although these specimens agree with *A. lamellosa* in general outline, they differ in almost all other particulars, notably in the absence of pectinated ridges.

1 George, N. T., 1933, p. 448.

They resemble *A. roysii* in the convexity of the valves, in the character of the ornamentation, and in having a sinus in the pedicle valves which causes the anterior margins of the valves to be waved. There may be a corresponding fold in the brachial valve but this is not usually well-developed. The hinge-plate takes the form of a flat triangular plate occupying the space between the dental sockets and spreading laterally between them. It is limited at both edges by ridges. The apex is perforated by a visceral foramen, which is continued in the hinge-plate as a narrow slit.

These shells from Luihuigui are distinct from *Cleiothyridina roysii* since the breadth of the shell is always greater than the length and it is more pentagonal in outline.

From *Cleiothyridina macleayana* Eth. Fil., the common Western Australian species, they are readily distinguished because in *C. roysii* the antero-lateral margins of the shell are not in the same plane as the hinge-line, the shell is more globose, and the general outline is pentagonal rather than rounded or oval.

Specimens Nos. 2777, 3039, 10666, University of W.A.

Locality: Luilnigui Station, Kimberley Division.

Genus ORIOCRASSATELLA Eth. Jun.

1906. Etheridge, R., jun. South Australian Parliamentary Papers, No. 55, p. 8.

Oriocrassatella stokesi Eth. jun.

Pl. II., fig. 19 & 20.

1906. *Oriocrassatella stokesi* Eth. fil, South Australian Parliamentary Papers No. 55, p. 9, Pl. VI., fig. 2-5.

1923. *cf. Protoschizodus*, Chapman, List of Fossils from the West Kimberley: G.S.W.A. Ann. Prog. Rept., 1923, p. 36.

The specimen No. A. from Chapman's list, is a right valve with the hinge-line entire, and agrees in all essentials with *O. stokesi* from Treachery Bay, Victoria River Estuary. As in that species, the chrondophore and anterior socket are large while the posterior socket is narrow, linear and obliquely inclined. This socket (the posterior) is more sharply limited than in the specimens figured by Etheridge and widens towards the hinge-margin. In this specimen the dental formula would be ROICIO.

Specimen No. 10665, University of W.A.

Locality: St. George's Range, Kimberley, nine miles E.N.E. by E. from Trig. Stn. G2.

DISTRIBUTION OF SPECIES.

The forms described in this paper may be grouped into three types.

The first group contains species common throughout the Western Tethyan beds. These are:—

Linoproductus cancriniformis Tschern.

Seminula globulina Phillips.

Spirifer musakheylensis Dav.

Cleiothyridina roysii l'Ev.

Linoproductus cancriniformis is not found in beds of greater age than Permian. It is very characteristic of the Artinskian Limestone of the Russian Permian, but is also found in the Lower Productus Limestone of the Salt Range of India, which is regarded as of Lower Permian age. The statement that *Linoproductus cancriniformis* is confined to the Permian is dependent on the conclusions of Grabau and Schuchert that the Permian should be continued downwards to include the Omphalotrochus and Cora zones. This species has been recorded from the Lower Zechstein of Germany and from the Vladivostock region, but is most common in the Russian formations.

Of widespread distribution, *Seminula globulina* ranges from Devonian to Permian in England, but is not known from formations older than Permian in Asia. It has been recorded from China (Yunnan), India (Salt Range), and the Schwagerina, Artinskian and higher Permian beds of Russia.

A common form in the beds of the Western Tethyan Permian, *Spirifer musakheylensis* is not found in formations of younger age. The species has been recorded from the Schwagerina Limestone, Russia, the Salt Range, and the Himalayan Permian beds, China, Indo-China, Mongolia, the Vladivostock region and Timor.

Cleiothyridina roysii is found in all the areas given for *Spirifer musakheylensis*, but continues downwards into the Carboniferous in the Donetz Basin.

In the second group there is only one form, *Productus subquadratus*, which is abundant in the Lower Bowen beds of Queensland. Reid (the Queensland Upper Palaeozoic Succession. Queensland Geol. Surv. Publication No. 278, p. 91) places this series as of Uralian age, and it will therefore be of Lower Permian time. Identifications of this species from the Star series (Carboniferous) have been questioned by Reid, who considers that *P. subquadratus* may prove diagnostic of the Lower Bowen beds. It is interesting to note that a form allied to *P. subquadratus* has been recorded from the Vladivostock region (Grabau, 1931, p. 528).

The third group includes the misfits that is *Composita subtilita*, *Camarotoechia pleurodon*, and *Phricidothyris lineata*.

Composita subtilita ranges throughout the Pennsylvanian and into the early Permian of America.

It is possible that *Camarotoechia pleurodon* should have been included in the second group since it occurs in the Upper Devonian and Carboniferous of New South Wales. The difference in age between the beds containing it and those with *P. subquadratus* is sufficient to separate the two. In England this species ranges from the Devonian to the Permian, while in other parts of the world it is common in the Carboniferous.

In England, *Phricidothyris lineata* is not found in beds of older than Upper Avonian age; Girty states that in America the septate forms are not present below the Pennsylvanian. The upper limit is not determined.

Throughout his work, Grabau refers to *Squamularia asiatica* Chao, as a synonym of *Reticularia lineata*, so that it is not possible to compare the Western Australian and Asiatic distribution.

TABLE TO SHOW THE DISTRIBUTION OF THE SPECIES DESCRIBED.

——	——	Devonian.	Carboniferous.			Permian.		
			L.	M.	U.	L.	M.	U.
Linoproductus caneriniformis	Russia					—	—	—
	Salt Range ...					—	—	—
	Kashmir ...					—	—	—
	Himalayas ...					—	—	—
	E. Siberia ...					—		
Productus subquadratus	E. Siberia ...					—		
	E. Australia ...					—		
Seminula globulina ...	Gt. Britain ...	—	—	—	—	—	—	—
	Russia					—	—	—
	Salt Range ...							—
	Yunnan, China ...						—	
Composita subtilita ...	Gt. Britain ...		—	—				
	U.S.A.				—	—		
Camarotoechia pleurodon	Gt. Britain ...	—	—	—	—	—	—	—
	Russia							—
	E. Australia ...	—	—	—	—			
Spirifer fasciger	Russia				—	—	—	—
	Salt Range ...				—	—	—	—
	Kashmir ...					—	—	—
	Indo-China ...					—	—	—
	Mongolia ...					—	—	—
	E. Siberia ...					—		
	Timor					—	—	—
Phricidothyris lineata ...	Gt. Britain ...		—					
Cleiothyridina roysii ...	Russia		—	—	—	—	—	—
	Salt Range ...					—	—	—
	Kashmir ...					—	—	—
	Himalayas ...					—	—	—
	Indo-China ...					—	—	—
	Mongolia ...					—	—	—
	E. Siberia ...					—		
	Timor					—	—	—
	Gt. Britain ...		—					

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EXPLANATION OF PLATES.

Plate II.

Figures 1-5.—*Camarotoechia pleurodon* var. **tripla** var. nov. Morphotypes. Dept. of Geology No. 2515. 1A-5A, Dorsal view. 1B-5B, Anterior view to show development of the sinus.

Figure 6.—*Camarotoechia pleurodon* var. **tripla** var. nov. Morphotype. Side view.

Figures 7-12.—*Linoproductus cancriniformis* Tschern. 7, Side view of Brachial valve. Dept. of Geology, No. 10822. 8, Same specimen from above. 9, Specimen showing ornamentation. Dept. of Geology, No. 10822. 10, Specimen of pedicle valve. 11, Pedicle valve. Paratype of *Productus bellus* Eth. Jun. 12, Pedicle valve. Australian Museum specimen.

Figures 13-15.—*Cleiothyridina roysii* L'Ev. var. **penta** var. nov. Dept. of Geology, No. 3039.

Figures 16-18.—*Seminula globulina* Phil. Dept. of Geology, No. 10370.

Figures 19-20.—*Oriocrassatella stokesi* Eth. Jun. Dept. of Geology, No. 10665.

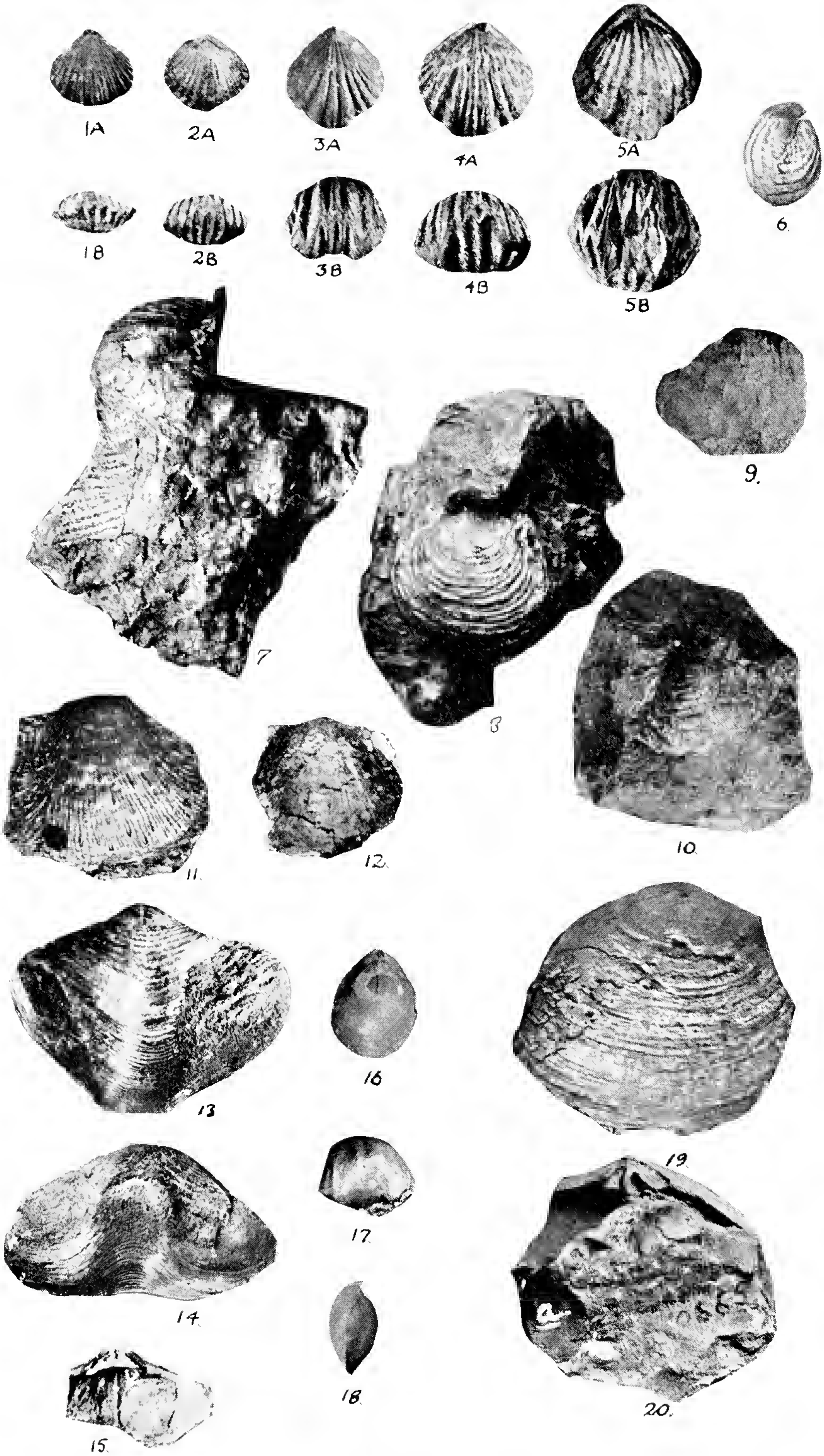

PLATE II.

Plate III.

Figure 1.—**Spanodonta hoskingiae** sp. nov.—Interior of the brachial valve. Syntype. Dept. of Geology, No. 3052.

Figure 2.—**Spanodonta hoskingiae** sp. nov.—Dorsal view showing the area of both valves. Syntype. Dept. of Geology, No. 2530.

Figure 3.—**Spanodonta hoskingiae** sp. nov.—Side view of syntype No. 2530.

Figures 4-5.—*Composita subtilita* Hall. Dorsal and side views of the same specimen. Dept. of Geology, No. 2507.

Figures 6-7.—*Phricidothyris lineata* Martin. Interior and exterior views of the same specimen. Dept. of Geology, No. 10927.

Figure 8.—*Phricidothyris lineata* Martin. Microphotograph of the external surface showing the biramous character of the spines.

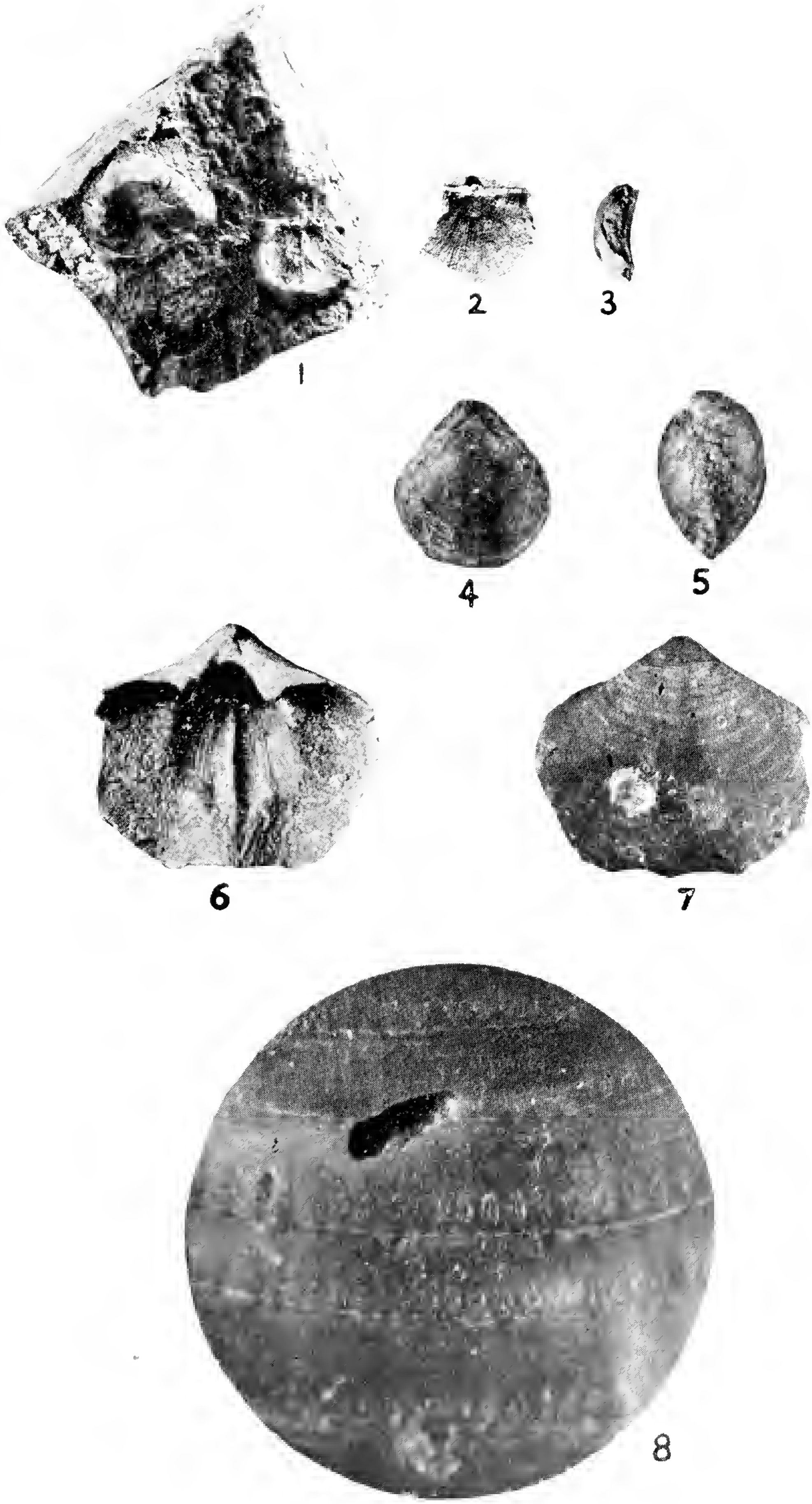

PLATE III.

Plate IV.

Figure 1-3.—**Waagenochoncha imperfecta** sp. nov.—1, Syntype No. 2777.—Cast of the brachial valve. 2, Syntype No. 3044—Pedicle valve. 3, Syntype No. 2768—Dorsal view of brachial valve of a weathered specimen. All specimens in the collection of the Dept. of Geology.

Figure 4.—*Productus subquadratus* Morris. Dorsal view of a limonite cast. Dept. of Geolgoy, No. 10931.

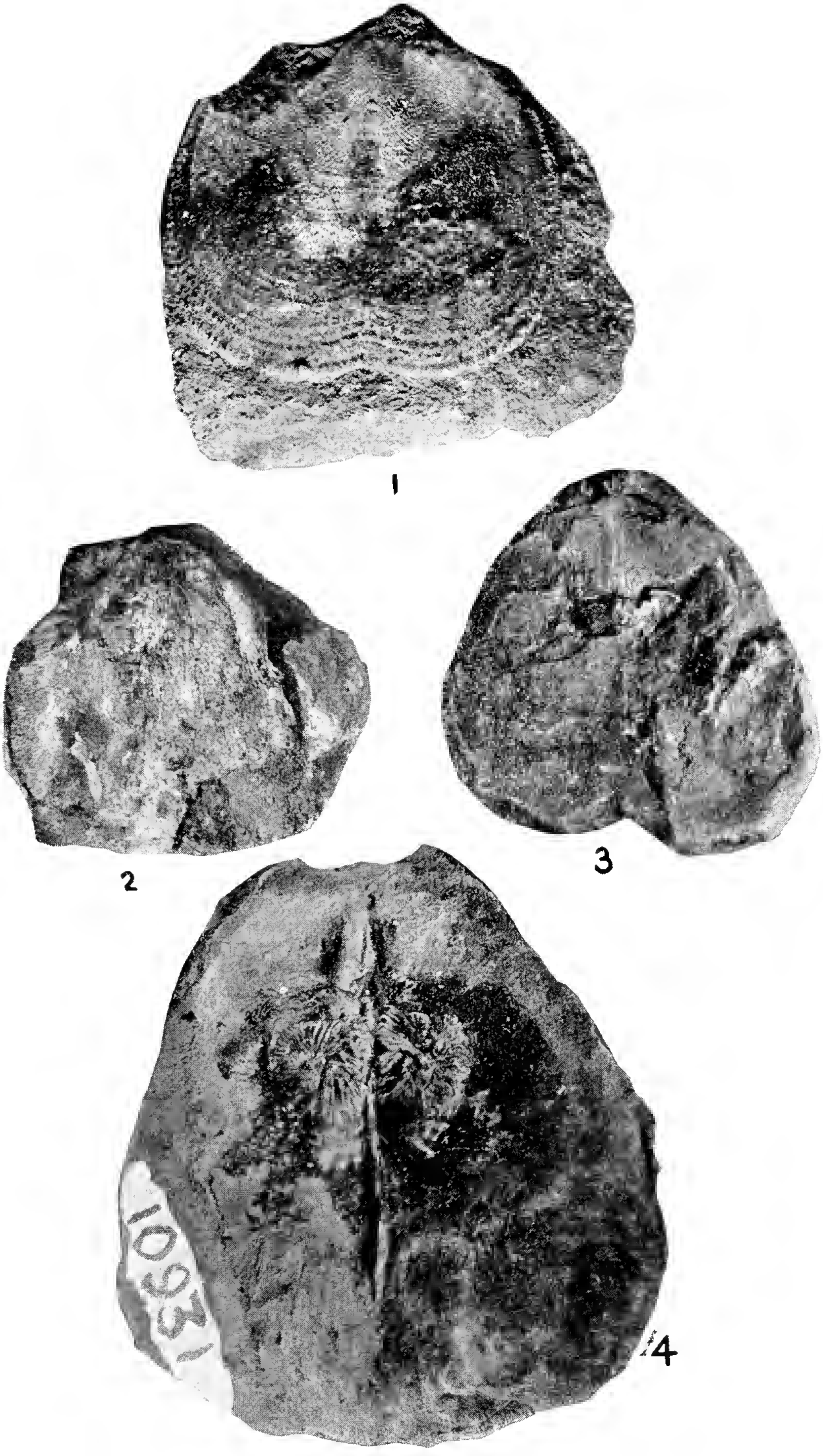

PLATE IV.

By Authority: Fred. Wm. Simpson, Government Printer, Perth.

3.—NOTE ON AN AUSTRALITE OBSERVED TO FALL IN WESTERN AUSTRALIA.

By EDWARD S. SIMPSON, D.Sc., B.E., F.A.C.I.

Read 9th October, 1934; Published 8th March, 1935.

In the whole of the voluminous literature on that mysterious group of glassy bodies known as tektites, of which the Australian members are known as australites, there does not appear to be any authentic record of one having been observed to fall, except that at Igast in Latvia in 1855 (1, 2, 3). The supposed cosmic glass which was seen to fall at Halle, in Germany, in 1904 (2), was later shown to be an artificial glass of terrestrial origin.*

In one of the latest published papers on australites, that by Dr. Chas. Fenner (4), the author states in his summary:—

"The evidence of this collection supports the idea that australites are glass meteorites, that they all fell at one time, in a prehistoric period . . ."

In a study of many hundreds of these objects extending over 37 years, the present writer has been fully convinced that they did not all fall at one time, and that they are probably still falling. The main arguments for this attitude are:—

(1) Within small areas of our semi-arid interior, australites with surfaces very unequally abraded by blown soil have been collected.

(2) In many specimens found lying on the surface where they would have been exposed to such abrasion, the extreme brightness and freshness of the surface, and sharpness of the sculpturing, have left no doubt that the age of their fall was to be measured in years, and not in centuries or milleniums.

(3) They have been encountered not only on the present surface, including the spoil banks of recently excavated dams, and the bare surfaces of clay pans which would engulf a solid object when flooded, but also at various depths down to ten feet. Examples of such finds are: Jitarning, on the bank of a dam in 1931; Bilbarin, on a clay pan in 1930; Corrigin, at a depth of 7 feet when sinking a well in old river gravel in 1932. This range of depth indicates a very considerable range in time.

On several occasions in the past, specimens have been inspected which were said to have been found "just about where a meteor was seen to fall," for example, in 1931 at Gundaring (Lat. 33° 10′ S., Long. 117° 30′ E.). The connection between the atmospheric phenomenon seen and the specimen collected in such cases has always been too slender to be accepted as evidence.

In September of this year, however, what appears to be conclusive evidence of an observed fall was submitted. Mr. Archibald Dewar, of Lake Grace, has shown me a typical ellipsoidal australite, weighing 31 grammes, and measuring 48 x 23 x 20 mm. It is without any distinct "equator," has a very fresh looking, brilliant black surface, and is sculptured with many sharply defined vermiform grooves and circular pits. He has informed me

* A. Brezina, private communication.

that he and Mr. Alfred Brunning, with two other men, were working in the daytime in a field at Lake Grace (Lat. 33° 5′ S., Long. 118° 30′ E.) in the summer of 1932-33, when something flew past him with a hissing noise "like a piece of shrapnel," and struck the ploughed earth with an audible thud only a few feet away. On examining the spot, he noticed a small hole in the ground, and underneath it at a depth of about 12 inches (30 cm.) he found the australite. Although it was obtained within about three minutes of its fall, it did not appear to him to possess a temperature differing from that of the soil in which it was embedded. It is to be noted that there is no evidence whatever of any large meteorite having fallen in the vicinity at the same time.

This, then, is the first evidence, tangible and testamentary, of the fall of an australite from the sky in our own times. It was impossible, unfortunately, to retain the specimen for more than a few minutes. It is now in the possession of Mrs. G. Dewar, who has taken it to Scotland to present to her brother, an amateur collector of natural history specimens.

The circumstances of its fall somewhat discount L. J. Spencer's recent suggestion (5, 6) that tektites may be small masses of rock fused with a certain amount of meteoritic material in the heat generated by the impact with the earth's surface of a meteorite of a more usual basic type, but of unusual size, and travelling at unusual velocity. In natural glasses, such as those of Wabar in Arabia, which are undoubtedly of this origin, he detected innumerable microscopic pellets of nickel-iron (7), an important piece of supporting evidence of their origin. No trace of nickel, however, could be detected chemically by the writer in an australite found in 1933 at Mt. Ida (Lat. 29° 0′ S., Long. 120° 30′ E.).

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By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

4.—EARTHWORMS FROM SOUTH-WESTERN AUSTRALIA.

By DR. W. MICHAELSEN (Hamburg).
(Honorary Member.)

Read 9th August, 1934; Published 31st May, 1935.

The examination of two collections of Earthworms from South-Western Australia has induced me to review the Earthworm-fauna of this region. These collections have confirmed my opinion that the endemic species of South-Western Australian Earthworms in general are restricted to a very small district, and that such a small district harbours only a very small number of endemic species. At times one of these few dominates the others by its abundance and general distribution, occasionally only one endemic species may be present in a small district. The first of my series collected by Mr. W. S. Brooks for the Zoological Laboratory of the Harvard University in 1927 at Pemberton (34° 26′ south lat., 116° 1′ east long.), consists of many specimens of *Megascolex syndetoporus* Jackson (1).* The type specimens of this species also were collected at Pemberton (in the year 1928 or 1929). The two collectors, quite independently obtained one and the same species in a district from which no other endemic species is known. The second of my series was collected by Mr. John Whistler on his farm "Brancaster," a little south of Dinninup. Complying with my requests, Mr. Whistler investigated different localities of his farm, i.e., localities of rather different character. All those localities (4 of them) contained in abundance specimens of *Notoscolex brancasteri* Michaelsen (2), previously known from another locality at Brancaster. Only one of the five investigated localities contained a few specimens of a second endemic species, a new one which, in honour of the collector, is named *Plutellus whistleri*. The result of intensive collecting in the district of Brancaster has yielded only two endemic species, one of which is by far more abundant than the other rather rare one.

The new collections confirm my assertion that most genera of endemic Earthworms have in South-Western Australia very restricted ranges, the genus, *Plutellus* forming the single exception of this rule. It occurs in the whole region of Western Australia as far as its climate permits earthworms to live there (3). Miss Jackson (loc. cit. p. 73) mentioned three exceptions of this rule, but I am unable to regard them as valid. Firstly, the discovery of a *Plutellus* at Yalgoo in no way constitutes an exception to the rule, for this genus occurs, as I have stated above, in the whole region of Western Australia as far as it is habitable for earthworms. The new Yalgoo species only slightly extends the range of the genus as previously known to us. It is another matter with Miss Jackson's second exception, *Megascolex imparicystis* Michaelsen. Miss Jackson examined different specimens of this species, one from an unknown locality, one from a garden at Mount Lawley, near Perth. My type-specimen of *M. imparicystis* came from **Dongarra** (I omitted to mention this locality in my original description because I did not collect it myself and therefore could not answer for the accuracy of this statement, which seemed to be very doubtful.) As the faunistic character of

* Reference to bibliography at the end of this paper.

this species is now made clear by additional specimens, there remains no reason to doubt the accuracy of the Dongarra statement. This species is therefore known from at least two (perhaps three) different localities, very far from one another, and from the proper *Megascolex* district. Whilst this proper district with its 13 endemic *Megascolex* species extends from 35° S. to 33° S., Perth lies about 32° S. 116° E., and Dongarra 29° 10′ S. 114° 55′ E. Consequently, this species is not at all to be regarded as an endemic one; it is peregrine and probably transported by man. It is worth remarking that at least one specimen was found in a garden, that is in a situation very apt to receive transported earthworms and their cocoons. Probably also the third species mentioned as an exception by Miss Jackson, being found far from the proper district of its genus, namely, *Megascolex longicystis* Nicholls and Jackson (4), is to be regarded as peregrine to a certain degree. This species is found at two different localities, Armadale and Wongong.*

In Miss Jackson's list of South-Western Australian Oligochaets there are two other species which must be divested of their endemic quality. *Kerria nichollsi* Jackson (l.c. p 121) is not a new species. It is identical with the peregrine *K. saltensis*, imperfectly described by Beddard in 1896 (5), circummundane in the warmer zones and previously recorded from Australia under the name of *Acanthodrilus sydneyensis* by Miss Sweet. (The genus *Ke ria* has endemic species only in the warmer regions of America.) The genus *Eiseniella* also has no endemic species in Australia. *Ei. intermedia* Jackson (l.c. p. 123) is an *Ei. teraedra* (Sav.) *forma typica*. The difference of the Western Australian form from it, suggested by Miss Jackson, does not exist. This excusable error is due to the erroneous description by Rosa (6) already corrected by E. de Ribaucourt in 1896 (7). After examining hundreds of specimens I found, as he recorded, the spermathecal pores nearly always at IX./X. and XI./XII., an anomality with 3 pairs at IX./X., X./XI., and XI./XII. occurred only once. Miss Jackson's supposition that her species represents an intermediate condition between the genera *Eiseniella* and *Eisenia* cannot be sustained. As I showed in 1932 (8) *Eiseniella* is not allied to *Eisenia*, as I myself formerly supposed but to the genus *Allolobophora*. The position of the spermathecal pores is not bound to the median dorsal line as in *Eisenia*, but to the lines of the dorsal setae as in *Allolobophora*. They are variable in number. Often they occur in groups of two, one in the line of seta *d* (or even seta *c*), the other a little more dorsally, but always near the line *d*, and far from the median dorsal line. One of these twin spermathecae may often be absent and then there remains only the one situated somewhat dorsally from the setal-line *d*, thus delusively showing, or rather coming near the position characteristic for *Eisenia*.

Plutellus (Pl.) whistleri sp. nov.

Western Australia. Brancaster, near *Dinninup* (33 degrees 53 S, 116 degrees 33 E); Mr. John Whistler, leg. 1933 (6 specimens, one mature).

Dimensions of the largest mature specimen: Length, 65 mm.; thickness, 3-4 mm.; number of segments, about 150. The other specimens were not fully mature, one nearly mature is only a little smaller, the specimens with the first signs of external sexual organs very much smaller.

* (About two miles apart and about 18 miles south of Perth.—ED.)

Colour of the preserved specimens: dirty yellowish gray.

Head tanylobous. The prostomium broad and short, its dorsal appendix broad, a little narrowed in its middle part, and here divided by a transverse furrow. The prostomium shows a median-dorsal longitudinal furrow continued over the appendix as far as to its transverse furrow.

The *segments* of the fore-end are simple as far as to the third inclusive; segments IV-VI divided by a more or less distinct transverse ringlet-furrow; segments VII-XIV three-ringed; the following ones not distinctly divided into ringlets.

The *setae* are S-shaped, with a distinct nodulus somewhat ectally from the middle, with simple, moderately sharp ectal end. The ectal end bearing a few small irregularly placed punctures more or less filled by a minute blunt thorn. The ornamentation distinct only at the large setae of the posterior part of the body, being indistinct at the smaller setae. The setae are in general small at the middle part of the body 0,16 mm. long at the nodulus 16 μ thick. The setae of the posterior end of the body (at about the 20 last segments) are enlarged, especially the most dorsally placed ones of the setae-lines *d*, the setae *c*, *b*, and *a* only a little. The largest setae *d* are 0,26 mm. long, and at the nodulus 32 μ thick. The setae are generally placed in quite regular longitudinal lines, the ventral ones, moderately close together, the dorsal ones very far apart. In the middle part of the body the distance between the ventral setae is about half as wide as the ventral median distance which is very little less than the middle lateral distances. The distances between the dorsal setae a little greater than the median lateral distance, and about half as wide as the median dorsal distance (here *aa*: *ab*: *bc*: *cd*: *dd*: equal 26: 13: 29: 32: 64). Anteriorly the distance between the ventral setae diminishes a little (here *aa* equals 3 *ab*). In the more closely examined specimen many of the large setae *d* at the posterior end of the body, beginning with the 17th-segment from the anal-segment, are displaced to a rather large extent, partly ventrally, partly dorsally, but in a quite irregular manner, regular alternation occurring in only very short tracts.

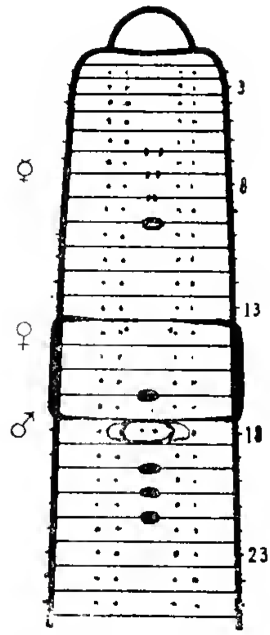
First *dorsal pore* at the intersegmental furrow V/VI.

Clitellum whitish, somewhat prominent, indistinctly ring-shaped, ventrally at least less developed, occupying the four segments XIV to XVII inclusive. Intersegmental furrows distinct at the clitellum.

Male pores very delicate, hardly visible on the setal zone of segment XVIII near the ventral median line about 0,2 mm. distant from one another at the top of a common ventral median *male porophore*. This porophore has the shape of a transversely oval, rather high cushion reaching at each side as far as the setae-line *a*, and occupying the whole length of segment XVIII.

Female pores also very delicate, seen only in horizontal sections, close to setae *a* of segment XIV, medially from them.

Spermathecal pores as delicate as the other sexual pores, seen only in horizontal sections: 3 pairs at the intersegmental furrows VI/VII, VII/VIII and XIII/IX, near the ventral median line. The distance between the pores of one pair diminishes towards the hindermost pair, the pores of VIII/IX being only 0,07 mm. distant from one another, the distance between those of VI/VII amounting to 0,15 mm.



External accessory glands: Single median-ventral intersegmental papillae transversely oval. At least four of them are constantly present at XVI/XVII, XIX/XX, XX/XXI and XXI/XXII, in one case a fifth one at XV/XVI, and in another an indistinct fifth one at IX/X. A pair of small glandular swellings without sharp borders at segment XVIII just lateral from the male porpophore, with which they are grown together.

Septa: VI/VII very little thickened, VII/VIII-XI/XII moderately thick, XII/XIII a little thickened, the following delicate.

Alimentary tract: A large gizzard in segment VI. The *oesophagus* moniliform in segments VII-XVI, widely swollen in the segments, strongly narrowed intersegmentally. Its wall has in this region the structure of chyle-organs, densely crowded shrivelled longitudinal folds, projecting into the lumen. The *intestine* seems to begin in segment XVIII, it has no typhlosole, but its lumen is irregularly narrowed, partly in an irregular spiral manner.

Anterior male organs holandric. Two pairs of (indistinctly recognised) testicles, and two pairs of small (not yet fully developed?) *sperm-funnels* ventrally free in segments X and XI, one pair of rather small, simple *sperm-sacs* in segment XII.

Posterior male organs: Prostates with a thick, cylindrical glandular part, irregularly bent, about 6 mm. long, and 0,4 mm. thick, uneven at the surface, the ental tops of the glandular cells projecting in the shape of warts. The axial channel simple and very narrow. The prostate-duct sharply set off from the glandular part, shorter and much thinner. It enters the body wall in the line of seta *b*, and then bends itself medialwards, within the layer of the longitudinal muscles running towards the male pore, in the meanwhile becoming more and more attenuated. *Penial* setae absent.

Female organs: One pair of tuft-like *ovaries* depends from septum XII/XIII into segment XIII. Opposite to the ovaries are a pair of small *ovi-ducal funnels* at the anterior side of septum XIII/XIV, being continued each into a slender, narrow tube in segment XIV, the *oviduct,* running in a nearly straight line towards the female pore.

Spermathecae: Ampulla more or less slender pear-shaped without a distinctly marked duct. Into the thin ectal end of the ampulla enters a simple diverticulum. It is club-shaped or slender pear-shaped, and much shorter and thinner than the ampulla. Its thin ectal end is not distinctly marked as a diverticulum stalk.

REMARKS.

P. whistleri belongs to the small group of Western Australia *Plutellus*-species, which are devoid of penial-setae. This group is restricted to the extreme southern part of W.A. *p. schünemanni* Mich., *p. carneus* Mich., and *P. asymmetricus* Mich. (Michaelsen, l.c. 1907, pp. 181, 182, 183), all from Albany belong to this group. *P. whistleri* is most nearly allied to *P. asymmetricus,* in which the pairs of male pores and of spermathecal pores are replaced by single median-ventral pores, whilst they approach this line in *P. whistleri.* On the other hand the new species is near to *P. blackwoodianus* Michaelsen (l.c. 1907, p. 179) from Bridgetown, not very far from Brancaster, agreeing with this species in the character (not in the arrangement) of the accessory glands. In the situation of the spermathecal pores (and of the male pores?) *P. whistleri* is intermediate between *P. asymmetricus* and *P. blackwoodians.* In the latter these pores seem to lie just inside the lines of setae *a*. *P. blackwoodianus* differs from *P. whistleri* in having only two pairs of spermathecae, and in possessing penial-setae.

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5.—A SURVEY OF THE ONISCOID GENUS PHALLONISCUS BUDDE-LUND, WITH A DESCRIPTION OF NEW SPECIES.

by

EILEEN A. BOWLEY, B.Sc. (Hons.).

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CONTENTS.

I.—INTRODUCTION.

During a number of years there has been accumulating in the collection of the Biology Department of the University of Western Australia a large amount of material of the Terrestrial Isopods. Recently, at the suggestion of Professor G. E. Nicholls—to whom the author wishes to express her sincere thanks for much helpful advice and criticism during the course of the investigation—an examination and report upon this material was undertaken.

At a very early stage it became evident that considerable confusion existed in relation to the species grouped together under the genus *Phalloniscus*, and further material was sought from New Zealand and elsewhere. Finally, it was apparent that this confusion could not be cleared up without reference to material reported upon by Budde-Lund, Chilton and Wahrberg. Through the courtesy of the Curators of the Museums of Hamburg, Stockholm, Western Australia, Sydney and Canterbury (New Zealand) these specimens were made available, and it is now evident that Budde-Lund's genus *Hanoniscus* is scarcely separable from his earlier genus *Phalloniscus*. It has been considered desirable, however, to retain it as a sub-genus to include the Western Australian Phalloniscids which, differing from Wahrberg, the author regards as specifically distinct from those recorded from New Zealand.

II.—THE GENUS, *PHALLONISCUS* BUDDE-LUND.

The genus is of considerable interest in view of its geographical distribution. Originally, it was erected by Budde-Lund (1908, p. 296) to receive two New Zealand species *Oniscus punctatus* G.M.T. and *O. kenepurensis* Chilt., a species recorded by Dollfus, from Chile, under the name *Philoscia anomala* and two undescribed species.[1] Its range was subsequently found to be much more extensive when Wahrberg (1922) recorded its occurrence in Western Australia, referring his forms to the New Zealand species.

Unfortunately, the original description of the first named New Zealand species *Ph. punctatus* (Thomson, 1879) was very brief, and did not include a description of the mouth parts. Later, examples referred to the latter species were collected from Mt. Wellington, Tasmania (1892), and in recording their occurrence Thomson then gave a short account of the mouth parts; but, following the lines usual at that time, omitted certain of the details now regarded as essential. Moreover, it is by no means certain that his material from Tasmania was identical with the New Zealand *Ph. punctatus* as was subsequently pointed out by Chilton (1901).[2]

The second New Zealand species was not obtained until 1901, and was then described by Chilton, who followed Thomson in referring it to the genus *Oniscus*. In the same paper Chilton gives further details concerning *Ph. punctatus*, notes its wide distribution throughout New Zealand, refers to its variability of form, and remarks that more than one variety is included in the species. Chilton (1901) realized that *Ph. punctatus* differed markedly from the definition of *Oniscus* as given both by Budde-Lund and Sars in that the mandibles did not bear so many "penicils" behind the cutting-edge.

Wahrberg devotes considerable space to a discussion of the generic characters of Budde-Lund's genus, since the latter considered it to be closely related to the genus *Alloniscus* Dana, whereas Wahrberg viewed it as a more specialised genus forming to some extent a connecting link between *Oniscus* and *Philoscia*.

For the Western Australian species he described the mouth parts, but figured only the maxillipeds. In the absence of an exact description of the mouth parts of the named species of this genus, he failed to appreciate the fact that quite considerable differences actually existed between the Western Australian and New Zealand forms. He directed attention, however, to what appeared to be a useful character for systematic purposes, viz., the form of the scale-setae.

Only quite recently has there been published a really detailed account of a *Phalloniscus* species. This we owe to Monod (1931), who figured a New Zealand form which he identified with some hesitation as *Ph. punctatus* (G.M.T.). Monod points out that the scale-setae of his New Zealand (Stewart Island) specimens are remarkably unlike those figured by Wahrberg, and suggests that the Western Australian species *Ph. punctatus* would probably prove distinct if, indeed, it ought not to be referred to a new genus.

1. I have been unable to find any further reference to these species.

2. It is noteworthy that Thomson described and figured the inner lobe of the first maxilla as ending in "five weak slightly curved teeth" whereas in all other known Oniscoids this lobe is furnished with plumose setae and not teeth. This, if correct, would establish the distinctness of the Tasmanian species.

There can be no doubt that Monod's suggestion is well founded. The examination of the very extensive collection available here has made it evident that actually no fewer than three species, all distinct from those recorded from New Zealand, are to be found in Western Australia. At first it was impossible to decide whether any of these were to be identified with those named by Wahrberg, for his account, while sufficient to show that his species are closely related to the species in the University collection, nevertheless, omits some of the detail essential for their identification.

The determination of these species was hampered by the vagueness which characterised some of the earlier accounts, and further by the fact that the descriptions of the scale-setae by Wahrberg and Monod appear discordant. It seemed possible, however, that this discrepancy might be due to the chance that the scale-setae figured by these authors had been taken from different regions. In the hope of determining to what extent the scale-setae were actually distinct, an appeal was made to Professor Percival, of Canterbury, Christchurch, for named New Zealand material, and two specimens apiece of *Oniscoids*, identified by Chilton as *Ph. punctatus* (from Auckland Island) and *Ph. kenepurensis* (from Stephens Island) were kindly sent. A study of these had unexpected results, for the specimens labelled *Ph. punctatus* were found to differ in an important character from any named form, and made unavoidable the recognition of these as a new species (*Ph. chiltoni*).

The examination did, however, serve to clear up the question of scale-setae, and established that the Western Australian specimens are most certainly not referable to either of the New Zealand species, and almost justified Monod's prediction that generic separation might be necessary. It had been decided to segregate these in a new sub-genus of *Phalloniscus*, and this paper was almost completed when a specimen in the collection of the Western Australian Museum, collected by Michaelsen and Hartmeyer, at York, in 1905, came to the author's notice. The tube containing the specimen has several labels. One of these, possibly in Budde-Lund's handwriting, is inscribed *Harroniscus tuberculatus*, York 11/8:05. A second, presumably the Hamburg Museum label, records the name as "*Hanoniscus tuberculatus*, B.-L. (Type!)," whilst the third, the official label of the Western Australian Museum, reads "7166, Isopoda, *Harroniscus tuberculatus*, BL. TYPE, York, Hamburg Exp." Budde-Lund's account (F.S.W., 1912, vol. 4, p. 42), which was left incomplete at his death, records specimens from several localities, including a single specimen from York, which is presumably the specimen in question. It was undissected, and there can be little doubt that it was referred to this species on external appearance, but, as events proved, it was an erroneous identification. By the courtesy of Mr. L. Glauert, Curator of the Western Australian Museum, the author was allowed to examine the specimen, and found that it bore a strong superficial resemblance to a species abundant in the University Collection of Terrestrial Isopods, and which had definitely proved to be *Phalloniscus* and provisionally named *Phalloniscus monodi* n. sp. Partial dissection revealed its complete agreement with that species, except for trivial differences in the condition of the maxilliped in both endite and endopodite. Surprisingly, however, it differed essentially from the figures of *Hanoniscus tuberculatus* furnished by Budde-Lund (op. cit., Taf. 1, figs. 14-20, and text fig. 26) in the form of the outer lobe of maxilla 1. the endite of the maxilliped and in the number of penicils in the left mandible. It was plain, therefore, that at least two distinct species had been included under the name *Hanoniscus tuberculatus,* of which the specimen in the Western Australian Museum could not be the type. Nevertheless, the fact that Budde-Lund could confuse a species of *Phalloniscus* with another which he referred to the genus *Hanoniscus* (unfortunately undescribed) raised the question as to whether the latter might not prove to be identical with *Phalloniscus.* The matter was further complicated by the fact that not only was *Hanoniscus* undescribed, but that three species had been referred to it, and of two of these neither figures nor description existed.

It was also remarkable that no specimens referable to *Hanoniscus tuberculatus,* as figured by Budde-Lund, were represented in the University collection. With a view to clearing up the relationship of the two genera, an appeal was made to the Hamburg and Stockholm Museums for the material of *Phalloniscus* (as identified by Wahrberg) and *Hanoniscus.*

III.—LIST OF MATERIAL EXAMINED BY BUDDE-LUND AND WAHRBERG.

1. *Phalloniscus punctatus* (Thoms). (2 specimens) collected by Chilton from Canterbury and identified by Budde-Lund.

2. 2 specimens, collected by Michaelsen (1905) from Dongarra and referred by Wahrberg to *Phalloniscus punctatus* (G.M.T.).

3. 2 specimens, collected by Michaelsen (1905) from Perth and referred by Wahrberg to *Phalloniscus kenepurensis* (Chilt.).

4. *Hanoniscus tuberculatus* B-L. (5 specimens) collected by Michaelsen from Cannington (1905) and identified by Budde-Lund.

5. *Hanoniscus* sp. (6 specimens) collected by Michaelsen (1905) from Moora.

6. *Hanoniscus* sp. (5 specimens) collected by Michaelsen (1905) from Bunbury.

7. *Hanoniscus tuberculatus* (1 specimen) collected by Michaelsen (1905) from York and identified by Budde-Lund. This is labelled type, but as before-mentioned, it was undissected and did not correspond with Budde-Lund's figures.

IV.—DIAGNOSIS OF PHALLONISCUS.

The genus was originally instituted by Budde-Lund (1908) in a paper which was not available here. In a paper published in 1909 Chilton stated that Budde-Lund had indicated by letter that he was instituting a new genus to receive *Oniscus punctatus* but remarked that he was not aware of its publication. Wahrberg (1922) erroneously attributes the genus to an earlier (1904) date and in a rather indefinite way enlarges the generic diagnosis, but, as Monod points out, this contribution has complicated rather than clarified the matter.

Through the kindness of Dr. Calman, of the British Museum, a copy of the original diagnosis was received. This is as follows:—

"Ausser obenerwähnter Gattung *Niambia,* die Verwandschaft mit *Alloniscus* zeigt, scheinen die in New-Zealand vorkommenden Arten von *Oniscus, O. punctatus* Thoms und *O. kenepurensis* Chilton, mit *Alloniscus* verwandt zu sein und stehen von der Gattung *Oniscus* mehr entfernt. Ich fasse diese Arten, wozu noch zwei unbeschriebene kommen, in einem neuen Gattung *Phalloniscus* zusammen. Hierher gehört auch *Philoscia anomala* Dollf. von Chile.

"Während *Niambia* zweigleiderige Antennengeissel hat, ist die Geissel bei *Phalloniscus* wie bei *Alloniscus* dreigliedering. Die Mandibeln haben in allen drei Gattungen nur einen "freien" pinselförmigen Anhang. Bei *Phalloniscus* ist die Mala der Maxillipeden mit Dornen in der Spitze besetzt, während *Niambia* nur einen Dorn hat und *Alloniscus* einen Anhang. Sehr übereinstimmend mit *Alloniscus* ist rücksichtlich der Form der Innenäste der Pleopoden des ersten Paares beim Männchen die stark entwickelt sind, und noch mehr klumpig als in *Alloniscus* enden."

It has become evident that Wahrberg was undoubtedy in error in assigning his Western Australian material to the New Zealand species *Ph. punctatus* and *Ph. kenepurensis* so that it is a question how far his modification of the diagnosis can be accepted. Indeed, so different is the character of the scale-setae in the New Zealand specimens from that of the Western Australian forms that a reliance upon this character as of generic importance would necessitate a new genus for the Western Australian forms. It has been decided to retain the three Western Australian species in the genus, this determination being fortified by the fact that in a similar case (*Exzaes*), Barnard (1932) has considered such differences no bar to congeneric grouping. From a consideration of characters other than scale-setae, however, it seems desirable to place them in a distinct sub-genus.

The generic diagnosis (based on a study of material from New Zealand and Western Australia and on descriptions and figures given by Thomson, Chilton, Wahrberg and Monod) may be set out as follows:—

Genus PHALLONISCUS Budde-Lund 1908.

1908. Budde-Lund, Isop. Madagaskar und Ostafrika, in Voeltzkow, Reise, Band II., p. 296.

1922. Wahrberg, Ark. Zool., XV., p. 86.

Body, oblong-oval. Cephalon of "discrete" type and with lateral lobes. Mesosome with side plates moderately expanded and posterior margins of anterior segments almost straight. Metasome, not abruptly narrower than the mesosome though tapering away strongly; epimera of metasomatic segments 3-5 well developed, narrow and ending acutely; terminal piece triangular in shape, being broader than long and bluntly rounded apically. Eyes moderate, lateral in position. Flagellum of second antennae, 3-jointed. Mandibles with one (or two) "free" penicils; molar penicil represented by a tuft of plumose setae. Maxilla 1, outer lobe, with the fifth inner tooth simple; inner lobe with spine. Maxilliped, endite with 1 spine and 3 teeth; second joint of endopodite with 2 tufts of setae on inner margin, third joint with apical tuft. Pleopods conspicuous, with well developed opercular plates lacking air cavities. Uropods exposed, moderately developed; outer margin of peduncle grooved; inner ramus arising slightly anteriorly to outer.

As noted, the Western Australian species, as a group, differ in a number of minor characters from the New Zealand species and it seems desirable to set them apart in a sub-genus for which the name *Hanoniscus*, proposed by Budde-Lund has prior claim.

V. Sub-genus HANONISCUS (Budde-Lund).

Lateral lobes of the head in the form of tubercles in front of the eyes. Supra-antennal line of cephalon interrupted between antennary sockets. Maxilla 2 with inner lobe only slightly smaller than outer; distal margin of outer lobe curved. In the endopodite of the maxilliped the setae in the b-position (Pl. V., fig. 8) arising directing from inner margin; endite with 3 extremely small teeth. Scale-setae dilated and rounded apically.

The details in which *Ph* (*Phalloniscus*) differs from *Ph.* (*Hanoniscus*) are shown in the following table:—

	Ph. (*Phalloniscus*).	*Ph.* (*Hanoniscus*).
Supra-antennal line of cephalon	Visible between antennary sockets	Interrupted between antennary sockets.
Maxilla 2	Inner lobe very much smaller than outer	Inner lobe only slightly smaller than outer
Maxilliped Palp	Setae in b-position numerous and borne on a prominence	Setae in b-position few and arising directly from inner margin
Maxilliped Endite	Distal margin with 3 prominent teeth	Distal margin with 3 extremely small teeth
Scale-setae	Tricuspid form	Dilated form

Remarks:

As previously mentioned, Budde-Lund (1908) expressed the view that the New Zealand species of *Phalloniscus* stood nearer to *Alloniscus* than to *Oniscus*. According to Wahrberg, who considered *Phalloniscus* as intermediate between *Oniscus* and *Philoscia*, primitive characters possessed by *Alloniscus* and not shared by *Phalloniscus* are:—

(1) The endite of the maxilliped which is without teeth or spines but provided with a feather-seta.

(2) The endopodite of the maxilliped which bears complete tufts of setae which become reduced to a few setae in the more specialised genera (e.g. *Philoscia*).

(3) The molar penicil of the mandible which originates from a comparatively broad base whereas, in more specialised genera, the basal part has become compressed.

Wahrberg adduced as further evidence of the intermediate position of *Phalloniscus* the condition of the porefields along the edges of the epimera and the types of exoskeleton. According to him, in *Philoscia* the pores are scattered along the entire length of the lateral border of the epimeron and the exoskeleton is thin and flexible and without granules: the scale sculpture poorly developed. He describes the pores as congregated into a central region along the lateral border of the epimeron in *Oniscus*, the exoskeleton as thick, brittle and granulated and the scale sculpture as well developed. In *Phalloniscus* the pores are found to be arranged in a fashion similar to that of *Oniscus* and the exoskeleton is with or without granules whilst the scale sculpture is well developed; exoskeleton moderately thick.

Other characters which may be cited in support of Wahrberg's view as to the intermediate position of *Phalloniscus* are to be found in the cephalon, mesosome and metasome. In *Oniscus* the cephalon is with well developed lateral lobes. The lateral lobes are moderately well developed in the New Zealand forms of *Phalloniscus*, whilst in the Western Australian forms they are reduced to the form of prominent tubercles in front of the eyes. *Philoscia* is without lateral lobes. The mandibles are with 3-5 "free" penicils in *Oniscus*, 1 (or sometimes 2) in *Phalloniscus*, and with but 1 in *Philoscia*. The posterior margins of the anterior segments are deeply sinuous in *Oniscus*, whereas in *Phalloniscus* and *Philoscia* they are almost straight. In *Oniscus* the epimera of the metasome are well developed so that the metasome is not sharply marked off from the mesosome. The epimera are moderately developed in *Phalloniscus*, the mesosome being scarcely narrowed. In *Philoscia* the metasome is very abruptly narrowed, the epimera sometimes not being visible from above.

The more important of these characters may be conveniently set out in tabular form.

	Oniscus	*Phalloniscus*	*Philoscia*
Lateral lobes of cephalon	Well developed	Moderately developed	Absent
Mandibles ..	3-5 "free" penicils	1 (or 2) "free" penicil	1 "free" penicil
Posterior margins of anterior segments	Deeply sinuate	Almost straight	Almost straight
Metasome	Not narrowed	Not or very little narrowed	Narrowed

VI. DESCRIPTION OF SPECIES OF *PHALLONISCUS* BUDDE-LUND.

The material from Auckland Island identified by Chilton in 1909 as *O. punctatus* must be separated as a distinct species.

Phalloniscus chiltoni n. sp. (Pl. V., Figs. 1-19).

1909. *Oniscus punctatus.* Chilton, Subantarctic Is. of N.Z. (*non* G. M. Thomson).

Occurrence: Auckland Island.

Size: The larger male was 7.5 mms. in length and 3.8 mms. in width.

Colour: (Preserved specimens).

A light brownish background with a wide median band of a darker brown. The specimens are obviously very much faded.

Specific description.

Body (Pl. V., fig. 1), oblong-oval in shape, approximately twice as long as broad and moderately convex. Dorsal surface covered with conspicuous setae.

Cephalon (Pl. V., Fig. 2).

Wider than long. Frontal line not distinct in middle. Lateral lobes appear in front of the eyes as slightly raised crests. Profrons slightly bulbous, forming, when seen from above, an obtuse prominence. Marginal line forms hind margin of head and then passes obliquely across pleural portion of head to be joined just above the antennary tubercle by the supra-antennal line. Supra-antennal line distinct, sinuous. Antennary sockets distinct from supra-antennal line. Postfrons with a rounded median prominence. Lateral processes of clypeus moderately large. Eyes laterally placed and consisting each of 18 ocelli.

Mesosome with the posterior margins of the first three segments very slightly sinuous and their posterior angles rectangular. Epimera of first segment produced anteriorly into rounded lobes extending a little in front of the posterior margins of the eyes. Lateral angles of the last four segments produced more and more backwards to end acutely: those of the seventh reaching to the middle of the epimeral portion of the third metasomatic segment.

Metasome a little more than one-third the length of the mesosome. Epimera of segments 3-5 well developed, narrow and recurved backwards. Epimera of the fifth metasomatic segment reach to the middle of the terminal piece. Terminal piece short and triangular in shape, being much broader than long. Apex rounded, reaching almost to the level of the distal margin of peduncle of uropod. Sides almost straight.

Appendages.

Antenna 1 consists of three joints, first joint broader and longer than second, third longer and narrower than second and bearing at apex and along the inner border a number of fairly stout setae.

Antenna 2 (Pl. V., fig. 3), fairly short and covered with short stout setae. First joint of peduncle short, second and third joints sub-equal in length, fourth longer than third, fifth approximately equals the length of the third and fourth combined. Flagellum equal in length to the fifth joint of peduncle and composed of three joints; first and second joints subequal, third equal to the first and second combined and followed by a styliform bristle almost as long as the first joint.

Right mandible with outer cutting edge strongly chitinised and composed of four teeth; inner cutting edge less strongly developed and divided into indefinite teeth; setose lappet beneath inner cutting edge with one penicil; two "free" penicils between setose lappet and molar penicil; molar penicil consisting of a tuft of plumose setae. Outer margin of mandible with a number of spines distally.

Left mandible (Pl. V., fig. 4) differs from right in that the inner cutting edge is more strongly chitinised and the setose lappet provided with two penicils.

Maxilla 1 with outer lobe (Pl. V., fig. 5) provided with 4+6 teeth-like projections and two short spines alongside the shortest of the outermost teeth; five of the inner teeth obsoletely denticulate, the fifth being simple; outer margin fringed distally with fine setae. Inner lobe (Pl. V., fig. 6) with two moderately long plumose setae and outer apical margin produced into a short spine-like projection.

Second maxilla (Pl. V., fig. 7) with outer lobe much broader than inner and covered apically with fine setae; its apical margin flattened. Inner lobe covered with groups of fine setae and provided along the margin with a row of stouter setae. At the junction of the lobes three still stouter setae occur.

Maxillipeds (Pl. V., fig. 8) long and narrow; epipodite more than three-quarters the length of basal joints; basipodite elongated, rectangular and covered with short setae. Only first joint of endopodite distinct and provided with two stout spines; endopodite bears a tuft of setae in the a-position, a group in the b-position and a few in the c-position. Those in the b-position are borne at the apex of a prominence, whilst those in the c-position arise directly from the inner margin. Endite truncate, with one spine and three conspicuous teeth, one towards the inner margin and two towards the outer; outermost tooth strongly curved; inner surface with a group of stout setae.

Peraeopods (male). Merus and carpus of anterior legs with spinous-setae of the type figured (Pl. V., fig. 9); dactyls (Pl. V., fig. 10) slender, biunguiculate and with simple dactylar seta. Peraeopods show slight progressive increase in length.

Pleopods (male) (Pl. V., figs. 11-16). Pleopod 1, exopod 1 with inner margin strongly curved, outer margin slightly sinuous and with spinous setae; endopod stout, turned outwards at tip and outer and inner margins towards apex with stout spines. Pleopod 2, exopod longer than broad, inner margin with fine setae, outer margin sinuous and with spinous setae; endopod, slender, styliform and reaching to tip of exopod. Exopods 3-5 triangular, progressively decreasing in size and with outer margin well supplied with spinous-setae. Endopods 3-5 subrectangular.

Uropod. Greatest width of peduncle slightly more than length of outer margin, outer margin grooved. Rami setose with tuft of apical setae; inner ramus slender, arising slightly anteriorly to outer and three-quarters its length.

Scale-setae of body tergites. These are of the tricuspid type (Pl. V., figs. 18 and 19). Except for the marginal scale-setae they are very much elongated; in both forms, however, the length is greater than the width of the base.

Remarks.

These specimens, identified by Chilton as *O. punctatus*, are presumably two of those collected during an expedition to the subantarctic islands of New Zealand. In recording these specimens from Auckland Island, Chilton remarked that they were quite the same as *O. punctatus*, a statement which an examination of external appearances would bear out, but a comparison of the appendages of *Ph. chiltoni* with Monod's figures of *Ph. punctatus* from Stewart Island shows considerable differences. Monod's figures do not agree altogether with Chilton's description in such details as the length of the joints of the flagellum of antenna 2 and the ratio of outer ramus: inner ramus of uropod. *Ph. chiltoni*, however, differs markedly from both descriptions in that the mandible is with two "free" penicils behind the setose lappet. It also differs from Chilton's account in that the joints of the flagellum of antenna 2 do not increase in length distally. *Ph. chiltoni* differs from *Ph. punctatus* as figured by Monod in maxilla 1 (the second of the innermost teeth being represented by that author as simple), in the endopodite of the first male pleopod and in the scale-setae (those figured by Monod are very much shorter than those of *Ph. chiltoni*). The most important of these characters is the form of the endopodite of the first male pleopod, which character is regarded as of specific value in other genera.

Through the kindness of Professor Benham of the University of Otago, Dunedin, an examination of specimens of *Ph. punctatus* (G.M.T.) collected by Thomson in the neighbourhood of Dunedin (the type locality) was later made possible.

In general appearance these specimens closely resemble *Ph. chiltoni*. Even the flagellum of antenna 2 corresponds very well, for the first and second joints are subequal rather than progressively longer. In the cephalon, however, the lateral lobes are better developed in *Ph. punctatus* than in *Ph. chiltoni*. In *Ph. punctatus* the frontal line of the cephalon is distinct in the middle. Mandibles are with a single "free" penicil behind the setose lappet. Five of the inner teeth of outer lobe of maxilla 1 more distinctly denticulate than in *Ph. chiltoni*; outer margin of inner lobe produced into a spine-like projection which is apparently a normal feature, though not represented by Monod. In maxilla 2 (Pl. V., fig. 22) only the upper half of the inner lobe is with stout setae along the margin. The scale-setae (Pl. V., figs. 23 and 24), as figured by Monod, differ from those of *Ph. chiltoni* in that the width of the base is greater than the total length. Unfortunately all the specimens are female and the uropods missing.

Phalloniscus kenepurensis (Chilton).

1901. *Oniscus kenepurensis*. Chilton. Trans. Linn. Soc. Lond. Zool., Vol. 8, p. 135.

Occurrence: Stephens Island, New Zealand.

These specimens differ slightly from Chilton's description in that the eyes consist of more than 15 ocelli; the lateral lobes are not very small as compared with other species and the epimera of the seventh mesosomatic segment reach as far back as two-thirds the length of the epimeral portion of the third metasomatic segment, whereas they are described as extending to the end of it. These differences are, however, comparatively trivial, and may be individual variations. Below are added other details not previously recorded.

Cephalon (Pl. VI., figs. 2 and 3).—Comparatively small, deeply sunk into the first mesosomatic segment, and wider than long. Frontal line distinct, and produced in front of the eyes into upwardly projecting, moderately large subacute lobes. These lobes are developed to a greater extent than in any of the other species examined. Frontal line depressed mesially. Marginal line passes obliquely across pleural portion of the cephalon and above antennary tubercle turns towards the supra-antennal line. Supra-antennal line slightly sinuous between antennary sockets and separated from their upper borders. Clypeus protuberant, with moderately large lateral processes. Profrons rounded. Postfrons with a small rounded prominence medianly. Eyes laterally placed and moderate in size, consisting each of 20-21 ocelli.

Appendages.

Antennule of three joints; the first broader and longer than the second, third still narrower, but approximately equal in length to the first and set with stout setae at apex and along mesial border.

Mandibles.—In the male both mandibles are normal; the right mandible is with one penicil on the setose lappet and one "free" penicil behind the lappet. The outer margin is provided distally with spines. In the single female available, a quite unusual condition was found in the right mandible where a second penicil occurs on the setose lappet just beneath the setose area. The presence of this additional penicil is a notable deviation from the diagnosis of the family Oniscidae.

Maxilla 1.—Outer lobe (Pl. VI., fig. 7) with 4 + 6 teeth and 2 spines at apex; outer margin sinuous and densely turnished with setae distally. Of the 6 inner teeth some show the merest trace of denticulation, whilst others are simple; fifth tooth short, slender and simple; inner spine more slender and longer than outer. Inner lobe (Pl. VI., fig. 8) with two moderately long plumose setae; outer margin with inconspicuous spine-like projection.

Maxilla 2 (Pl. VI., fig. 9) has the usual platelike structure. Inner lobe very much smaller than outer, and covered with a furry coating of setae; upper two-thirds of margin also with a row of still stouter setae. Outer lobe covered subapically with fine setae, and with apical margin flattened.

Maxilliped (Pl. VI., fig. 10).—Endite with one spine and three teeth, of which the middle is conspicuous and strongly curved: inner surface of endite with a small group of setae towards its inner margin. In endopodite all three joints distinct, in which respect it differs from *Ph. chiltoni.*

Peraeopods.—In the male, merus and carpus densely fringed with spinous setae of the type found in *Ph. chiltoni.* These joints in the female, but sparsely setose.

Plepods (Pl. VI., figs. 11-16).—Expods of male similar to those of *Ph. chiltoni,* and bear the same type of spinous setae along the outer margin. Inner margins with a band of fine hair-like setae. Endopodite stout, and turned outwards at tip, but differing from *Ph. chiltoni* in that the apex is produced into a knob-like projection, on which are borne a number of denticles arranged in rows. Endopodite of pleopod 2 styliform, and those of pleopods 3-5 subrectangular in outline.

In the female exopod of pleopod 1 differs from those of pleopods 2-5 for the upper margin is strongly convex; outer margin slightly concave. Exopods 2 and 3 with outline subrectangular and apices scarcely produced. In the posterior exopods the apices are more produced, exopod 5 being subtriangular. Inner margins of all fringed with short fine setae and outer margins in addition with spinous setae.

Uropods (Pl. VI., fig. 17) covered with scale-setae similar to those of tergites. Peduncle grooved along outer margin. Inner ramus slender, arising slightly in front of and extending to the middle of the outer; surface set with scale-setae, whilst its inner margin is densely fringed with setae of a different type. Apex with two or three longer setae. Outer ramus stout, and with apical tuft of setae.

Scale-setae of the tricuspid type (Pl. VI., fig. 18).—These appear to be intermediate between those of *Ph. chiltoni* and *Ph. punctatus*, the greatest width being approximately equal to the length.

Remarks.

Ph. kenepurensis may, therefore, be distinguished readily from *Ph. punctatus* and *Ph. chiltoni* by the form of the lateral lobes of the cephalon and the endopodite of the first male pleopod, as well as by details of the mouth appendages.[1]

The two specimens referred to, *Phalloniscus punctatus*, and belonging to the Hamburg Museum, were collected by Chilton and identified by Budde-Lund. Since the specimens differ in several details from *Ph. punctatus* (G.M.T.) from Dunedin and from Monod's figures of that species from Stewart Island, a new species is therefore necessary for their reception.

Phalloniscus armatus n. sp.

(Pl. VIII., figs. 19-24.)

(*Phalloniscus punctatus*, det. Budde-Lund (non G.M.T.).)

Occurrence—Canterbury, New Zealand (2 specimens (cotypes) in Hamburg Museum and 8 specimens in Australian Museum).

Size—(Hamburg Museum specimens): The female specimen measures 8.5 mms. in length and 4 mms. in width. The male specimen was smaller in size.

Colour.—Mottled brown and yellowish-white. A lightish line runs along the median line of the mesosome, whilst another, in the four anterior segments, marks the junction of tergite and epimera.

Specific description.

Body, oblong-oval in shape, the length being a little more than twice the breadth. Dorsal surface covered with setae.

Cephalon differs from that of *Ph. punctatus* (Dunedin) in that the lateral lobes are better developed, approaching more nearly the condition found in *Ph. kenepurensis*, and in that the frontal line is not distinct in the middle.

Eyes lateral in position, and consisting each of 16-17 ocelli (eyes of *Ph. punctatus* with 20 ocelli).

Mesosome: Epimera moderately well developed, those of the first segment being produced anteriorly into rounded lobes, posterior angles of segment 1 rounded, whilst those of 2 and 3 are subrectangular. Posterior margins of anterior 3 segments slightly sinuous. Posterior margins of remaining 4 segments produced progressively more and more backwards to end acutely. Epimera of 7th segment reach to the middle of the epimeral portion of the third metasomatic segment.

Metasome: Anterior two segments wholly embraced by mesosome. Epimera of segments 3-5 well developed, those of the fifth reaching to the apex of terminal segment.

Terminal piece, short, triangular, sides slightly sinuous, and apex bluntly rounded.

1. The collection of the Australian Museum, Sydney, contains several specimens of *Ph. kenepurensis* which were collected from the type locality, Kenepuru, New Zealand. These specimens differ from Chilton's description and agree with the specimens from Stephens Island in the eyes, length of the seventh mesosomatic segment and the size of the lateral lobes. The mandibles in a female specimen examined were quite normal and not as in the Stephens Island specimen. The condition of the endopodite of the first male pleopod was constant.

Appendages.

Antenna 2 missing from male co-type. In the female the flagellum of the right antenna 2 is peculiar in that it is biarticulate, whilst the left is triarticulate. In the normal flagellum the first and second joints are subequal, and the third longer than their combined lengths. (In the Australian Museum material the flagella were normal.)

Left mandible: Outer cutting edge strongly chitinised and composed of 4 teeth, inner cutting edge as strongly chitinised, but indefinitely divided into teeth. Setose lappet with 2 penicils. A single "free" penicil between the setose lappet and the molar penicil; molar penicil consists of a tuft of plumose setae.

Right mandible differs from left in that the inner cutting edge is not as strongly chitinised, and in that setose lappet is with a single penicil.

Maxilla 1: Outer lobe with a dense fringe of fine setae along the distal portion of the outer margin, and with 4 + 6 setae and two spines at the apex. The inner six teeth are almost simple, there being only the merest trace of denticulation (cf. *Ph. kenepurensis*). Inner lobe with outer margin produced into a spine-like projection, the two plumose setae moderately long.

Maxilla 2 and maxilliped as in *Ph. punctatus*.

Peraeopods not noticeably unlike those of the other New Zealand forms.

Pleopods: The only distinct difference is in the first male pleopod, the endopodite of which is beset apically with denticles. This condition of the endopodite of the first male pleopod was also constant in the Australian Museum specimens.

Uropods: Peduncle reaching beyond terminal segment, and with the outer margin grooved. Outer ramus tapering to a point which bears an apical tuft of setae. Inner ramus slender, half the length of outer, and with a row of long setae along the inner margin (cf. *Ph. kenepurensis*), and with two stout setae at apex.

Scale-setae differ from those of *Ph. punctatus* in that the scale portion is more expended. Those along the margin of the tergite are with the scale portions projecting beyond the margin, and usually overlapping each other, but in some instances they are only touching. These scale setae would probably produce the scale-like markings to which Chilton referred.

Remarks.

These specimens differ markedly from the other New Zealand forms in the conditions of the 1st male pleopod endopodite, and in the form of the scale-setae, and thus justify the erection of a new species.

Phalloniscus (Hanoniscus) tuberculatus (Budde-Lund).[1]

(Pl. VIII., Figs 1-12.)

1912. *Hanoniscus tuberculatus* Budde-Lund, F.S.W. Taf. 1, figs. 14-20 and text fig. 26.

1922. *Phalloniscus punctatus* Wahrberg (non G.M.T.), Ark. Zool. XV., p. 91.

1 The description of this species is brief and frequent reference is made to *Ph. (H) nichollsi*. This is due to the fact that *Ph. (H) nichollsi* was intended to be the type species of the West Australian sub-genus, before it was realised that one of the species of the sub-genus was identical with *Hanoniscus tuberculatus* B-L.

Occurrence: 1. Tambellup.
2. Crawley, Perth.
3. Cannington. (Specimens in collection of Hamburg Museum.)
4. South Perth.

The Tambellup specimens were collected by Professor Nicholls in damp soil along the banks of the Gordon River in 1925. The Crawley specimens were collected from under decaying sacks on the edge of a swamp which exists on a peninsula (Pelican Point) projecting into the Swan River. The estuary is tidal and water strongly salt except during the rainy season. *Ph.* (*H*) *tuberculatus* was found in association with *Philoscia* (*Laevophiloscia*) *perlata*. The Cannington specimens were collected by the Michaelsen and Hartmeyer Expedition in 1905.

Size: The largest female (Crawley specimens) was approximately 9 mms. in length and 3 mms. in width, although the majority were smaller (about 6 mms. in length).

Colour: When alive the specimens were uniformly slaty-grey but after preservation a definite pattern became more obvious. The background is dark brown whilst the markings are whitish. The cephalon is irregularly marked. On the mesosome the light markings are arranged as a number of fine wavy lines forming two longitudinal bands, one on each side of the median line. On the posterior six segments of the mesosome there is a patch placed obliquely across the region of junction of tergite with epimeron. Towards the posterior angle of the epimeron there is another lightish patch. On the metasome the longitudinal bands of the mesosome are continuous as a series of light patches which are also carried on to the terminal segment. There is another light patch at the junction of tergite with epimeron. Running the entire length of the body is a faint median line. The legs are not as densely mottled as in *Ph.* (*H.*) *nichollsi*.

Specific description: Body, oblong-oval in shape; twice as broad as it is long and slightly convex. It is to be noted that it is not as convex as *Ph.* (*H*) *nichollsi*. The dorsal surface is granulated and with a slight wrinkling on the anterior mesosomatic segments.

Cephalon is of a similar type to that of *Ph.* (*H*) *nichollsi* but differs slightly in detail. As in that species the frontal line is obvious only at the sides where it is produced into narrow upward projecting lateral lobes. These lobes when seen from in front appear acute, whereas in *Ph.* (*H.*) *nichollsi* they are more obtuse. The hind margin of the head is more evenly rounded. The profrons although bulbous is not as prominent and differs in that it is rounded and not acute when seen from above, not being so deeply excavated above the antennal sockets.

Mesosome. Epimera of first mesosomatic segment produced anteriorly into lobes which are a little more acute than in *Ph.* (*H*) *nichollsi*. Posterior angles of the epimera and the posterior margins of the segments as described for *Ph.* (*H*) *nichollsi*. Epimera of the seventh mesosomatic segment only reach to the level of the middle of the epimeral portion of the third metasomatic segment.

Metasome comparatively short, being approximately two-fifths the length of the mesosome. Segments increase in length posteriorly and epimera of segments 3-5 moderately developed. Epimera of the fifth metasomatic segment do not extend to the tip of the terminal segment.

Terminal piece short, triangular in shape and almost two and one-half times as broad as it is long. The length varies somewhat, the rounded apex usually reaching a little beyond the distal margin of the peduncle of the uropods. The sides of this segment appear noticeably sinuous, due to the fact that the terminal portion is slightly depressed.

Appendages: Antenna 1 is extremely minute. First joint wider and longer than second; third narrower but only slightly longer than second; first longer than third. Distal joint is produced into a short apical spine and is armed apically and along the inner border with setae.

Antenna 2. Peduncle as in *Ph.* (*H*) *nichollsi*. As in that species an examination of a number of specimens collected from the same locality established that it was impossible to derive a constant ratio for the joints of the flagellum.* The distal joint was followed by the usual styliform bristle.

Specimen.		Ratio of joints of flagellum.
A	1 : 2 : 3	1.1 : 1 : 1.75
B	1 : 2 : 3	1 : 1 : 1.5
C	1 : 2 : 3	1.2 : 1 : 1.1
D	1 : 2 : 3	1.4 : 1 : 2
E	1 : 2 : 3	1.1 : 1 : 1.3
F	1 : 2 : 3	1.1 : 1 : 1.3
G	1 : 2 : 3	1.2 : 1 : 1.3

Mouth parts as described for *Ph.* (*H*) *nichollsi*.

Peraeopods differ from those described for *Ph.* (*H*) *nichollsi* in that the merus and carpus of the male specimens are not thickly clad with spines along the inner border.

Of 171 examples of the present species which were collected at one time at Crawley 86 were males. Although these were of varying sizes they all exhibited the less strongly spinose condition of the merus and carpus. The legs of the male, therefore, do not differ markedly from those of the female. Three weeks later 60 specimens were collected, 30 of which were males. The legs of these males exhibited the same condition as in the previous case.

Pleopods. In the pleopods the exopods of both male and female are as described for *Ph.* (*H*) *nichollsi*. The endopodite of the first male pleopod differs in form from that of *Ph.* (*H*) *nichollsi* in that it is more slender and without tooth-like projections along the outer distal margin.

Uropods. These are similar to those of *Ph.* (*H*) *nichollsi*.

Scale-setae. The scale-setae of this species are rounded apically but not dilated to the extent of those in *Ph.* (*H.*) *nichollsi*. As in *Ph.* (*H.*) *nichollsi* towards the posterior angle of the mesosomatic segments an elongated seta is to be found; in this species it is seen to be placed in the centre of the lightish spot described as occurring towards the posterior angle.

Remarks: This species can be readily distinguished from *Ph.* (*H*) *nichollsi* by the form of the head and terminal segment, by the markings on the dorsal surface of the body and the sparsely spinose condition of the anterior male legs.

Budde-Lund's type material must have been either from Cannington or from South Perth. It is of interest that Cannington lies in a swamp zone, that the Crawley specimens of *Ph.* (*H*) *tuberculatus* (B-L) and the 2 specimens which Wahrberg assigned to *Ph. punctatus* (here identified as *Ph.* (*H*)

* In the majority of specimens $1 > 2 < 3$ and $1 < 3$, but in others $1 = 2$, whilst in the largest female $1 > 3$.

tuberculatus (B-L), were collected from swamp areas. Budde-Lund's South Perth specimens were not included in the material sent from the Hamburg Museum, so a search was made in the swamps at Mill Point, South Perth. This search revealed specimens identical with *Ph.* (*H*) *tuberculatus* of Cannington. These specimens were found amongst the roots of plants and beneath decaying sacks.

Phalloniscus (Hanoniscus) nichollsi n. sp.

(Pl. VII., figs. 1-27.)

Occurrence—

1. Nornalup (Frankland River).
2. Nornalup (Walpole Inlet).
3. Bunbury (Hamburg Museum material).

This species was collected by Professor G. E. Nicholls (after whom it is named) from under karri logs in the valley of the Frankland River in November, 1925. Specimens were also taken by the author in January, 1933, from under fallen karri logs found on the hill slopes of Walpole Inlet. Only a few specimens were found, although there was an abundance of *Philoscia* (*Laevophiloscia*) *perlata* under the same logs.

Size: The larger specimens are approximately 7.5 mms. in length and 3 mms. in width.

Colour: When alive the specimens appear uniformly slaty-grey in colour but after preservation in spirit a more or less definite pattern becomes visible. In the male, the background is a dark brown and the markings of yellowish white. These lighter markings are arranged on the thorax, in two longitudinal bands of fine wavy lines on either side of the median line and on all but the first of the mesosomatic segments as a series of patches at the junction of epimera with tergites. On the metasome the patches are small and irregularly scattered. The cephalon is dark brown mottled with yellowish-white. In some of the females the pattern is as described for the males but in the majority of cases it is not as definite, the different regions being but faintly marked. For the dark brown of the male is substituted a reddish-brown in the female. In some of the smaller female specimens the body is mottled reddish-brown and yellowish-white. The peraeopods in both sexes are mottled brown and yellowish-white.

Specific description: Body (Pl. VII., fig. 1) oblong-oval in shape, slightly convex, approximately two and one-half times as long as it is broad, the convexity being more pronounced in the female specimens which are with young in the brood pouch.

Cephalon (Pl. VII., figs. 2 and 3) small, much broader than long and slightly wrinkled on the dorsal surface. Clypeus protuberant, but not quite so distinctly marked off from the face as the figure suggests, lateral processes moderately large. Frontal line ill defined in the middle region. Antennary tubercle very much reduced and lateral in position. Postfrons not distinctly separated from the profrons, owing to the absence of the middle region of the supra antennal line. Profrons not distinctly marked off from the vertex as frontal line is not obvious except in front and slightly to the inner side of the eye, where it runs along a tubercle-like lateral lobe. Profrons bulbous being produced into an eminence which, when viewed from above, appears to be sub-acute; profrons may be distinguished readily from the vertex since it is densely pigmented. Marginal line forms hind margin of head; it is well defined laterally and after passing along the hind margin of the eye, runs obliquely across the pleural portion of the cephalon. Following Budde-Lund's terminology, the head is of the "discrete" type.

Eyes lateral in position and moderate in size, each consisting approximately of 20 ocelli.

Mesosome. Epimera of first mesosomatic segment produced anteriorly into subacute lobes reaching to a little in front of the hind margin of the eyes; posterior angles rounded. Posterior angles of epimera of segments 2 and 3 subquadrate. Posterior margins of anterior three segments slightly sinuous. Posterior margins of remaining segments more obviously sinuous and epimera produced progressively more and more backwards to end acutely. Epimera of segment 7 reach as far back as two-thirds the length of the epimeral portion of the third metasomatic segment.

Metasome (Pl. VII., fig. 4) short, being from one-third to one-quarter the length of the mesosome. Segments 1 and 2 sub-equal in length; segments 3-5 progressively longer. First two segments wholly embraced by the last mesosomatic segment. Epimera of segments 3-5 well developed, narrow, acute and recurved backwards. The ratio, length of epimeron: length of segment was not constant. Epimera of segment 5 extend almost to the level of the apex of the terminal segment.

Terminal segment (Pl. VII., fig. 5) short, triangular in shape and two and one-half times as broad as it is long, its apex, which reaches a little beyond the distal margin of peduncle of uropod, rounded, its lateral margins sinuous.

Appendages.

Antenna 1 extremely minute but relatively stout. First joint wider and longer than second; third joint longer and narrower than the second and with setae along the mesial border and at the apex.

Antenna 2. Peduncle of five joints; first joint short, second and third joints subequal, fourth longer than either second or third, and fifth approximately equal to the third and fourth joints combined. All the joints of the peduncle are covered with short spinous setae. The three joints of the flagellum (Pl. VII., fig. 6) together approximately equal to the length of the fifth joint of the peduncle. Wahrberg in describing what he identified as *Ph. punctatus* from Dongarra gave a definite ratio of the length of the joints of the flagellum. In the present species the examination of a number of specimens has shown that the ratio is quite inconstant and altogether useless for systematic purposes. In general, first and second joints subequal (the first may be shorter than the second) and the third from one and one-half to twice the length of first. Third joint followed by the usual styliform bristle which branches at the apex to form a compact penicil. The spinous setae of the flagellum are longer than those of the peduncle.

Right mandible (Pl. VII., fig. 7) has outer cutting edge strongly chitinised and composed of four rather indefinite teeth. Inner cutting edge not as strongly chitinised and even less definitely divided into teeth. Setose lappet beneath inner cutting edge with one penicil. A single "free" penicil occurs between the setose lappet and the molar penicil. Molar penicil consists of a tuft of plumose setae. Lateral surface of mandible with scattered bifid spines as figured.

Left mandible (Pl. VII., fig. 8) with outer cutting edge composed of four teeth. Inner cutting edge as strongly chitinised as outer. Setose lappet with two penicils; a single "free" penicil between lappet and molar penicil. Outer margin of body with scattered bifid spines.

Maxilla 1. External margin of outer lobe sinuous and fringed distally with fine setae. Apex of outer lobe (Pl. VII., fig. 9), with 4 + 6 teeth (outer 4 teeth more strongly chitinised than inner 6) and 2 spines (close to the shortest of the outer teeth). Five of the inner group distinctly bifid or occasionally trifid; fifth tooth slender and simple. Inner spine elongated. Inner lobe (Pl. VII., fig. 10) delicate and with moderately long plumose setae; outer edge produced into a spine-like projection, outer margin distally with a number of fine setae.

Maxilla 2 is a delicate plate-like structure incompletely divided into lobes. Inner lobe narrower than outer and with two types of setae; fine setae completely covering the lobe and a row of stouter setae along the margin. Outer lobe covered distally with fine setae, apical margin curved. Three stout setae occur at junction of outer and inner lobes.

Maxilliped. Basal joint broad and rectangular. Basipodite elongated and with short spinous setae. Only first joint of endopodite well defined; endopodite with a tuft of setae in the a-position, a group in the b-position, two or three in the c-position, two small setae along the outer margin and two stout spines on the first joint. Endite with a single prominent spine and three short teeth, one towards the inner margin and two near the outer corner; a group of setae on the inner surface. Epipodite approximately two-thirds the length of the basal joints.

Peraeopods. Those of the female practically all similar in structure, increasing slightly in length posteriorly. Basipodite elongated and rectangular in shape, ischium subtriangular; merus and carpus subrectangular (the carpus of the first leg differs, however, a little in shape from the same joint in the following legs, being broader and not so elongated in form); propod slender; dactyl, short, biunguiculate and with simple dactylar seta. The setae on the anterior legs, except for one borne on the distal margin of the carpus (Pl. VII, fig. 13), are similar to those found on the New Zealand forms.

In the male the legs 2-7 are similar in structure, the first differing from them in that, as in the female, the carpus is broader and less elongated than in the other legs. In the male, however, the merus and carpus are much more densely provided with spines than in the female. Monod, in figuring the legs of the male of *Ph. punctatus* from Stewart Island, shows that of the juvenile to be sparsely clad with spines along the inner margin. Of the ten males of *Ph. (H) nichollsi* collected nine were found to be densely clad with spines whilst the remaining example, which was very much smaller (2.5 mms.) than the others, a juvenile, was sparsely armed.

Pleopods (Pl. VII., figs. 15-25), in the female pleopod 1, exopodite differs slightly in shape from the remainder; outer margin concave, upper margin strongly curved. Exopods 2 and 3 subtriangular with apices slightly produced; in the posterior exopods the apices are more produced so that exopod 5 appears subtriangular. Inner margin of exopods fringed with very short fine setae and the outer with the typical spinous setae.

In the male pleopod 1, exopodite is of a different form from exopods 2-5; outer margin slightly concave and with spinous setae. Endopodite 1 produced into an elongated structure, turned outwards apically where the inner margin is produced into a minute lobe furnished with stout setae; the outer margin is set with a band of tooth-like projection. Pleopod 2 with apex of exopod produced; endopod styliform, tapering to a fine point. Exopods 3-5 subtriangular; inner margins of all fringed with short fine setae. Endopods 3-5 moderately developed and irregular in form.

Uropod (Pl. VII., fig. 26). Basal joint subquadrilateral; length along external margin slightly greater than the greatest width of peduncle; outer margin grooved. Outer ramus stout, pointed, grooved externally and with a tuft of setae at apex. Inner ramus inserted slightly anteriorly to outer, about half its length and flattened on its inner surface.

Scale-setae found covering the body tergites of dilated form (Pl. VII., fig. 27), similar to those figured by Wahrberg. Towards the posterior angles of the mesosomatic segments a conspicuous, elongated seta is to be found (cf. *Ph. kenepurensis*).

Phalloniscus (Hanoniscus) monodi n. sp.

1922, *Ph. kenepurensis*, Wahrberg (non Chilton), Ark. Zool. Bd., XV., p. 86.

Occurrence—

1. Wooroloo.
2. York. (Western Australian Museum specimen.)
3. Moora. (Stockholm Museum specimens.)

Examples were taken at Wooroloo (September, 1932) from under stones on the banks of a creek where the soil was permanently damp. Subsequently other specimens were collected from the same locality from under the bark of nearby trees.

A specimen, in the collection of the Western Australian Museum, collected by Michaelsen, at York, in 1905, apparently belongs to this species, whilst the specimens collected at Moora and referred to *Hanoniscus sp.* (F.S.W., 1912) are identical with this species.

Size—The larger specimens are 7 mms. in length and 3 mms. in width.

Colour—As in the other Western Australian species the specimens are a uniform slaty-grey. After preservation in spirit light brown markings on a dark brown background are distinguishable. These lighter markings on the thorax, whilst following the general plan of *Ph.* (*H*) *tuberculatus*, nevertheless form a quite distinct pattern. The light patch towards the posterior angle of the epimeron is minute. The metasome is almost completely dark brown, though sometimes there may be faint patches on the anterior three segments. Irregular light patches occur on the terminal segment. The underside is mottled.

Specific description.

Body, oblong-oval in shape, and much more flattened than is the case in *Ph.* (*H*) *tuberculatus*. Length of body a little more than twice the breadth Dorsal surface with wrinkled areas on the anterior segments, but, as in *Ph.* (*H*) *tuberculatus*, they are not markedly raised. Dorsal surface irregularly granulated; the coarser granules are scattered over the mesosomatic segments, and also form continuous rows along the posterior margins. In the metasome the coarser granules are restricted in some of the specimens to the posterior margins of the segments.

Cephalon, approximately twice as broad as it is long, wrinkled on the dorsal surface and with a slightly raised crest along hind margin. Front margin, when seen from above, is bilobed as the cephalon is slightly depressed in the middle. Lateral lobes, small. The eminence into which the profrons is produced is rounded as in *Ph.* (*H*) *tuberculatus*. Margin of clypeus, to which labrum is attached, markedly concave.

Mesosome: Epimera of first segment produced anteriorly into subacute lobes which reach a little in front of the hind margins of the eyes. Posterior angles of the first segment, rounded, whilst those of the second and third are quadrate. Epimera of the seventh segment reach to the level of the middle of the epimeral portion of the third metasomatic segment.

Metasome short, approximately one-third the length of the mesosome. The metasome is shorter, in comparison to the length of the mesosome, than in *Ph.* (*H*) *tuberculatus*.

Terminal piece more bluntly rounded than in *Ph.* (*H*) *tuberculatus*. Apex not obviously depressed.

Appendages.

Antenna 1: First joint approximately equal to second and third joints combined; third joint slightly longer than second, produced distally into a spine-like projection, and with a number of stout setae.

Antenna 2: In the flagellum the first and third joints are subequal in length, whilst the second is shorter than either.

Mouth parts as described for *Ph.* (*H*) *nichollsi*.

Peraeopods as in *Ph.* (*H*) *tuberculatus*, *i.e.*, joints 4 and 5 of peraeopod sparsely setose in both male and female.

Pleopods as in *Ph.* (*H*) *tuberculatus*. The first male endopodite does not differ markedly from that of *Ph.* (*H*) *tuberculatus*.

Uropods as in the other Western Australian species.

Scale-setae are for the most part greatly dilated, though towards the anterior margins of the tergites narrower examples (more like those of *Ph.* (*H*) *tuberculatus*) are to be found in some instances.

Remarks.

This species may be distinguished from *Ph.* (*H*) *tuberculatus* by the colour pattern, the bluntly rounded terminal segment, the presence of coarse granules on the dorsal surface and the crest along the hind margin of the cephalon.

The single specimen from York (collected by Michaelsen and Hartmeyer) should be referred to this species with which it completely agrees, except for the condition of the maxilliped (the endite bears two spines and four teeth instead of the usual one spine and three teeth, whilst the first joint of the endopodite bears four instead of two spines) and not to *Phalloniscus* (*Hanoniscus*) *tuberculatus* (B.L.). It differs from the figures of *Hanoniscus tuberculatus* furnished by Budde-Lund (op., cit., Taf. 1, figs. 14-20, and text fig. 26), and from the other specimens which Budde-Lund referred to that species.

VII.—KEY TO THE SPECIES OF THE SUB-GENUS *HANONISCUS*.

1.	(a) Merus and carpus of anterior male legs densely spinose	*Ph.* (*H*) *nichollsi* n. sp.
	(b) Merus and carpus of anterior male legs sparsely spinose	2
2.	(a) Dorsal surface finely granulated	*Ph.* (*H*) *tuberculatus* (Budde-Lund)
	(b) Dorsal surface coarsely granulated	*Ph.* (*H*) *monodi* n. sp.

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IX.—EXPLANATION OF PLATES.

PLATE V.

Fig. 1.	**Phalloniscus chiltoni** n.sp. ..	Specimen (dorsal view).
Fig. 2.	„ ..	Cephalon, from in front.
Fig. 3.	„ ..	Antenna 2.
Fig. 4.	„ ..	Left mandible, distal portion ("free" penicils and molar penicil bent).
Fig. 5.	„ ..	Maxilla 1, distal portion of outer lobe.
Fig. 6.	„ ..	Maxilla 1, distal portion of inner lobe.
Fig. 7.	„ ..	Maxilla 2, distal portion.
Fig. 8.	„ ..	Left maxilliped, distal portion.
Fig. 9.	„ ..	1st peraeopod, terminal segments.
Fig. 10.	„ ..	Dactylus of 1st peraeopod, distal portion.
Fig. 11.	„ ..	Pleopod 1, exopod. ♂
Fig. 12.	„ ..	Pleopod 1, endopod. ♂
Fig. 13.	„ ..	Pleopod 2. ♂
Fig. 14.	„ ..	Pleopod 3. ♂
Fig. 15.	„ ..	Pleopod 4. ♂
Fig. 16.	„ ..	Pleopod 5. ♂
Fig. 17.	„ ..	Uropod.
Fig. 18.	„ ..	Scale-setae from thoracic tergite.
Fig. 19.	„ ..	Scale-setae from edge of tergite.
Fig. 20.	Phalloniscus punctatus (G.M.T.) ..	Cephalon, dorsal view.
Fig. 21.	„ ..	Maxilla 1, distal portion of inner lobe.
Fig. 22.	„ ..	Maxilla 2, distal portion.
Fig. 23.	„ ..	Scale-setae from edge of tergite.
Fig. 24.	„ ..	Scale-setae from thoracic tergite.

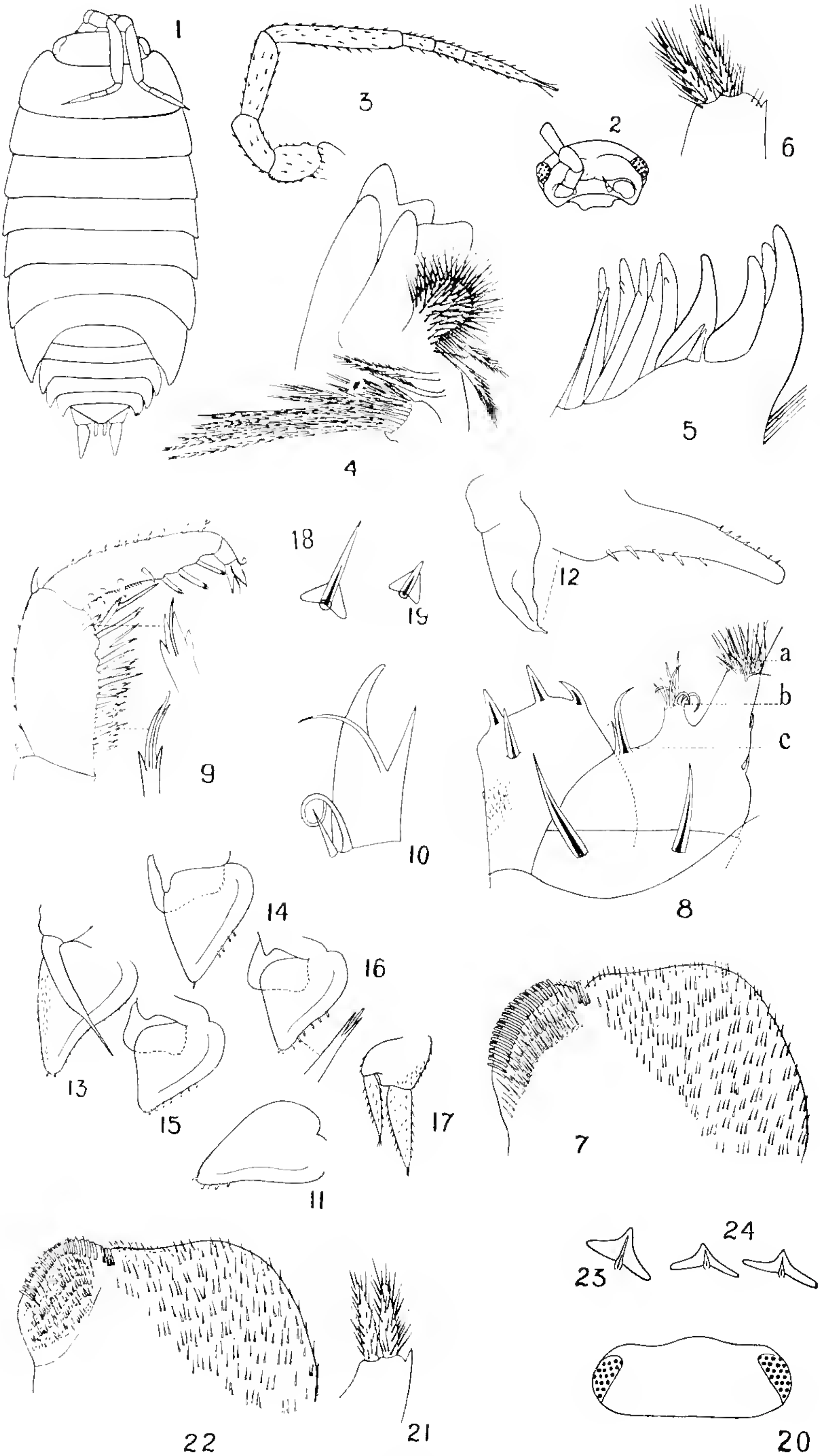

PLATE V.

PLATE VI.

Fig. 1.	**Phalloniscus kenepurensis** (Chilt.)	.. Dorsal view of mesosome and metasome. ♂
Fig. 2.	"	.. Cephalon, from in front.
Fig. 3.	"	.. Cephalon, from side.
Fig. 4.	"	.. Antenna 2.
Fig. 5.	"	.. Left mandible, distal portion.
Fig. 6.	"	.. Left mandible, distal portion enlarged.
Fig. 7.	"	.. 1st maxilla, distal portion of outer lobe.
Fig. 8.	"	.. Distal portion of inner lobe of maxilla 1.
Fig. 9.	"	.. Distal portion of maxilla 2.
Fig. 10.	"	.. Distal portion of left maxilliped.
Fig. 11.	"	.. Pleopod 1, exopod. ♂
Fig. 12.	"	.. Pleopod 1, endopod. ♂
Fig. 13.	"	.. Pleopod 2. ♂
Fig. 14.	"	.. Pleopod 3, exopod. ♂
Fig. 15.	"	.. Pleopod 4, exopod. ♂
Fig. 16.	"	.. Pleopod 5, exopod. ♂
Fig. 17.	"	.. Uropod.
Fig. 18.	"	.. Scale-setae from thoracic tergite.
Fig. 19.	"	.. Thoracic seta from edge of epimeron.

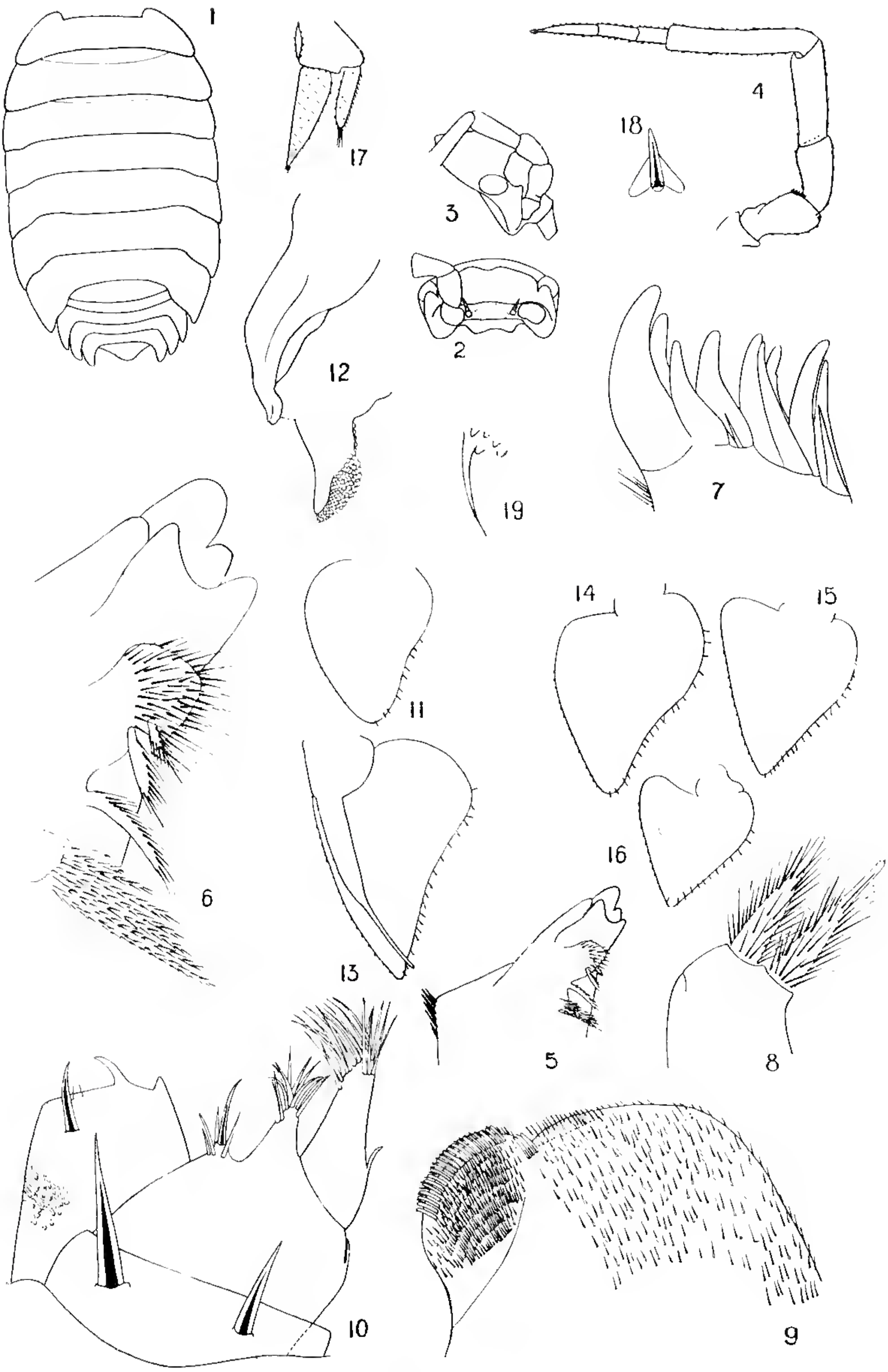

PLATE VI.

PLATE VII.

Fig. 1.	**Phalloniscus (Hanoniscus) nichollsi** n.sp.	..	Specimen, dorsal view.
Fig. 2.	”	..	Cephalon, from in front.
Fig. 3.	”	..	Cephalon, from side.
Fig. 4.	”	..	Metasome (enlarged).
Fig. 5.	”	..	Terminal segment of metasome further enlarged.
Fig. 6.	”	..	Antenna 2, flagellum.
Fig. 7.	”	..	Right mandible, distal portion.
Fig. 8.	”	..	Left mandible, distal portion.
Fig. 9.	”	..	Outer lobe of maxilla 1, distal portion.
Fig. 10.	”	..	Inner lobe of maxilla 1, distal portion.
Fig. 11.	”	..	Maxilla 2, distal portion.
Fig. 12.	”	..	Left maxilliped, distal portion.
Fig. 13.	”	..	Terminal segments of 1st peraeopod. ♂
Fig. 14.	”	..	Dactylus of 1st peraeopod enlarged. ♂
Fig. 15.	”	..	Pleopod 1, exopod. ♂
Fig. 16.	”	..	Pleopod 1, endopod. ♂
Fig. 17.	”	..	Pleopod 2, exopod. ♂
Fig. 18.	”	..	Pleopod 3, exopod. ♂
Fig. 19.	”	..	Pleopod 4, exopod. ♂
Fig. 20.	”	..	Pleopod 5, exopod. ♂
Fig 21.	”	..	Pleopod 1, exopod. ♀
Fig. 22.	”	..	Pleopod 2, exopod. ♀
Fig. 23.	”	..	Pleopod 3, exopod. ♀
Fig. 24.	”	..	Pleopod 4, exopod. ♀
Fig. 25.	”	..	Pleopod 5, exopod. ♀
Fig. 26.	”	..	Uropod.
Fig. 27.	”	..	Scale-setae from thoracic tergites.

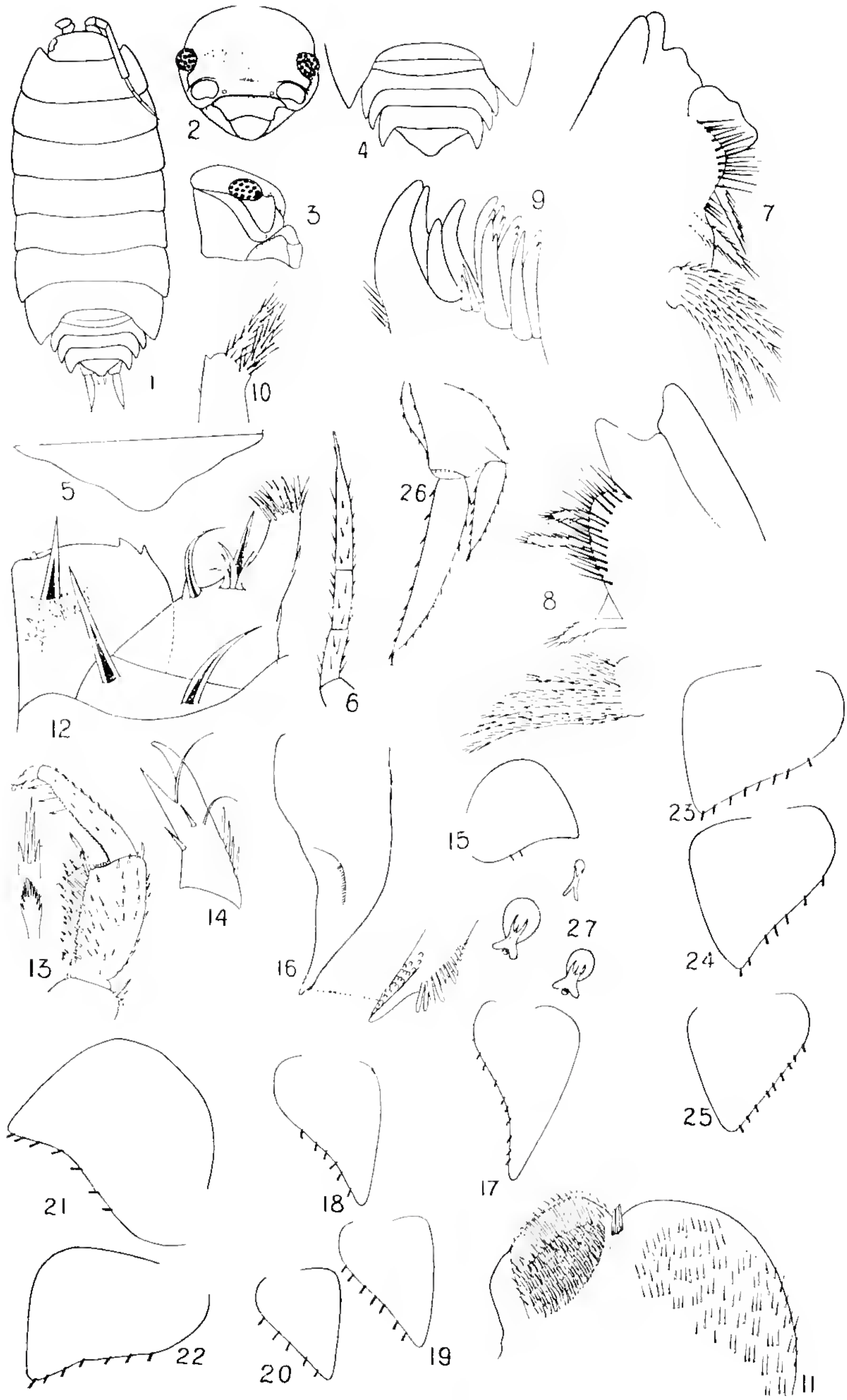

PLATE VII.

PLATE VIII.

Fig. 1.	**Phalloniscus (Hanoniscus) tuberculatus** (B-L.)	..	Specimen.
Fig. 2.	,,	..	Metasome (enlarged).
Fig. 3.	,,	..	Terminal segment of metasome mounted.
Figs. 4 and 5.	,,	..	Two views of cephalon from in front.
Fig. 6.	,,	..	Cephalon partly from above.
Fig. 7.	,,	..	Antenna 2, flagellum.
Fig. 8.	,,	..	Terminal segments of 1st peraeopod. ♂
Fig. 9.	,,	..	Pleopod 1, endopod. ♂
Fig. 10.	,,	..	Scale sculpture.
Fig. 11.	,,	..	Scale setae from margin further enlarged.
Fig. 12.	,,	..	Markings of thoracic segment (half only).
Fig. 13.	**Phalloniscus (Hanoniscus) monodi** n.sp.	..	Specimen.
Fig. 14.	,,	..	Metasome (enlarged).
Fig. 15.	,,	..	Terminal segment of metasome mounted.
Fig. 16.	,,	..	Antenna 2, flagellum.
Fig. 17.	,,	..	Scale-setae.
Fig. 18.	,,	..	Markings of thoracic segment (half only).
Fig. 19.	**Phalloniscus armatus** n.sp.	..	Specimen.
Fig 20.	,,	..	Cephalon, from above.
Fig. 21.	,,	..	Cephalon, from in front.
Fig. 22.	,,	..	Pleopod 1, endopod. ♂
Fig. 23.	,,	..	Two views of distal portion of pleopod 1, endopod. ♂
Fig. 24.	,,	..	Scale-setae from edge of tergite.

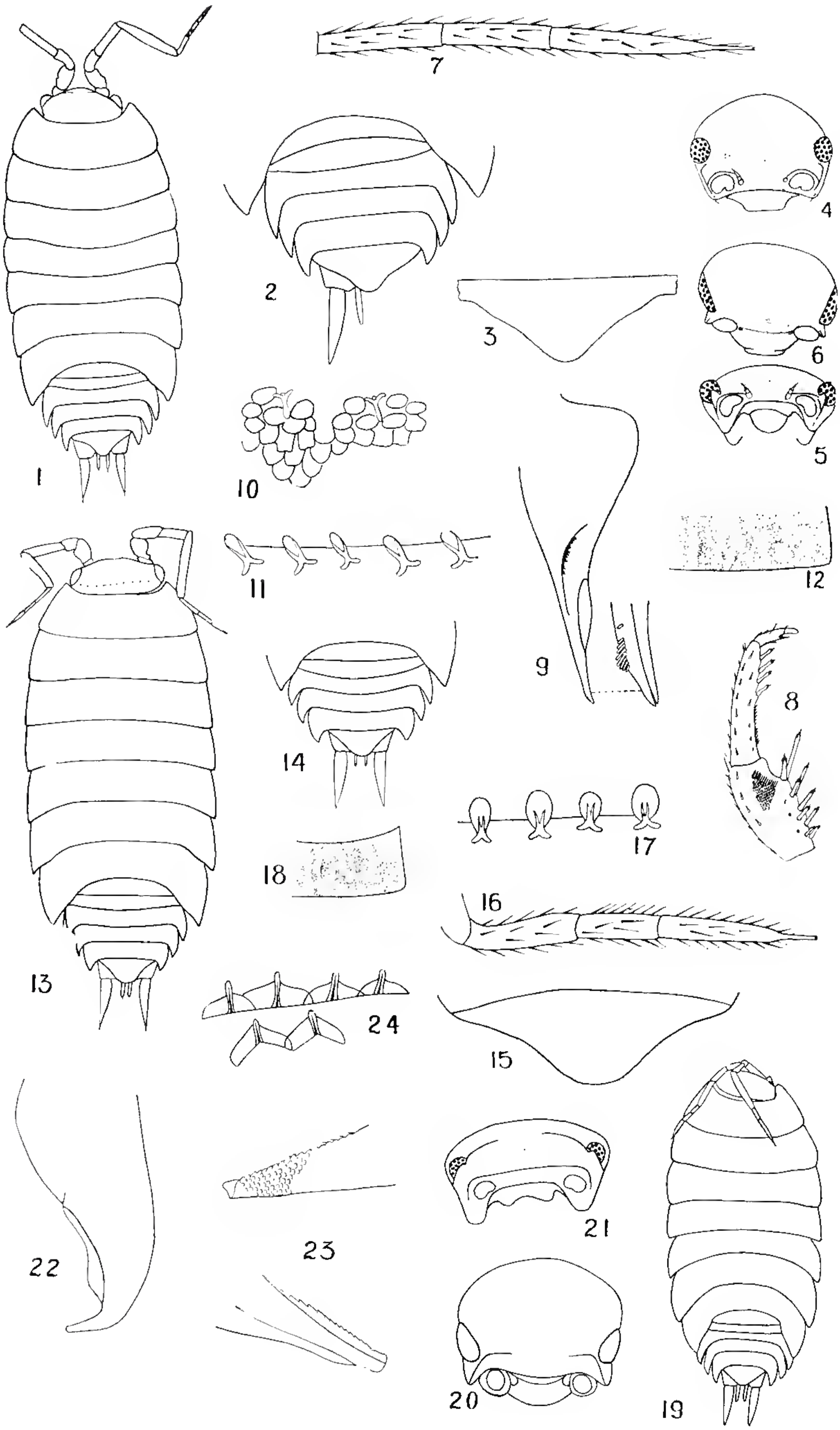

PLATE VIII.

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6.—ON A NEW GENUS AND TWO NEW SPECIES OF WESTERN AUSTRALIAN ALEYRODIDAE.

BY

M. E. SOLOMON, B.Sc. (HONS.).

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The Homopterous family Aleyrodidae is one that has been neglected by Australian entomologists. In a few countries, notably in America, a good deal of attention has been given to the description of species, as well as to the biology of some which are important pests of cultivated plants. In Australia a number of species occur on the native plants, but as these seem to be of no immediate economic importance, they have attracted but little attention.

Aleyrodidae are considered to be related most closely to the Psyllidae. The imagines, in spite of their small size, are easily recognisable by the flocculent waxy secretion covering wings and body. (Hence the popular names: "Snowflies," "Whiteflies.") Like the larvae, they are phytophagous, possessing a proboscis with piercing maxillary and mandibular stylets. The stalked eggs are attached to the leaves of the host plant. After moving about on the leaf for a short period, the young larva becomes stationary and its appendages begin to degenerate. Larvae of this and the two succeeding instars appear as small scales, usually, like the eggs, on the underside of the leaf. In most of the species the scale-like larvae are encircled by a fringe of white wax. The fourth is the pupal instar, and at this stage the integument is hardened to form a puparium or "pupa-case." In all stages from first larva to imago there is to be found on the postero-dorsal part of the abdomen a highly characteristic *anal apparatus*, peculiar to the Aleyrodidae. This consists of a pit or *vasiform orifice* partly or completely covered over by an *operculum*, from beneath which projects a mobile *lingula* (pl. ix., fig. H.; Pl. x., fig. B.). The morphology of the anal apparatus has been found very useful in systematics.

A number of species have earned notoriety by their attacks on cultivated plants. Thus *Dialeurodes citri* (Riley and Howard) has caused serious damage in the orange groves of Florida and California, while several species have proved destructive to sugar cane in Java. But the best known member of the family is the "Greenhouse Whitefly," *Trialeurodes vaporariorum* (Westwood), a pest which has spread to almost all civilised countries. Frequently the damage is not restricted to the piercing of the leaves and removal of sap; in the case of *Dialeurodes citri* (Riley and Howard), for example, the "honey-dew" secreted on the leaves provides a growing place for a sooty mould which chokes up the stomata; and the recent work of Kirkpatrick has proved an Aleyrodid to be the vector of a virus disease of cotton in the Sudan. Many useful parasites of Aleyrodid larvae have been recorded, the best known being the Chalcid wasp, *Encarsia formosa* Gahan, parasitic on *Trialeurodes vaporariorum* (Westwood). In Australia the pest is well known, and in Tasmania (1933) an attempt was made to introduce *Encarsia* from England to control the Whitefly. In this connection it is interesting to note that one of the parasites of *Synaleurodicus hakeae* n. sp. is probably a species of *Encarsia*.

METHODS.

In the past, the published descriptions of Aleyrodid species have in many cases been very poor. Owing to the fact that the pupa-cases are more easily collected than the imagines, and show more variety of structure, many species have been described from the pupa-case alone. The imagines of the eight Australian species described by Maskell are still unknown, and in only one instance did he mention the egg. This state of affairs is unfortunate both from the systematic and the economic viewpoints, for the imaginal characters are of importance in classification, and the adults, as well as the larvae, are plant feeders. Thus Quaintance and Baker urged in 1914: "It is much to be desired that descriptions of Aleyrodidae should be made as complete and full as possible." Nevertheless, brief accounts of pupa-cases continue to appear as descriptions of new species.

In the present paper an attempt has been made to give a suitably full description of each new species. In order to do this it was first necessary to connect the five stages in the life-history by means of breeding experiments. Time did not permit the breeding out of a direct series from egg to imago, but as a careful examination of a number of leaves revealed specimens in all stages of development it was possible to link up successive instars in pairs. The results of these short breeding experiments when fitted together gave a complete record of the life-cycle. In most cases it was sufficient to label the leaves while on the plant or to mark them with Indian ink. When breeding out imagines from pupae, or eggs from imagines, the leaf was enclosed in a small celluloid cylinder, closed at each end by muslin which was held in place by a ring of cork. The leaf was passed in between the celluloid and the cork, the latter then being pressed into place. These traps had the advantage of being light, transparent and easily made, and could be left exposed on the plant indefinitely.

An attempt was made to hasten the development in some cases by enclosing small potted plants in an electrically heated box. One specimen of the shrub *Dryandra floribunda* was kept alive under such conditions for four weeks at a maximum temperature of 38° C. The heat chamber also proved useful for accelerating the development of eggs and larvae on leaves which were detached from the plant and floated on water.

GROWTH OF LARVAE.

In referring a larva of a known species to its correct instar, the overall length may be used as a diagnostic character. The table given below shows the range of possible length in each instar, based on measurements of over 120 larvae for each of the two new species. It will be noted that the length-ranges in successive instars do not overlap, so that there is no difficulty in placing a larva correctly, if its length has been determined.*

Table of minimum and maximum lengths in larval instars.

Species.	First instar. mm.	Second instar. mm.	Third instar. mm.	Fourth instar (or pupa-case). mm.
Synaleurodicus hakeae n.sp. ..	0.378-0.411	0.545-0.669	0.858-1.047	1.149-1.556
Aleurotrachelus dryandrae n.sp.	0.232-0.320	0.378-0.494	0.552-0.800	0.843-1.309

* Investigations into the laws of growth of these larvae are at present being undertaken. In this connection, the writer wishes to express his thanks to Dr. R. J. Tillyard for helpful criticism, though the section to which that criticism applies has been deleted from the present paper.

SYSTEMATICS.

Although Aleyrodidae are widely distributed through temperate and tropical countries, it seems that the family must have originated in the Neotropical region, sending out branches, chiefly of the subfamily *Aleyrodinae*, to other parts of the world. Most of the remaining species are restricted to the New World, and all except two are placed in the *Aleurodicinae*. Two additional subfamilies are represented each by a single species. One of these, *Udamoselinae* (Enderlien, 1909), is described as "probably South American," while the second is the Japanese *Siphonaleyrodinae*, established in 1932 by Takahashi. In America a moderate amount of work has been done on the family, with the result that several hundred New World species are now known. The only other countries where the Aleyrodidae have received much attention are India and Japan.

In Australia, only ten species have hitherto been described, all from the south-eastern part of the continent. Eight of these species were described by Maskell (1896) and two by Froggatt (1911 and 1918). All were placed in the old genus *Aleyrodes* (sens. lat.), which was later split up by Quaintance and Baker (1914), Maskell's species being referred to several different genera. Owing to their incomplete description, it is not possible to refer Froggatt's two species to their correct genera, so they remain in *Aleyrodes* (sens. lat.). The described Australian species are as follows:—

Aleurocanthus banksiae (Maskell, 1896)—locality, Melbourne.

Aleurocanthus hirsutus (Maskell, 1896)—locality, Sydney.

Aleurocanthus T-signatus (Maskell, 1896)—locality, Sydney.

Aleurotrachelus croceatus (Maskell, 1896)—locality, near Sydney.

Aleurotrachelus limbatus (Maskell, 1896)—locality, Sydney, etc., N.S.W.

Bemisia decipiens (Maskell, 1896)—locality, near Sydney.

Aleurolobus niger (Maskell, 1896)—locality, Melbourne.

Tetraleurodes stypheliae (Maskell, 1896)—locality, Melbourne and Sydney.

Aleyrodes (?) *atriplex* (Froggatt, 1911)—locality, Broken Hill, N.S.W.

Aleyrodes (?) *albofloccosa* (Froggatt, 1918)—locality, N.S.W. and Victoria.

Ten species have so far been discovered on the native scrub in the suburban districts of Perth, all of them distinct from the described Eastern forms. Two of these have also been collected at Two People Bay, near Albany, together with an additional new species from an unidentified host. Seven of the Perth species are found on plants of the family Proteaceae, while the hosts of the remaining four species are Papilionaceae. Although these two families are particularly well represented in the flora of South-Western Australia, the field observations so far made by the writer suggest that the Aleyrodidae are somewhat restricted in their range, all of the specimens collected being found less than 200 feet above sea-level, most of them at an altitude of less than 50 feet.

Of the two new species described in this paper, the first, for reasons given below, cannot be referred to any of the established genera. The new genus *Synaleurodicus* is erected for its reception.

Synaleurodicus n. gen. is remarkable for the completeness of the wing-venation. The presence of the anal vein in the forewing marks it out at once as one of the most primitive members of the family, for in only two other genera is such a vein known to occur. Of these two, the South American genus *Radialeurodicus* Bondar, 1923 is the more closely akin to *Synaleurodicus*. Its wing-venation is at about the same stage of reduction, R_1, Rs, M and Cu being constantly found, while A is sometimes present. Other characters in which it agrees with *Synaleurodicus* are the non-produced vertex, the segmentation of the antennae, and the presence of compound wax pores and a layer of wax on the dorsum of the puparium. But *Synaleurodicus* is clearly distinguished from *Radialeurodicus* by the absence of the radial markings characteristic of the puparium of the latter genus and by the uniform colour of the wing-membrane. The second genus in which an anal vein has been described is *Udamoselis*, based on a single specimen described by Enderlein in 1909. *Udamoselis* differs from all other Aleyrodidae whose wings have been described in possessing a distinct subcostal vein in the forewing. On account of the presence of Sc and A, in addition to the veins R_1, Rs, M and Cu, *Udamoselis* was left in possession of a separate subfamily *Udamoselinae* in the Quaintance and Baker system. The characters of the paronychium and wax pores were also used in separating subfamilies, but unfortunately in the case of *Udamoselis* the former (if present) was not described by Enderlein and the puparium is unknown.

In view of these facts, it is significant that in the two most primitive genera of the subfamily *Aleurodicinae*, namely *Radialeurodicus* Bondar and *Synaleurodicus* n. gen., an anal vein is found in the forewing. Furthermore, in the forewing of *Synaleurodicus* there is a line which may represent the subcosta, but it is not so distinct as in *Udamoselis*. In both genera Cu in the forewing is represented by a clear bright line. (Probably this foreshadows the observed fact of the disappearance of the cubitus from the forewing of most *Aleurodicinae*.) The new genus, however, differs markedly from *Udamoselis* in lacking the cone-shaped protuberance of the vertex, and also in the shape of the wings, though the latter character was not used by Enderlein in defining the genus.

Thus, while on the one hand the spine-like paronychium and the presence of compound wax pores in the puparium undoubtedly place *Synaleurodicus* n. gen. in the subfamily *Aleurodicinae*, on the other hand its wing-venation is almost as primitive as that of *Udamoselis*. The result of this is that the position of the subfamily *Udamoselinae* is very much weakened.

In fact it seems that the retention of a separate subfamily for *Udamoselis* is unjustified, and that it should be included in the subfamily *Aleurodicinae*.

The occurrence of the primitive Aleurodicine genus *Synaleurodicus* in Western Australia is particularly interesting because the headquarters of the subfamily are in the Neotropical region, and, as already mentioned, the vast majority of the species are American. This is the second member of the subfamily to be recorded from Australia. (The other is *Aleyrodes albofloccosa* Froggatt, which, judging by the author's illustrations, belongs in the *Aleurodicinae*, and is probably an *Aleurodicus*).

The second new species herein described is referred to *Aleurotrachelus*. This genus contains nearly thirty species from widely separated regions—the Indian and the Neotropical as well as Japan and Australia. The present

Western Australian species does not strictly belong to *Aleurotrachelus* as defined by Quaintance and Baker (1914), but is so closely allied to it that one hesitates to erect a new genus for its reception. The point at issue is the presence of dorsal pores on the puparium of the new species. These are absent from *Aleurotrachelus* as defined by Quaintance and Baker, and Corbett (1926) established a new genus, *Zaphanera*, to receive a Ceylonese species differing from *Aleurotrachelus* chiefly in the presence of pores on the dorsum. But other characters, particularly the position of the vasiform orifice, place the present species under *Aleurotrachelus* rather than with *Zaphanera.*

SUBFAMILY ALEURODICINAE.

Genus **Synaleurodicus** n. gen.

Forewing with rounded apex, membrane of uniform colour, veins R_1, Rs, M and A distinct, Sc if present less distinct, Cu represented by a conspicuous clear line; antennae of seven segments, the third being the longest; paronychium a narrow spined process; vertex not produced. Pupa-case covered dorsally with a layer of wax; compound wax pores of a primitive type, lacking a chitinous process; lingula of pupa case conical, setose, not extending beyond the rim of the vasiform orifice.

Genotype **Synaleurodicus hakeae** n. sp.

This genus is related, though not closely, to *Radialeurodicus* Bondar, and possibly also to *Udamoselis* (see page 78).

Synaleurodicus hakeae n. sp.

Female.—Length from front of head to tip of genitalia 2.33 mm. Ground colour yellow. Head with dark brown on frons, clypeus and part of epicranium; antennae dark brown, tip of rostrum almost black; compound eyes red; ocelli pink. Thorax with sides and pronotum dark brown, the rest chiefly yellow; coxae dark brown, rest of legs light brown or grey. Abdomen yellow, except a few dark brown sclerites near base, and some faint markings on the tergites.

Epicranial suture distinct. Compound eyes (Pl. X., fig. A) bilobed, due to an indentation of the posterior margin; a pink ocellus above each eye. Antennae (Pl. X., figs. F and G) about 0.78 mm. in length; seven segments, first two short and stout; segments 3 to 7 subcylindrical, with numerous imbrications and fine setae; segment 3 a little thicker than those following; each of the last four segments roughly two-thirds length of the preceding segment; segment 7 with a strong apical seta. Rostrum (Pl. X., fig. D): suture between distal and penultimate segments is the only one distinctly visible; distal segment stout, of even width for most of its length, but tapering near apex, which is dark brown except for a clear distal circlet bearing taste sensoria.

Legs: second pair with femora slightly longer, tibiae slightly shorter than corresponding segments of the first legs; third legs with femora (length 0.49 mm.) and tibiae (length 0.80 mm.) markedly longer than those of the other legs; tarsi of all legs subequal; paronychium (Pl. X., fig. E) much shorter than the claws, consisting of a short spine borne on a subcylindrical process; tarsal claws recurved, flattened in the vertical plane and constricted at the base, near which each bears a ventral spine on a raised process. Forewing (Pl. X., fig. H) 2.33 mm. long, 1.16 mm. broad; Sc possibly represented by a dark submarginal band extending for about one-third wing length; R_1 distinct and Rs strongly developed; M not so well marked as Rs, and indistinct at the base; Cu a conspicuous clear line in the wing membrane; A moderately well-marked but vague at the base; an ill-defined fold diverges from anterior border of the radial vein near the base. Hindwing with Rs and M distinct; R_1 faint, diverging from Rs at about one-fourth wing length from the apex; the usual series of coupling setae on anterior margin near the base. Both wings with veins and margins yellow; margin with a series of setose tubercles; membrane faintly yellow, with a covering of minute setae.

Anal apparatus (Pl. X., fig. B): operculum about twice as wide as long, its posterior border very slightly concave; lingula extending well beyond the operculum, sides of exposed part almost parallel, apical part sharply pointed and minutely tuberculated; lingula and operculum finely setose; vasiform orifice subcircular, including most of lingula. Ovipositor slender, tapering to a point.

Male.—With the exceptions mentioned below, the description of female applies also to the male. It is smaller than the mature female and differs in the construction of the abdomen.

Length from front of head to tip of genitalia 1.60 mm.,* antennae about 0.59 mm.; hind femur 0.36 mm.; hind tibia 0.62 mm.; claspers 0.15 mm.; length of forewings 1.75 mm., breadth 0.73 mm. Colour: the brown colouring of head and thorax slightly more extensive, and the abdomen is dark brown except venter, genital apparatus and posterior part of the triangular lobes. The whole surface of the abdomen is beset with small transparent tubercles.

Abdomen subcylindrical with 5 ringlike segments showing very distinctly; posteriorly a pair of large lateral subtrianguar flaps conceal most of terminal segment and genital apparatus when these are viewed from the side (Pl. X., fig. C). Claspers somewhat sigmoid, the recurved extremity directed upwards and inwards; basal part narrower than the rest which is somewhat flattened in the vertical plane and bears some fairly large setae. Copulatory organ, except the enlarged base, subsigmoid in shape and more or less erect, with apex directed posteriorly; tip divided by a wedge-shaped horizontal incision into an upper and a lower pointed process.

Pupa-case (Pl. IX., fig. E).—Length 1.45 mm., width 1.05 mm. Dorsum minutely punctate; slightly convex; outline ovoid, wider posteriorly. Colour: very light yellow peripherally, with a large central brown area; a pale sutural band occurs behind each of the three thoracic and first seven abdominal segmental areas. Simple wax pores (Pl. IX., fig. F) appear as small clear spaces in the brown central area of cephalothorax, some collected into groups; two lateral compressed groups of two or three simple pores in each sutural band of thorax and abdomen, the groups aligned in two longitudinal rows. Eight compound wax pores in a longitudinal row on each side of dorsum; each compound pore appearing as a raised dark brown circlet enclosing a clear depressed area in which appear several circular or oval pores (Pl. IX., fig. G), varying in number from 3 to 7 in the type specimen; each of these central pores is continuous with a transparent downwardly-projecting tube,

* The type specimen is mounted with the abdomen in a compressed condition. Extended specimens measure about 1.93 mm.

the tubes being enclosed in a cylindrical sheath; on the crest of the brown rim is a circlet of small pores. Tracheal folds not evident. Narrow marginal band (Pl. IX., fig. J) marked by fine radial striations, and bearing 26 small supra-marginal setae, with a posterior pair of longer infra-marginal setae; small bilobed supra-marginal processes occur between the setae. Vasiform orifice (Pl. IX., fig. H) with upraised bright yellow rim, of which the outer margin is obtuse anteriorly but otherwise subcircular; adjoining this anteriorly is an elevated area, rounded in front, and bearing a posterior pair of small spines; the rim passes obliquely downwards into the orifice where it has a subcordate inner margin, and is raised into several intermediate ridges; operculum just over twice as wide as long, anterior and posterior borders slightly concave, lateral borders convex; projecting part of lingula widens a little, then tapers with minute crenulations to posterior end, which reaches almost to outer margin of the orifice rim; lingula and posterior part of operculum finely setose dorsally.

Larva, third instar.—Soft and scale-like. Length 0.86 mm.; width 0.52 mm. Dorsum slightly convex; outline ovoid, slightly wider posteriorly; distinct narrow marginal area with minute supra-marginal setae at intervals; narrow marginal wax fringe. Colour pale yellow. Anal apparatus as in pupa-case. Antennae much reduced, consisting of a stout segmented tapering basal portion with apical spine or rudimentary flagellum. Mouth parts as in first instar larva. Anterolaterally to these is a pair of red ocelli. Legs as in first instar, but relatively shorter and stouter. Intersegmental sutures visible, associated with two longitudinal rows of dorsal pores which are not very distinct.

Larva, second instar.—As in third instar, but length 0.64 mm., width 0.41 mm., and not wider posteriorly.

Larva, first instar (Pl. IX., fig. C).—Soft and scale-like. Length 0.39 mm., width 0.22 mm. Dorsum slightly convex, outline ovoid. Colour pale yellow.

Dorsum:—Narrow marginal area with 26 small supra-marginal setae spaced fairly evenly round the body; a pair of long curved marginal setae project from posterior end; anterior to vasiform orifice is a pair of small setae, preceded by two spines or spine-like ridges; anterolaterally to these are several small dorsal setae. Pair of red ocelli present. Abdominal and posterior thoracic regions with traces of intersegmental markings. (Two rows of dorsal wax pores and a narrow marginal wax fringe, as seen in second and third instars, are evident in living larvae, but not discernible in the type specimen.) Vasiform orifice stoutly pyriform, anterior border very slightly concave; operculum twice as wide as long, lateral borders convex: lingula, like posterior part of operculum, minutely setose, projecting beyond the operculum but included within the vasiform orifice.

Venter:—Antennae with five basal segments followed by an apparently unsegmented attenuated flagellum which is minutely setose and bears a small apical spine. Mouth parts of typical form, maxillary and mandibular stylets long and thread-like. Legs appear four-segmented, the small fourth segment bearing a stout curved subapical seta directed outwards, and two small apical processes or setae. Second and third legs bear a stout seta on basal segment and a small seta on base of the fourth segment. A pair of small submarginal setae just posterior to the first pair of supra-marginals; a pair of setae on base of oral cone; and a pair antero-laterally to the vasiform orifice, which is visible through the transparent integument; a pair of small spiral setae lateral to base of oral cone and two such pairs laterally between bases of legs.

Egg (Pl. IX., fig. A).—Length 0.275 mm. Shape ellipsoid. Pedicel* inserted subapically. Chorion frosty white, covered by rounded flattened tubercles (diameter varying about 0.018 mm.), each subdivided by a system of fissures (Pl. IX., fig. B): tubercles not well developed on ventral surface. A rounded mass of orange-red material visible through the chorion.

This species has a very characteristic appearance in the pupal stage, being raised upon a hollow cylindroid of whitish wax, which is usually somewhat taller at the posterior end (Pl. IX., fig. D). This may exceed 1 mm. in height in fully developed specimens. It closely resembles that shown in figures of the Aleyrodine species *Aleurochiton forbesii* (Ashmead) of North America, and similar structures are recorded for other species. Dorsally the pupa-case is covered by a sheet of wax through which the anal apparatus and compound wax pores project. The arrangement of both compound and simple wax pores seems to be fairly constant for the species.

The type specimens were taken in the Perth district, at Cottesloe, from the Proteaceous shrub *Hakea prostrata*. The species seems to be restricted to this plant.

From observations made during 1934, chiefly at Cottesloe, the following facts have been gathered concerning the ecology of the species. The imagines were collected at the beginning of April, but thereafter none could be discovered. A number of pupae at this time had disclosed no imagines, and most of these contained Chalcids in the pupal stage or else showed a large aperture gnawed by the emerging parasite. One of the species concerned was bred out (May, 1934) and proved to be a Pteromaline. During the winter months the leaves bore numerous larvae derived from eggs laid in the autumn. Some of these had reached the pupal instar in August. By the end of September, imagines were abundant, and many had already deposited their eggs. However, a few of the winter larvae had not reached the pupal stage. Although pupae were still common in mid-October, very few of these survived, owing to the attacks of Chalcid parasites. Two species were numerous: firstly the Pteromaline which had been bred out in May was again bred from pupa-cases of the Aleyrodids in late October, and invariably emerged by boring a large hole in the wax palisade near the posterior end; the second species, a yellow Eupelmine with fringed wings (probably a species of *Encarsia*), emerged always by a hole made anteriorly on the dorsum of the pupa-case. Never was more than one parasite bred out from a single Aleyrodid.

A few eggs were still being deposited in early November, and this went on throughout the summer. Nevertheless it appears from the above observations that at least two definite broods of pupae occur and give rise to imagines, one in the Autumn, the other in the Spring, and that the later members of each brood are very heavily parasitised. It is probable that such parasitism is one of the chief factors limiting the abundance of *Synaleurodicus hakeae* n.sp., for the food supply is practically unlimited and dead larvae are not numerous, as they would be if greatly reduced by physical conditions. The other limiting factors probably operate on the imagines.

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* Pedicel incomplete in the type specimen: it varies in length, usually between 0.03 mm. and 0.10 mm.

Synaleurodicus hakeae n.sp. differs from most species of Aleyrodidae in preferring the dorsal surface of the leaf, relatively few specimens being found on the ventral side. This, however, is not due to any peculiarity of the insect, but to a structural feature of the host plant.* It is unusual to find more than a score of eggs on a leaf, about half that number being more commonly observed. The abdomen of the female type specimen is distended with eggs, over sixty in number.

Subfamily ALEYRODINAE.

Genus ALEUROTRACHELUS, Quaintance and Baker, 1914.

Aleurotrachelus dryandrae n.sp.

The puparium of this species differs from that of *Aleurotrachelus* as defined by Quaintance and Baker in the possession of dorsal pores. However it is referred to this genus for reasons already outlined. (Page 79.)

Female.—Length from front of head to tip of genitalia 1.28 mm. Ground colour yellow; legs (except the hind coxae) grey, also front of head, second segment of antennae, mesosternal region, some dorsal areas on thorax, operculum, and a large median area anterior to it; distal segment of rostrum dark grey to brown; compound eyes dark red.

Compound eyes (Pl. XII., fig. E) constricted into two subcircular lobes connected by a broad isthmus; dorsal lobe slightly larger than the ventral; a prominent ocellus above each eye. Antennae (Pl. XII., figs. E and H) about 0.35 mm. long; seven segments, first two short and stout, second with a close covering of fine setae and several much stouter setae; segments 3 to 7 subcylindrical, with numerous imbrications and some fine setae; segment 3 wider than those following, slightly longer than 5, 6 and 7 together; segment 4 short; 5, 6 and 7 subequal in length; a circular fringed sensorium subapically on segment 7, a similar one on 5, and at least three on segment 3; apex of segment 7 with a group of setae and a larger seta or spine. Rostrum (Pl. XII., fig. D) three-segmented; widest near junction of second and third segments; third segment about twice as long as the second, tapering gradually to the apical area which is beset with projecting sensoria.

Legs:—Second pair with femora and tibiae only slightly longer than those of the first; third legs with femora (length 0.27 mm.) and tibiae (length 0.46 mm.) markedly longer than those of the other legs, tarsi also a little longer; trasal claws (Pl. XII., fig F) with setae along most of their length; paronychium blade-like, but long and slender, tapering and recurved distally, somewhat shorter than the claws. Forewing (Pl. XII., fig. A) 1.22 mm. long, 0.52 mm. broad; a dark pigmented band just within the costal margin and distinct for nearly one-third wing length possibly represents Sc.; R strongly bent just beyond the middle, R_1 absent, Rs distinct; M absent; Cu represented by a clear line in the membrane; several small setae on membrane near base of wing. Hindwing with only Rs present, extending almost to wing apex. Both wings with veins and margin yellow, margin with a row of setose tubercles (Pl. XII., fig. B).

* This is shown by the fact that *Aleurotrachelus dryandrae* n.sp. is also restricted almost wholly to the "dorsal" surface of the vertical *Hakea prostrata* leaf when it occurs on that plant. Although the internal structure of the leaf is essentially the same on both sides the morphologically dorsal side is concave and offers more shelter than the other surface.

Abdomen subpyriform, being enlarged near base by the mature reproductive organs (ovaries and two eggs visible within). Anal apparatus (Pl. XII., fig. C): operculum broader than long, but narrowing posteriorly; its posterior border slightly concave; lingula extending well beyond operculum, narrow, cylindrical, slightly enlarged distally, where the setae are longer than those covering the rest of the body, and apex with several obtuse lobes; vasiform orifice a little broader than the operculum, tapering posteriorly to include most of the lingula. Ovipositor slender and tapering, bearing several long hair-like setae near base.

Male.—With the exceptions mentioned below, the description of the female applies equally to the male. It differs from the female in its smaller size and in the structure of the abdomen.

Length from tip of head to tip of genitalia 0.97mm.; antennae about 0.29 mm.; hind femur 0.23 mm.; hind tibia 0.39 mm.; claspers 0.12 mm.; length of forewing 0.94 mm.; breadth 0.38 mm. Colour: several dorsal transverse brown markings on abdomen; the whole genital segment brown; rest of colour pattern as in female.

Abdomen subcylindrical; the last segment tubular (Pl. XII., fig. C), anteriorly wider than long, but tapering uniformly to posterior margin. Claspers (Pl. XII., fig. C) with a strong outer tubercle near the base, tips tapering evenly to a point and turned inwards; a number of fairly large setae present. Copulatory organ enlarged basally, and curved strongly upwards, especially near the apex.

Larva, fourth instar (early stage of pupa-case) (Pl. XI., fig. E).—Length 1.24 mm., width 0.92 mm. Dorsum pitted, with raised median part; outline subovate. A well-defined sinuous line follows a ridge of similar form between thoracic and abdominal regions; from midpoint of this a median line runs to the anterior margin, thus marking the position of the T-shaped rupture by which the imago emerges; thoracic region with prominent median ridge sagittiform anteriorly, and two prominent lateral ridges; prominent median ridge of abdominal region marked by seven transverse ridges; on surrounding flat area of dorsum is a radiating series of five prominent ridges on each side, directed laterally and posteriorly. Numerous raised circular pores on dorsum, each with a central column (Pl. XI., fig. G). Thoracic and caudal tracheal folds very faintly indicated. Margin (Pl. XI., fig. H) crenulated, with two series of teeth, the outer much paler than the inner; wax tubes well developed; a series of small spines a little within the margin, and a row of minute pores internal to these; dorsum just internal to margin bears ridges corresponding to the crenulations; an anterior and a posterior pair of marginal setae. Vasiform orifice (Pl. XI., fig. F) subcordate, situated between two ridges on a palmate area on posterior part of the median dorsal ridge where it slopes down towards the posterior margin; operculum filling the orifice; lingula included, setose; a pair of small setae on each side of orifice, another pair anterior to it. (The type specimen is a newly emerged larva, with slight pigmentation. The older larvae or pupa-cases appear black, usually metallic, with a marginal fringe of wax (Pl. XI., fig. J). In these, many of the details are obscured by the intense pigmentation.)

Larva, third instar.—Length 0.74 mm.; width 0.58 mm. General appearance like that of pupa case, but rounder and flatter. Ridge between thorax and abdomen less sinuous, abdominal prominence with eight visible transverse ridges, not well marked; fewer dorsal pores. Other details (including wax fringe) as in pupa case.

Larva, second instar.—Length 0.46 mm.; width 0.33 mm. Dorsum similar in most respects to that of puparium (but dark grey in the type specimen, which was mounted soon after the first ecdysis before pigmentation was complete); crenulations of margin smaller and less obtuse than in puparium, and represented in two series of teeth; internal to the margin is a series of about 18 small upstanding setae. Most of the large pores of the elevated part of the puparial dorsum are represented in this instar, but none on the surrounding flat area. Two dorsal ocelli as in first instar. Vasiform orifice subcordate, anterior margin only slightly convex; operculum filling the orifice and obscuring lingula. Mouthparts as in first instar, but relatively smaller; details of antennae and legs obscured by pigmentation of dorsum.

Larva, first instar (Pl. XI., figs. A and B).—Length 0.29 mm.; width 0.19 mm. Dorsum convex, outline ovoid. Colour grey. (Newly hatched larvae are transparent and almost colourless, but the dorsum rapidly assumes a dark grey and finally a black colour.)

Dorsum (Pl. XI., fig. B).—Coriaceous consistency; two pairs of very large dorsal bristles, curving upwards and backwards, the larger pair attached near anterior end, posterior pair in the anterior abdominal region; two pairs of small dorsal setae near the vasiform orifice; supra-marginal setae 18 in number, the anterior two bent over towards each other, posterior four larger than the rest. A pair of red ocelli occur laterally in the anterior region. Abdominal region marked with a number of intersegmental grooves; several less distinct transverse markings in the posterior thoracic region. Vasiform orifice subcordate, a little wider than long; operculum filling most of the vasiform orifice; lingula finely setose, tip just visible behind the operculum, but entirely enclosed within the orifice; vasiform orifice occupies the posterior part of a clearly demarcated area of the integument.

Venter (Pl. XI., fig. A).—Antennae with five basal segments followed by an attenuated flagellum which is not distinctly segmented; flagellum bearing an apical and a subapical seta; setae also on the basal segments. The ocelli are also visible from the ventral surface. Mouth parts of typical form, maxillary and mandibular stylets elongated and thread-like. Legs appear four-segmented; last segment small, bearing a short stout spine apically and a long curved seta subapically; third segment bears a stout curved seta, except on the anterior pair of legs; basal segment bears two setae. A pair of ventral setae anterior to base of the mouthparts.

Egg (Pl. XI., fig. C).—Length 0.22 mm. Shape somewhat reniform, tapering at one end, obtuse at the other. Pedical inserted below the obtuse end; length 0.13 mm. Chorion dark brown, with a network of raised lines dividing it up into small pentagonal areas (Pl. XI., fig. D).

At the articulation of the fore-coxa and trochanter of the imago (Pl. XII., fig. G) the anterior surfaces of these segments are deeply excavated so as to form a rounded groove when the trochanter is flexed forwards. Both the coxal and trachanteral walls of the groove bear a median longitudinal ridge with a stout seta at its mid-point. Projecting across the groove from the coxa is a chitinous column with a bifid and setose apex. The same structure is present but less well developed on the mid- and hind-legs, but in neither of these places is the bifid process present, and in the hind-legs the groove is not well developed. A similar but shallower groove with a median ridge on each side is found in connection with the femoro-tibial articulation in all the legs.

There can be little doubt that these grooves are used in clearing the limbs, antennae and wings of foreign bodies or of excess of the flocculent wax covering. Living imagines kept in a tube were seen frequently passing the limbs over the wings and rubbing the legs one against another. Since all Aleyrodids have the mealy covering, it seems likely that structures of this type may be of general occurrence: somewhat similar grooves occur in *Synaleurodicus hakeae* n. sp. Although Quaintance and Baker (1913) devoted a special section to the legs of the Aleyrodidae, they made no reference to any structures like those described above, nor has the author seen mention of them elsewhere.

The black scale-like larvae and pupa-cases of this species occur in large numbers on the Proteaceous shrub *Dryandra floribunda*. The type specimens were collected from the leaves of this plant in the Perth district at Crawley. The imagines were plentiful during April 1934, becoming scarcer during May until none could be found by the end of the month. The larvae developed slowly during the winter months, and gave rise to imagines which were first noticed and collected in November. This species is restricted to the hairy underside of the *Dryandra* leaves. Usually no more than five or six eggs or larvae are found on one leaf, the eggs being large considering the size of the female. The larvae and pupa-cases often have a metallic lustre, contrasting vividly with the narrow fringe of white wax, and frequently the exuviae of the previous instar are found attached to the dorsum, a circumstance which is useful in the study of the larval stages of this species. In addition to the above host, *A. dryandrae* has been collected in the Perth district from the Proteaceous shrubs *Hakea prostrata, Hakea varia, Banksia attenuata, Grevillea bipinnatifida, Dryandra nivea;* also at Two People Bay, near Albany, from *Banksia grandis.*

In conclusion, the author wishes to express thanks to those who have helped at various times with criticism and advice, particularly to Professor G. E. Nicholls, who in addition has given assistance with literature. He has also to thank Dr. W. T. Calman, of the British Museum, for his kindness in sending extracts of such of the necessary literature as was not to be had in Australia, and Mr. C. A. Gardner, Government Botanist, for identification of most of the plants mentioned.

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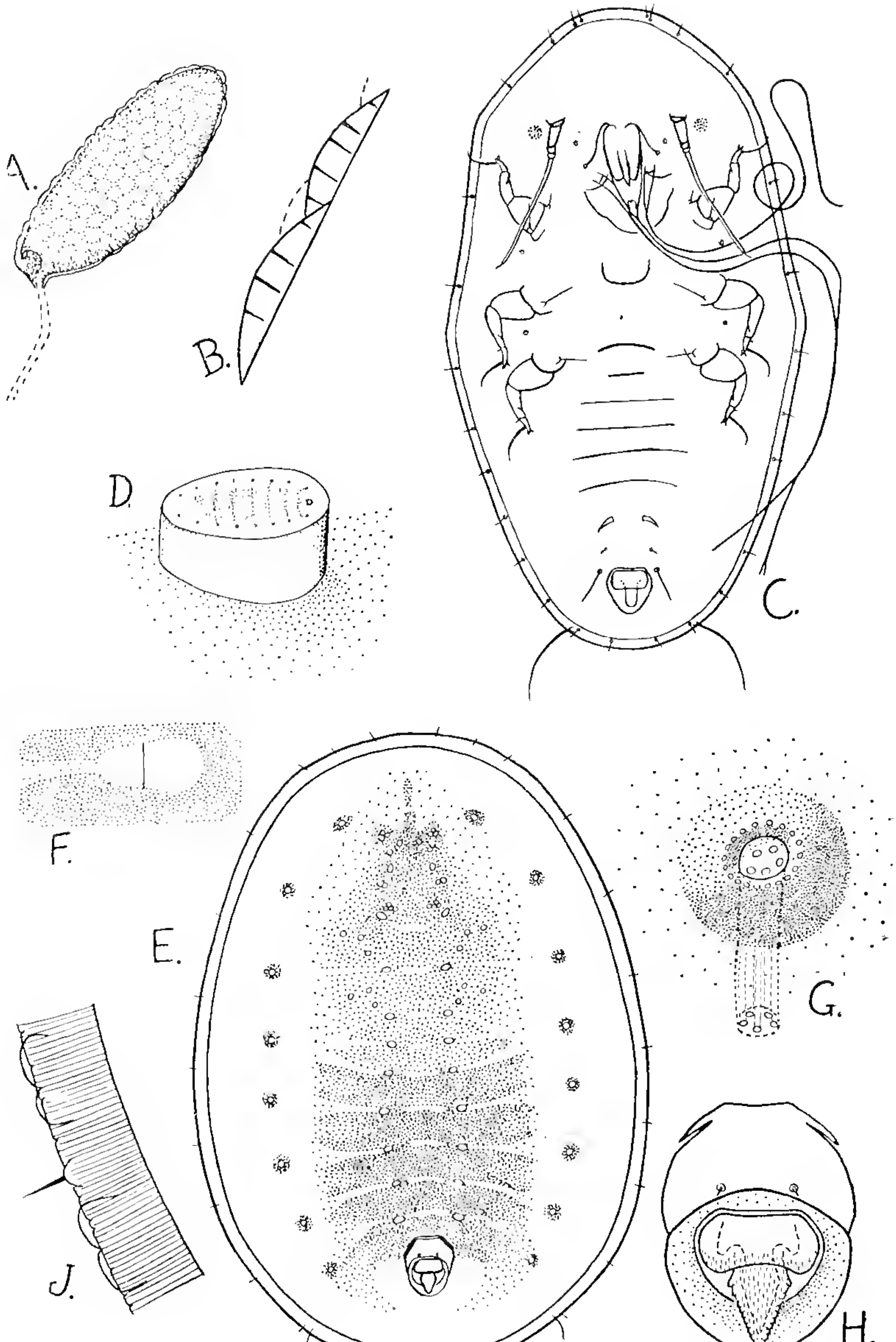


PLATE IX.

Synaleurodicus hakeae n.sp.

A., Egg. B., Sculpture of egg (optical section). C., Larva, 1st instar (shown as transparent object). D., Sketch of pupa-case on wax palisade. E., Dorsum of pupa-case. F., Simple, G., compound wax pore of pupa-case. H., Anal apparatus of same. J., Margin of same.

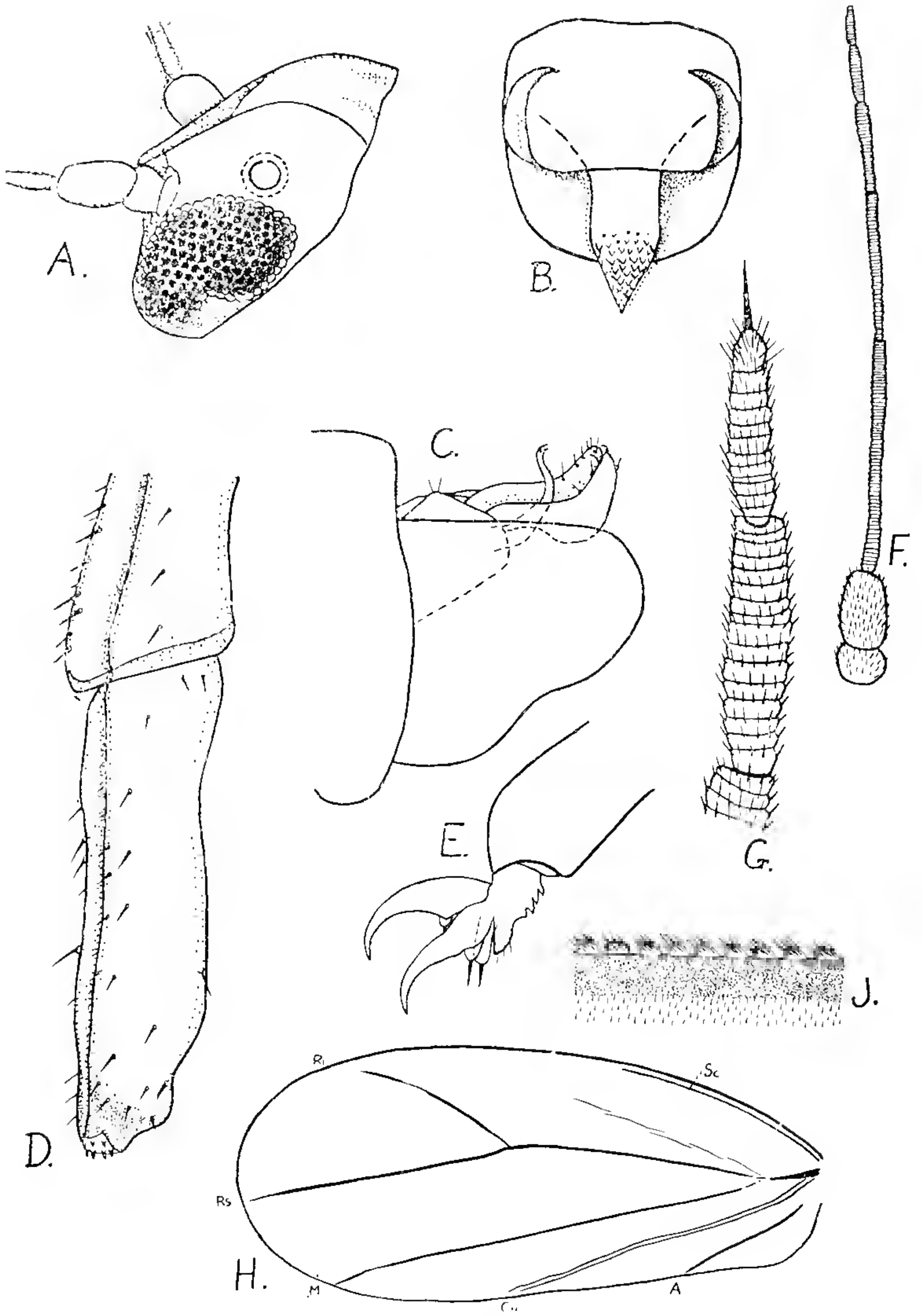


PLATE X.

Synaleurodicus hakeae n.sp. Imago.

A., Head ♂ (dorso-lateral). B., Anal apparatus ♀. C., End of abdomen ♂, lateral (drawn from a subsidiary type specimen). D., Distal part of rostrum ♀, E., Foot ♂. F., Antenna ♀. G., Distal segments of same. H., Forewing ♂. J., Anterior margin of same.

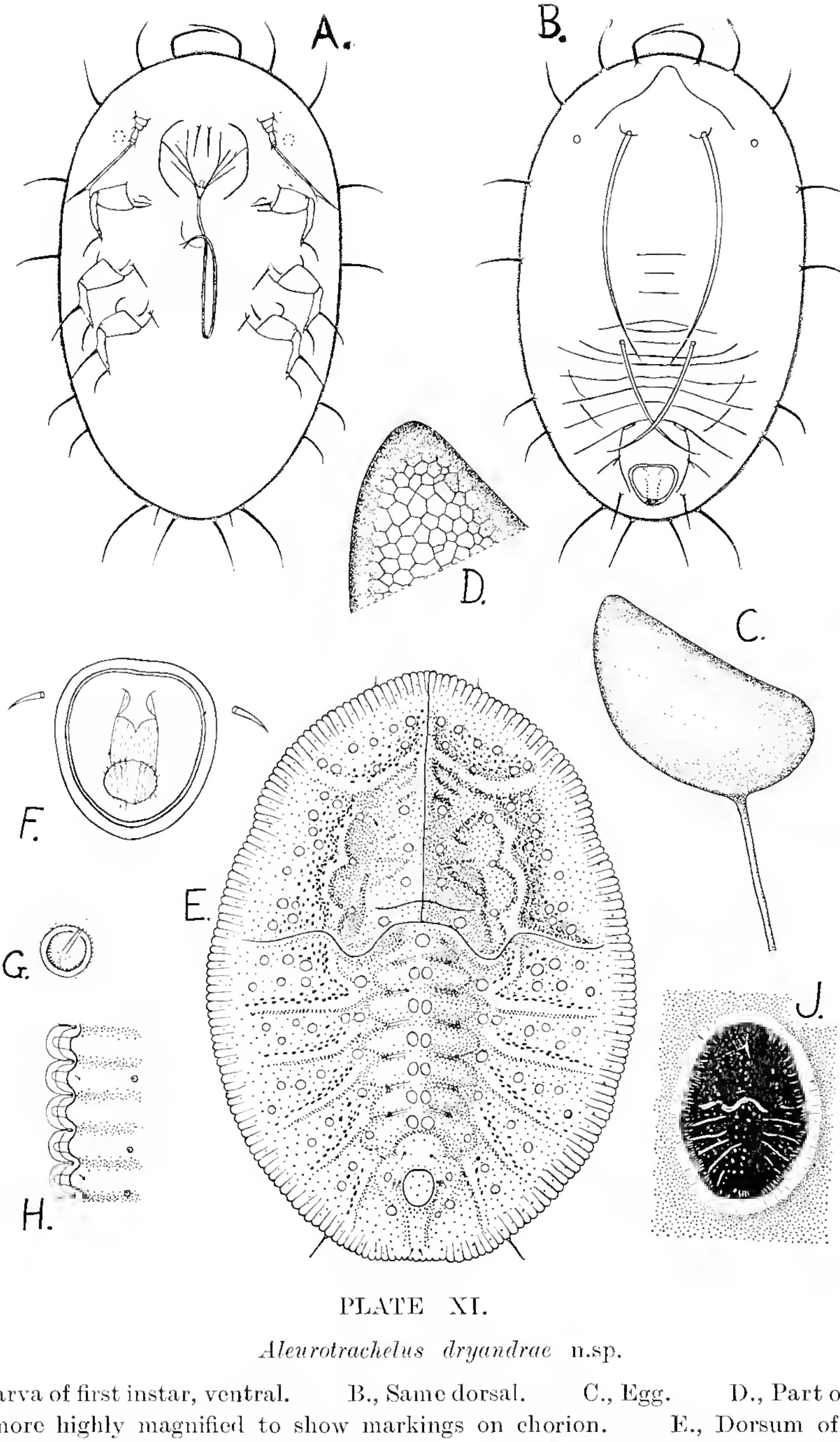


PLATE XI.

Aleurotrachelus dryandrae n.sp.

A., Larva of first instar, ventral. B., Same dorsal. C., Egg. D., Part of same, more highly magnified to show markings on chorion. E., Dorsum of fourth instar larva (for characters of pupa-case). F., Anal apparatus of same, showing lingula as seen through operculum. G., Dorsal pore of same larva. H., Margin of same larva. J., Sketch of an older larva, showing wax fringe.

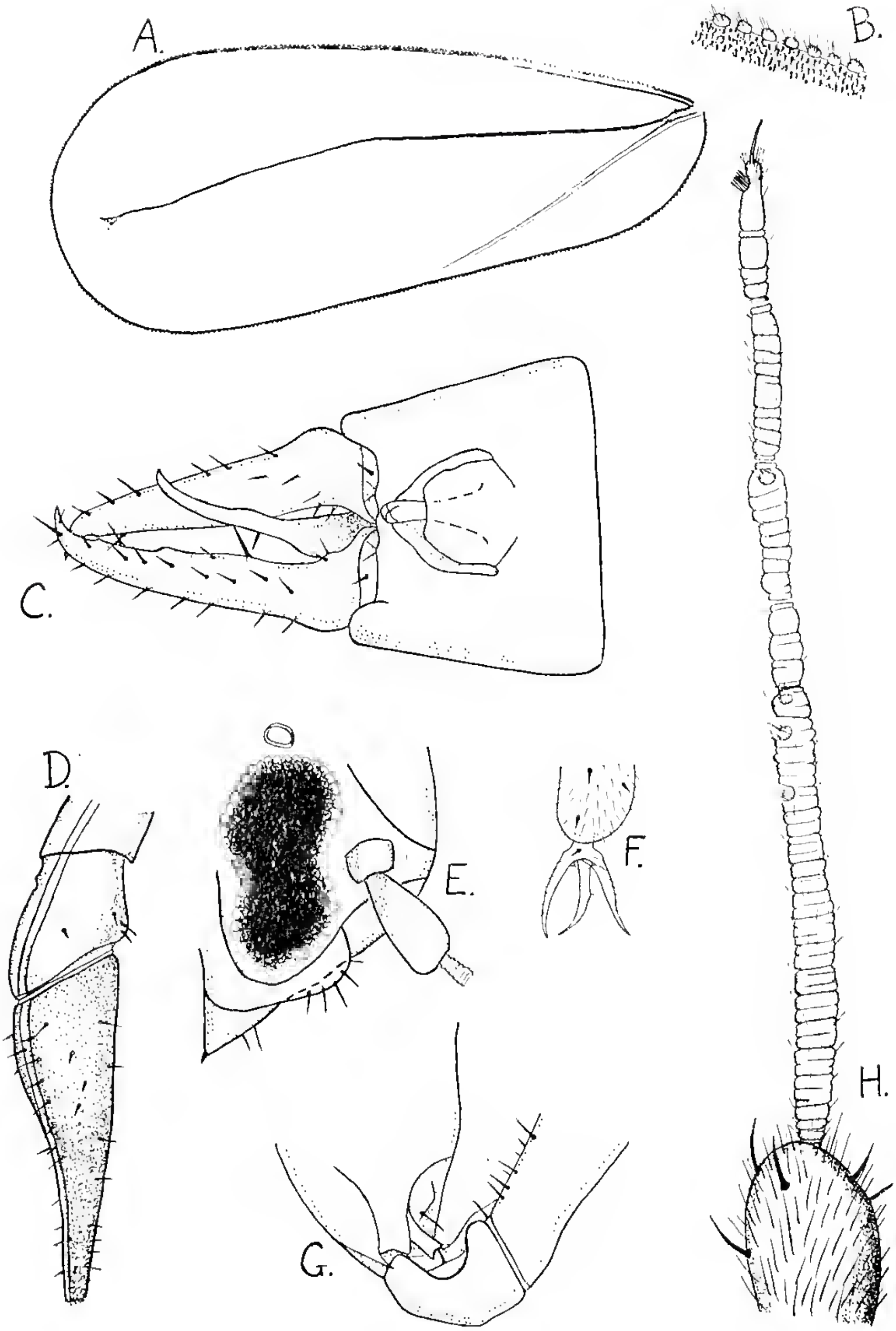


PLATE XII.

Aleurotrachelus dryandrae n.sp.

A., Forewing ♀. B., Anterior margin of same. C., Dorso-lateral view of anal and genital apparatus ♂ D., Distal part of rostrum ♀. E., Part of head ♂. F., Foot ♂ (drawn from a subsidiary type). G., Inner aspect of coxo-trochanteral articulation of left foreleg ♀. H., Flagellum of antenna ♀.

7.—THRIPS CENSUS.

By L. J. NEWMAN, F.R.E.S.

Read 14th May, 1935; Published 31st July, 1935.

Appendix by Dudley Moultan.

During the year 1932 from February to November inclusive, the Entomological and Horticultural Staffs of the Department of Agriculture, Western Australia, took a census of the thrips found in the fruitgrowing areas of the South-West. The areas over which the collection was made, included the Darling Range, country as far north as Gingin, the Avon Valley from Toodyay south, the coastal area from Perth south, and the fruitgrowing districts of Donnybrook, Capel, Bridgetown, Mt. Barker, Kalgan River and Denmark.

Thrips were collected each week from both native, garden and orchard flowers. The census revealed that 43 species of thrips were present in these fruitgrowing districts. The dominant and most damaging species was found to be *Thrips imaginis* (Bag). This is the common native flower thrip of Australia, which has, during plague years, caused very great loss to fruitgrowers and horticulturists.

The taking of the census in these areas proved that the plague thrip, *Thrips imaginis*, breeds in native and introduced acacias, some 15 other native flowers and many garden and fruit tree flowers.

In all, 43 species of thrips were collected. Amongst these the most prominent, other than *Thrips imaginis*, were the following:—

Isoneurothrips australis, chiefly found in Eucalyptus blossoms.

Thrips tabaci, infesting garden flowers and vegetables.

Odonto thrips australis, mostly infesting acacias and other native legumes.

Frankliniella insularis, found in garden flowers, tomatoes, etc.

A complete list of the thysanoptera collected during the period is here given.

RECORDS OF THYSANOPTERA.

Species.	Host Plant.	Locality.	Date.
Thrips imaginis (Bag.) ...	Eucalyptus spp.	Belmont	29-2-32, 7-4-32
		Spearwood	2-3-32
		Baker's Hill ...	7-3-32
		Gosnells	12-3-32
		Harvey	14-3-32
	Acacia podalyriaefolia ...	Perth	16-5-32
		Bayswater	27-7-32
	Acacia baileyana	Caversham ...	27-7-32
		Bedfordale	25-8-32
	Acacia cyanophylla	Narrogin	17-8-32
		Mt. Barker... ...	29-8-32
		Mundaring	30-9-32
	Acacia microbotrya ...	Perth	26-8-32
	Acacia extensa	Mt. Barker... ...	29-8-32
	Acacia alata	Kalamunda ...	16-9-32
	Acacia pulchella	Lesmurdie	22-9-32
		Mundaring	30-9-32
	Acacia oncinophylla ...	Lesmurdie	22-9-32
	Acacia saligna	Narrogin ...	3-10-32
	Acacia spp.	Mundaring	5-7-32
		Bedfordale	13-7-32
		Wooroloo	22-8-32, 21-9-32
		Waneroo	23-8-32
		Jandakot	26-8-32
		Spearwood	30-8-32

RECORDS OF THYSANOPTERA—*continued.*

Species.	Host Plant.	Locality.	Date.
Thrips imaginis (Bag.) ...	Eucalyptus calophylla ...	Mundaring	9–5–32
	Eucalyptus rudis	Wooroloo	22–8–32
		Kelmscott	15–10–32
	Hypocalymma angustifolia ...	Mundaring	30–9–32
	Agonis linearifolia	Kelmscott	15–10–32
	Hakea prostrata	Spearwood	21–10–32
	Dryandra floribunda ...	Spearwood	21–10–32
	Melaleuca radula	Lesmurdie	22–9–32
	Raphanus raphanistrum ...	Mundaring	5–7–32
	Rosa spp.	Bridgetown ...	29–2–32
		Bayswater	6–7–32
		Perth	26–8–32
	Nerium oleander	Bridgetown ...	29–2–32
	Dahlia spp.	Guildford	9–4–32
	Eriobotrya japonica (loquat)	Mundaring	30–5–32, 13–6–3
		Clontarf	4–6–32
	Citrus limonia	Mundaring	13–6–32
	Chrysanthemum coronarium (marguerite)	Maida Vale ...	21–10–32
	Prunus persico (peach) ...	Mundaring	30–9–32
	Prunus avium (cherry) ...	Mundaring	30–9–32
	Pyrus communis (pear) ...	Mundaring	30–9–32, 19–10–32
	Prunus salicina (Jap plum) ...	Mundaring	30–9–32
	Pyrus malus (apple) ...	Mundaring	19–10–32, 3–11–32
		Karragullen ...	1–11–32
		Kalgan River ...	28–10–32
	Miscellaneous garden flowers	Belmont	7–3–33
		Mundaring	9–5–32
		Perth	14–6–32
	Miscellaneous wild flowers ...	Maida Vale ...	17–6–32
		Denmark	6–7–32
		Narrogin	26–8–32
		Harvey	24–8–32
		Mt. Barker... ...	12–9–32, 19–9–32
		Mundaring	12–9–32
	Unspecified	Albany	7–7–32
Thrips tabaci (Lind.) ...	Rubus fruticosus	Bridgetown ...	29–2–32
	Acacia podalyriaefolia ...	Perth	16–5–32
	Acacia pulchella	Bridgetown ...	6–9–32
		Harvey	24–9–32
	Acacia cyanophylla	Bridgetown ...	6–9–32
	Acacia sp.	Spearwood	30–8–32
	Olearia paucidentata ...	Kalamunda ...	3–5–32
	Kennedya prostrata ...	West Swan ...	25–6–32, 24–9–32
	Raphanus raphanistrum ...	Mundaring	5–7–32
	Rosa spp.	Brigdetown ...	29–2–32
	Nerium oleander	Bridgetown ...	29–2–32
	Dahlia sp.	Guildford	9–4–32
	Allium cepa (leaves) ...	Mundaring	5–7–32
	Ageratum sp.	Bayswater	6–8–32
	Lupinus sp.	West Swan ...	24–9–32
	Chrysanthemum coronarium (marguerite)	Maida Vale ...	21–10–32
	Eucalyptus sp.	Harvey	14–4–32
	Miscellaneous garden flowers	Belmont	7–3–32, 10–5–32
		Queen's Park ...	6–4–32
		Serpentine	10–4–32
		Mundaring	9–5–32
		Perth	18–5–32, 14–6–32
		Bayswater	4–6–32
		Denmark	6–7–32
		Narrogin	17–8–32
		Mt. Barker... ...	19–8–32
	Miscellaneous bushflowers ...	Mundaring	13–5–32, 12–9–32
		Bedfordale	13–7–32
		Midland Junction...	12–8–32
		Harvey	24–8–32
		Mt. Barker... ...	19–9–32
		Kalgan River ...	28–10–32
Isoneurothrips australis (Bag.)	Eucalpytus calophylla ...	Bicton	11–5–32
		Mundaring	9–5–32
		Belmont	19–5–32
		Bridgetown ...	20–5–32
	Eucalyptus rudis	Gosnells	25–6–32
		Wooroloo	22–8–32, 21–9–32
		Wanneroo	22–9–32
		Kelmscott	15–10–32
	Eucalyptus cladocalyx ...	Bridgetown ...	6–9–32
	Eucalyptus spp.	Belmont	29–2–32, 7–3–32, 6–4–32, 7–4–32
		Baker's Hill ...	7–3–32
		Gosnells	12–3–32
		Harvey	14–3–32, 14–4–32
		Mundaring ...	30–5–32
		Bridgetown ...	15–6–32
		Denmark	6–7–32
		Wanneroo	23–8–32

RECORDS OF THYSANOPTERA—*continued.*

Species.	Host Plant.	Locality.	Date.
Isoneurothrips australis (Bag.)	Acacia Baileyana	Caversham	27–7–32
		Bridgetown ...	19–8–32
	Acacia cyanophylla	Mt. Barker... ...	29–8–32
		Bridgetown ...	6–9–32
	Acacia pulchella	Bridgetown ...	6–9–32
		Harvey	24–9–32
	Acacia spp.	Mundaring	5–7–32, 30–5–32
		Wanneroo	23–8–32
	Eriobotrya Japonica (loquat)	Mundaring	13–6–32
	Agonis linearifolia	Kelmscott	15–10–32
	Prunus avium (cherry) ...	Mundaring	30–9–32
	Pyrus communis (pear) ...	Mundaring	30–9–32
	Prunus salicina (Jap. plum)	Mundaring	30–9–32
	Rosa sp.	Bayswater	6–8–32
	Miscellaneous bush flowers ...	Toodyay	11–4–32
		Bibra Lake ...	22–4–32
	Miscellaneous bush flowers ...	Mundaring	30–5–32, 12–9–32
		Harvey	24–8–32
		Albany	6–9–32
		Mt. Barker... ...	19–9–32
	Miscellaneous garden flowers	Belmont	7–3–32
		Mundaring	9–5–32
		Denmark	6–7–32
Odomtothripella australis (Bag.)	Acacia podalyriaefolia ...	Perth	16–5–32
	Acacia cyanophylla ...	Mt. Barker... ...	29–8–32
	Acacia Baileyana	Bedfordale	25–8–32
	Acacia pilchella	Bridgetown ...	6–9–32
	Hovea trisperma	Maida Vale ...	17–6–32
	Hovea spp.	Mundaring	30–5–32
		Bedfordale	13–7–32
	Kennedya prostrata ...	West Swan ...	25–6–32, 24–9–32
	Daviesia pectinata	Cannington... ...	24–6–32
	Hardenbergia	West Swan ...	29–7–32
	Comptoniana	Guildford	10–9–32
	Oxylobium capitatum ...	West Swan ...	13–8–32
	Oxylobium cuneatum ...	Mundaring	19–10–32
	Banksia Menziesii	Guangara	16–6–32
	Raphanus raphanistrum ...	Mundaring	5–7–32
	Miscellaneous wild flowers ...	Mundaring	30–5–32
		Maida Vale ...	8–8–32
	Miscellaneous garden flowers	Perth	18–5–32
		Kelmscott	16–9–32
Taeniothrips breviocornis (Bag.)	Hypochœris radicata ...	Bridgetown ...	29–2–32
	Acacia pulchella	Harvey	24–9–32
	Eucalyptus sp.	Belmont	6–4–32
	Rosa sp.	Bridgetown ...	29–2–32
	Miscellaneous garden flowers	Queen's Park ...	6–4–32
Taeniothrips seticollis (Bag.)	Acacia sp.	Mundaring	5–7–32
Taeniothrips spp.	Acacia Baileyana	Caversham ...	27–7–32
	Acacia pulchella	Mt. Barker... ...	29–8–32
		Bridgetown ...	6–9–32
	Acacia cyanophylla	Mt. Barker... ...	29–8–32
		Bridgetown ...	6–9–32
	Acacia extensa	Mt. Barker... ...	29–8–32
	Acacia alata	Kelmscott	16–9–32
	Eucalyptus rudis	Wooroloo	22–8–32
	Ageratum sp.	Bayswater	6–8–32
	Chrysanthemum coronarium (marguerite)	Maida Vale ...	21–10–32
	Miscellaneous wild flowers...	Harvey	24–8–32
		Kalgan River ...	28–10–32
Microcephalothrips abdominalis	Zinnia elegans	Guildford	23–4–32
	Dahlia sp.	Perth	5–4–32
		Belmont ...	29–2–32, 7–3–32
	Miscellaneous garden flowers	Maylands	10–5–32
		Perth	18–5–32
Taeniothrips gladioli ...	Gladiolus sp.	Perth	28th Dec.
Isochaetothrips ignobilis ...	Eucalyptus sp.	Northam	11–4–32
Isochaetothrips uniformis ...	... ...	Perth	24–1–31
Frankliniella insularis (Frank)	Dahlia spp.	Perth	5–4–32
		Guildford	9–4–32
	Zinnia elegans	Guildford	23–4–32
	Eucalyptus sp.	Belmont	6–4–32, 7–4–32
	Miscellaneous garden flowers	Belmont	29–2–32, 7–3–32
		Gosnells	12–3–32
		Narrogin	6–4–32
		Queen's Park ...	6–4–32
		Serpentine	10–4–32
		Maylands	10–5–32

RECORDS OF THYSANOPTERA—*continued.*

Species.	Host Plant.	Locality.	Date.
Frankliniella nigripes ...	Miscellaneous garden flowers	Perth	18–5–32, 14–6–32
		Bayswater	4–6–32
Scholothrips sexmaculatus	Pyrus Malus (apple leaves)...	Bridgetown ...	29–2–32
(Pergande)	Solanum nigrum (leaves) ...	Bridgetown ...	29–2–32
	Salvia leaves	Perth	14–4–32
	Convolvulus leaves	Guildford	...
Glaucothrips sp.	Miscellaneous garden flowers	Perth	14–6–32
Limothrips cerealium (Hal.)	Trifolium spp.	Guildford	13–11–32
Limothrips angulicornis (Jab.)	Unspecified	Claremont	24–11–32
Anaphothrips	Acacia sp.	Jandakot	26–8–32
Anaphothrips newmani (Moulton)	Distorted leaves of Acacie sp.	Claremont	15–3–32
Anaphothrips varii (Moulton)	Trifolium spp.	Guildford	13–10–32
Pseudanaphothrips achaetus	Oxylobium capitatum ...	West Swan ...	13–8–32
	Rosa sp.	Guildford	29–1–32
	Miscellaneous wild flowers ...	Toodyay	11–4–32
		Maida Vale ...	17–6–32, 12–9–32
		Albany	6–9–32
		Mt. Barker... ...	12–9–32
		Mundaring	12–9–32
		Kalgan River ...	28–10–32
	Miscellaneous garden flowers	Mundaring	9–5–32
Scirtothrips australiae ...	Leaf of Cyclamen indicum...	Perth	29–4–32
Neophysopus sp.	Acacia pulchella	Mundaring	30–9–32
Agerothrips sp.	Miscellaneous wild flowers ...	Mt. Barker... ...	19–9–32
Australothrips, bicolor (Bag.)	Eucalyptus rudis (leaves) ...	Perth	Feb., 1931
	Hypocalymma angustifolium	Mt. Barker... ...	12–9–32
	Eucalyptus calophylla ...	Mundaring	9–5–32
	Eucalyptus sp.	Baker's Hill ...	7–3–32
Heliothrips haemorrhoidalis (Bouche)	Vitis vinifera (grape vine) ...	Nedlands	13–1–31
	Quercus sp.	Perth	1931
	Acacia podalyriaefloia ...	Perth	16–5–32
Hercothrips bifasciipennis (Gir.)	Eucalyptus sp.	Baker's Hill ...	7–3–32
	Dahlia sp.	Claremont	28th Dec.
Parthnothrips dracaenae (Heeger)	Dracaena sp.	Perth	29–6–32

AEOLOTHRIPIDAE.

Species.	Host Plant.	Locality.	Date.
Desmothrips australis (Bag.)	Eucalyptus calophylla ...	Mundaring	9–5–32
	Acacia sp.	Spearwood	30–8–32
	Dahlia sp.	Perth	5–4–32
	Blossoms of native trees ...	Toodyay	11–4–32
Desmothrips mendozai (Gir.)	Sweepings in bush	Mundaring ...	25–2–31
Desmothrips sp.	Oxylobium cuneatum ...	Mundaring	19–10–32
Melanthrips spp.	Acacia pulchella	Lesmurdie	22–9–32
	Acacia sp.	Jandakot	26–8–31
Cranothrips poultoni (Bag.)	Banksia Menziesii	Belmont	7–4–32
		Bibra Lake ...	22–4–32
		Gnangara	16–6–32
	Eucalyptus sp.	Belmont	6–4–32
Lamprothrips maculosus (Moulton) (n.g. and n. sp.)	Eucalyptus rudis	Perth	20–12–28
Cranothrips spp.	Hakea prostrata	Jandakot	26–8–32
		Spearwood	21–10–32
	Miscellaneous wild flowers ...	Wooroloo	22–8–32
	Chiefly Hakea spp. and Acacia spp.	Narrogin	26–8–32
		Albany	6–9–32
		(Unrecorded) ...	4–8–32
	(Unrecorded)	Albany	7–7–32
	Melaleuca radula	Lesmurdie	22–9–32

RECORDS OF THYSANOPTERA—*continued.*

Species.	Host Plant.	Locality.	Date.
Rhipidothrips aureus ...	Eucalyptus calophylla ...	Mundaring	9 5 32
	Eucalyptus spp.	Baker's Hill ...	7 3 32
		Gosnells	12 3 32
	Blossoms of native trees ...	Toodyay	11 4 32
	Eucalyptus spp. and Acacia spp.	Mundaring	30 5 32
Liothrips atratus (Moulton)	Sweepings in bush	Mundaring	25 2 31
Haplothrips victoriensis (Bag.)	Garden flowers	Perth	14 4 32
	Garden flowers	Belmont	7 3 32
	Garden flowers	Queen's Park ...	6 4 32
	Dahlias	Perth	5 4 32
	Roses	Bridgetown ...	29 2 32
	Eucalyptus erythrocoris ...	Perth	10 3 32
	Eucalyptus sp.	Northam	11 9 32
		Baker's Hill ...	7 3 32
Haplothrips gowdeyi ...	Globe amaranthus	Perth	7–3 32
Haplothrips varius... ...	Globe amaranthus	Perth	7 3–32
Haplothrips melanocerus ...	Garden flowers	Perth	27 2 32
Phaulothrips fuscus (Moulton)	Eucalyptus sp.	Bridgetown ...	15 11 27

Specimens of all species collected were mounted, also duplicates were preserved in spirits. As far as it was possible the thrips were named. The collection was then forwarded to Mr. Dudley Moulton, of Redwood City, California, a specialist on the taxonomy of the Thysanoptera. Mr. Moulton kindly undertook the work of identification and the checking of those already named.

Amongst the species sent, Mr. Moulton has recorded one new genus and six new species. The new species are named and described in the following appendix.

APPENDIX.

NEW SPECIES OF THRIPS FROM SOUTH-WESTERN AUSTRALIA.

By DUDLEY MOULTON.

Lamprothrips, Moulton, New Genus.

Genotype: *S. maculosus*, Moulton.

Closely related to and with most of the characters of *Aeolothrips* Hal.

Head wider than long, flattened in front, broadly rounded at the eyes, cheeks almost straight. Prothorax equals head in length; pterothorax much enlarged with broadly rounded sides. Eyes well developed, extended on ventral side; ocelli present. Maxillary palpus with three and labial palpus with four segments. Antenna with nine segments, three longest and with a distinct swelling on outer side near tip, four to nine rather closely joined and diminishing in length gradually; three and four each with a light-coloured sense area near tip. Prothorax without conspicuous spines. Each fore tarsus with a hook-shaped claw. Wings as in *Aeolothrips* but without darkened bands, without fringe along anterior margins. Terminal abdominal segments with long spines. Ovipositor upturned.

Lamprothrips maculosus, Moulton, n.sp.

Female holotype: Head blackish-brown, abdomen dark brown shading to blackish-brown at tip, middle and hind legs except basal portions of tarsi also blackish-brown; thorax, forelegs and first abdominal segments lighter but mottled or shaded with dark brown, the lighter portions greyish-yellow; abdomen with red pigment. Antenna greyish-brown mottled with dark brown on sides of segment two and median linear portion of segment three. Forewing white at base and tip and with a faint grey-brown shading in the middle especially along veins.

The light-coloured markings on head, thorax and legs are distinctive, and those on the prothorax are almost alike on the three specimens before me. There is a clear yellow, peanut-shaped area on either side near the posterior margin of the prothorax, an enlarged irregular shaped area near middle of posterior half and several oval-shaped spots on either side. These spots are also conspicuous on all femora.

Total body length 2.27 mm.; head length 0.18 mm., width 0.24 mm.; prothorax length 0.176 mm., width 0.28 mm.; pterothorax length 0.44 mm., width 0.45 mm.; forewing length 0.98 mm., width near middle 0.13 mm.; spines on ninth and tenth abdominal segments 147 to 160 microns. Antennal segments: length (width) I, 33 (43); II, 50 (31); III, 126 (near middle, 23, at swollen part 33); IV, 76 (23); V, 46 (23); VI, 36 (23); VII, 26; VIII, IX, 13 each; total length, 430 microns.

Type material: Female holotype and two female paratypes taken on *Eucalyptus rudis*, December 20, 1928, by B. A. O'Connor. Moulton No. 5084.

Type locality: Perth, Western Australia.

Rhipidothrips aureus, Moulton, n. sp.

Female holotype: Head and thorax golden yellow, abdominal segments one to eight lighter, nine and ten shading to grayish brown; antennal segments one, two and basal half of three grayish yellow, one darkened at extreme tip, two darker than one and basal half of three, distal half of three and four to nine blackish brown; legs yellow; wings clear with ring vein darkened with gray.

Total body length 2.03 mm.; head length 0.19 mm., width 0·22 mm.; prothorax length 0.205 mm., width 0.30 mm.; pterothorax width 0.42 mm.; antennal segments length (width): I, 33 (36); II, 56 (30); III, 133 (26); IV, 106 (23); V, 70 (20); VI, 53 (20); VII, 43 (20); VIII, 10; IX, 13; total 543 microns.

Type material: female holotype and three female paratypes taken in blossoms of a native tree, April 11, 1932, Cahill. Types in author's collection.

Type locality: Northam, Western Australia.

This species is close to R. *kellyanus* Bagnall but is at once distinguished by its bright golden yellow colour and the clear wings; *kellyanus* is grayish yellow and has a smokey brown stripe along posterior margin of fore wing between second longitudinal vein and posterior part of ring vein and also includes the scale. One paratype of *aureus* is darkened with grayish brown across abdominal segments one to eight.

Anaphothrips (Anaphothrips) *varii* Moulton.

Female holotype: mottled brown and yellow, prevailing colour brown; antennae blackish brown, segments two and three lighter in median distal portions; legs with coxae brown, femora and tibiae mostly yellow, shaded brown on outer margins, tarsi yellow; wings brownish, veins darker.

Total body length 1.6 mm.; head length 0.147 mm., width 0.18 mm.; prothorax length 0.16 mm., width 0.23 mm.; spines on ninth and tenth abdominal segments 66 microns. Antennal segments: length (width) I, 23; II, 36 (26); III, 43 (20); IV, 43 (19); V, 40 (18); VI, 46 (16); VII, 11; VIII, 10; IX, 13; total 286 microns.

Head and thorax without prominent spines, setae minute; back of head especially in darkened area transversely reticulate; ocelli present; style of antenna with three distinct segments; setae on fore wings exceedingly minute and hardly visible, arranged as follows: costa 20, fore vein 6 basal and 5 scattered distal, hind vein 8 at irregular intervals. Comb on eighth abdominal segment complete. Spines on ninth and tenth abdominal segments of about equal length.

Type material: female holotype and two female paratypes taken on clover October 13, 1930, H. Womersly. Moulton No. 5115. Types in author's collection.

Type locality: Guildford, Western Australia.

A. *varii* may at once be distinguished by its mottled brown and yellow colour and the extremely minute bristles on wings.

Anaphothrips newmani, Moulton, n.sp.

Female holotype: Uniformly straw yellow including all legs; wings also uniformly shaded except for darkened veins, tip of mouth cone black, spines on wings and distal portion of abdomen brown, crescents of ocelli orange; first antennal segment whitish, second abruptly darker like head, three to five whitish-yellow at bases and shading distally from brown to dark brown, six to nine dark brown.

Total body length 1.17 mm.; head length 0.09 mm., width 0.146 mm.; prothorax length 0.10 mm., width 0.17 mm.; spines on ninth and tenth abdominal segments 50-53 microns. Antennal segments: length (width) II, 26 (21); III, 33 (16); IV, 26 (16); V, 26 (16); VI, 26 (16); VII, 8; VIII, 7; IX, 10; total 186 microns.

Head and thorax without prominent spines or setae, ocelli present but small, style of antenna distinctly with three segments, comb on eighth abdominal segment complete, spines on tip of abdomen of about even length; setae on forewings short, stout and conspicuous, as follows: costa 22, fore vein 4, 3 and 4 scattered to tip, hind vein 9 or 10 more or less evenly placed.

Male allotype like female but somewhat smaller, wings fully developed, with fully developed comb on posterior margin of eighth abdominal segment: ninth segment with a prominent stout spine at each posterior angle and a prominent more slender pair of about the same length near middle of segment; with a pair of short stout spurs in line between this median pair and a second pair of smaller spurs immediately posterior to and lateral of the larger pair.

Type material: Female holotype and three female paratypes; male allotype, taken on leaves of acacia, March 15, 1932, by L. J. Newman. Moulton No. 5114. Types in author's collection.

Type locality: Claremont, Western Australia.

Anaphothrips (*Anaphothrips*) *newmani* may be separated from the closely related *obscurus* Muller by its shorter and broader head and the distinctly darkened wing spines.

Phaulothrips fuscus, Moulton, s.nov.

Female holotype: blackish brown, fore tarsi brownish yellow, antennae blackish brown except third segments which are mostly yellow but darkened at the tip. Fore wing white at base and tip, median half brownish.

Total body length 3.5 mm.; head length 0.73 mm., width at base 0.49 mm.; prothorax, length in the middle 0.19 mm. and 0.29 mm. at the sides; tube length 0.58 mm., width at base 0.17 mm. Antennal segments: length (width) II, 117 (60); III, 308 (43); IV, 191 (50); V, 161 (50); VI, 102 (50); VII, 73 (46); VIII, 73; total 1,102 microns. Length of spines: anteocellar and postoculats 140 microns, on anterior margin of prothorax 76, on anterior angles 66, midlaterals 116, on posterior angles outer 183-200 and inner 160 microns; on ninth abdominal segment 660 and at tip of tube 220 microns; basal wing spines 50, 86 and 153 microns respectively.

Prominent spines have blunt to dilated tips; each fore tarsus is armed with a prominent curved tooth; each fore wing has about twenty-seven double fringe hairs; fore femora are enlarged.

Male allotype coloured and shaped as in female except for the larger fore femora and stronger tarsal teeth.

Type material: female holotype, male allotype and three female, paratypes taken in blossoms of Eucalyptus sp., November 15, 1927, by L. J. Newman. Moulton No. 5117. Types in author's collection.

Type locality: Bridgetown, Western Australia.

P. fuscus may be separated from *ruilleti* Hood by its blunt to dilated tipped spines, these are pointed in *ruilleti*.

Liothrips atratus, Moulton, n.sp.

Female holotype: Colour black except distal portion of fore tibiae and tarsi which are yellowish-brown and first segments of middle and hind tarsi which are brown; third antennal segment brownish-yellow in basal half, grey-brown in distal half, fourth and fifth segments brownish-yellow at bases, otherwise the antennae are black; forewings uniformly greyish-brown, hindwings almost clear.

Total body length 2.1 mm.; head length 0.28 mm., width 0.26 mm.; prothorax length 0.22 mm., width 0.44 mm.; tube length 0.22 mm., width at base 0.088 mm. Antennal segments: length (width) II, 53 (33); III, 80 (30); IV, 76 (36); V, 73 (33); VI, 63 (30); VII, 63 (26); VIII, 33; total 460 microns. Length of spines: postoculars 60 microns, near anterior angles of prothorax 46, on posterior angles 50, on ninth abdominal segment 123, at tip of tube 216 microns, basal wing spines 40, 40 and 50 microns respectively.

Prominent head and body spines have blunt to dilated tips; antennal segments seven and eight are closely united; each fore tarsus is armed with a small tooth; forewings are without double fringe hairs. The prothorax is relatively wide for this genus, fore femora are slightly enlarged but the pointed mouth cone, single sense cone on third antennal segment and other characters are all true to the genus. This species is immediately separated from others by the absence of double fringe hairs on the forewings.

Type material: female holotype taken by sweeping on January 25, 1931, L. J. Newman. Moulton No. 5118. Type in author's collection.

Type locality: Mundaring, Western Australia.

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

8.—THE ESSENTIAL OILS OF THE WESTERN AUSTRALIAN EUCALYPTS.

PART I.

THE OIL OF *E. FLOCKTONIAE*, MAIDEN,

By E. M. WATSON.

Read 14th May, 1935; Published 31st July, 1935.

The monumental work of Baker and Smith on the eucalypts and their essential oils[1] deals mainly with the Eastern and Southern Australian species. Subsequent work in the Sydney Technological Museum by A. R. Penfold has been confined to the investigation of Eastern species and no attempt has been made to test the general conclusions advanced by Baker and Smith as far as the Western Australian species are concerned.

Baker and Smith examined some fifteen species from Western Australia; five of these (viz., *E. diversicolor*, *E. Lehmanni*, *E. cornuta*, *E. platypus* and *E. longicornis*) were trees cultivated in Melbourne; three (viz., *E. megacarpa*, *E. salmonophloia* and *E. accedens*) were of unknown origin, whilst the remaining seven (*E. calophylla*, *E. redunca*, *E. rudis*, *E. salubris*, *E. occidentalis*, *E. marginata* and *E. gomophocephala*) were from known localities in Western Australia.

The only other published work on Western Australian eucalypts appears to be that carried out by L. W. Phillips[2] on *E. spathulata* and *E. campaspe*.

These seventeen species comprise a very small proportion of the Western Australian eucalypts and it is obvious that before any attempt can be made to generalise, a systematic survey of the eucalypts must be made.

An examination of Baker and Smith's results shows that in Western Australia there occur the most primitive forms of the eucalypts, namely, *E. calophylla* (the red gum) and *E. diversicolor* (karri). The oils of these trees consist largely of pinene with only a very small amount of cineol present; the high boiling aldehydes (known collectively as aromadendral) and phellandrene are absent. The majority of the oils investigated by these authors, namely, those of *E. megacarpa*, *E. redunca*, *E. rudis*, *E. salmonophloia*, *E. accedens*, *E. Lehmanni*, *E. cornuta*, *E. platypus* and *E. longicornis*, are from more highly evolved species containing varying amounts of cineol, together with pinene, but not showing any evidence of the presence of phellandrene or aromadendral. Some three species, however, appear to be of a distinctly higher type, namely, *E. salubris*, *E. occidentalis* and *E. marginata*. The oils of these species show a marked decrease in the amount of cineol they contain (with corresponding diminution of their solubility in alcohol) but contain the aldehyde aromadendral; phellandrene is still absent from these oils. Of the species described by Baker and Smith, only one (*E. gomphocephala*) is considered by these authors to have reached a high state of evolution. The evidence from which this conclusion is made, however, appears rather scant. The oil was obtained from the leaves in very poor yield (0.03 per cent.) and was largely a terpene oil; no details of the fractionation of

(1) R. T. Baker and H. G. Smith: A research on the Eucalypts, especially in regard to their essential oils. (Technical Education Series, No. 24, Technological Museum, N.S.W.)

(2) Phillips: Jour. Roy. Soc., W.A., Vol. IX., Part 2, 1923, p. 107.

the oil are given and the authors appear to base their classification on the fact that they were able to isolate phellandrene as its nitrosite (in unstated amount) from the oil. In addition, the leaf venation is not characteristic of the more highly evolved species, or is its fairly typical "Box" mark confined to such types.

Of the species examined by Phillips (*loc. cit.*) the oil of *E. campaspe* is of the predominant cineol-pinene type, but that of *E. spathulata* is unique. It contains a very high amount of cineol (two different specimens both showing about 65 per cent.) together with a normal amount of pinene, but in addition there is a considerable quantity, estimated as 2.5 per cent., of aromadendral present. Such a proportion of cineol in oils rich in aromadendral is unexpected. Baker and Smith's results, obtained from both Eastern and Western Australian species, indicate that oils which contain appreciable quantities of aromadendral rarely contain more than 30 per cent. of cineol (the usual amount being in the neighbourhood of 10 per cent.), or, as in the cases of *E. odorata* and *E. cneorifolia*, if the cineol is high (about 60 per cent.) then the aromadendral content is low. Baker and Smith give no figures for the estimation of the aldehydes in the majority of their oils, or their appropriate fractions, but an examination of their physical properties such as density, refractive index and optical rotation shows that the proportion is generally low, rarely exceeding 0.25 per cent. of the original oils.

None of the Western Australian oils so far examined shows any trace of the peppermint ketone, piperitone, which appears to be characteristic of the highest types of the eucalypts.

From the scant evidence at present available, it seems possible, then, that the majority of the Western Australian eucalypts occupy a fairly low position in the scale of evolution and it is the author's present intention to carry out a systematic examination of the Western Australian oils with a view, not only of increasing our knowledge concerning the distribution and composition of these oils, but in the hope of throwing more light on the question of the evolution of the eucalypts.

The present paper deals with the oil of *E. Flocktoniae* Maiden (3), known as "Merrit." The tree is described by Kessell and Gardner (4) and the material used was identified by Mr. C. A. Gardner, Government Botanist.

The oil for examination was obtained by steam distillation of leaves and terminal branches such as might be used in commercial practice. The material was collected during the last week in July by Mr. G. H. Burvill, B.Sc. (Hons.) from Fitzgerald Location 422, about 8 miles east of Circle Valley, near Salmon Gums.

The trees had been previously scorched by fire and the foliage was very dense and vigorous.

The leaves are lanceolate in shape, from ½in. to little more than ¾in. in width and from 3in. to occasionally 6in. in length. They are profusely dotted with oil glands which are visible as dark spots by reflected light and light spots by transmitted light. The venation is of the type exemplified by *E. globulus* and *E. Smithii* (Baker and Smith, *loc. cit.*), the marginal vein being somewhat removed from the edge and incurved at intervals to meet the lateral veinlets. The oil might therefore be expected to consist largely of cineol and pinene, and to contain no phellandrene.

(3) Maiden: Jour. Roy. Soc., N.S.W., Vol. 49, 1915, p. 316.
(4) Kessell and Gardner: A Key to the Eucalypts of Western Australia.

These expectations were realised, the oil being found to contain 46.2 per cent. of cineol and an estimated amount of about 10 per cent. of pinene. No evidence was found of phellandrene and aromadendral was absent. Nearly 75 per cent. of the oil distilled below 195°C., the rectified oil containing 61.5 per cent. of cineol. This is below the standard required (70 per cent.) by the British Pharmacopoeia for medicinal eucalyptus oils. The amount of free acids in the oil is very low and the saponification value indicates a low percentage of esters. The saponification value of the acetylated oil (the acetyl value) is, however, very high and indicates a high proportion of hydroxyl compounds. The sesquiterpene aromadendrene was shown to be present in some quantity. The oil is therefore of the predominant cineol-pinene type already discussed.

One interesting feature demands special mention. On fractional distillation of the oil, the formation of a white insoluble substance was noted just as the oil commenced to boil, the liquid becoming cloudy and opaque. This separation continued for some time, but as the distillation approached completion (in the neighbourhood of 200°C.), the precipitate commenced to redissolve, owing, doubtless, to its increased solubility in the residual material of high molecular weight, and to the higher temperature. The insoluble matter was isolated subsequently and it appeared to be identical in properties with the substance described by Baker and Smith (*loc. cit.*, p. 422) as being formed in certain eucalyptus oils on standing for some years, and that described by Phillips (*loc. cit.*, p. 109). Phillips makes no mention of the separation of this substance *during* the distillation of the oils studied by him, whilst Baker and Smith remark on its formation in only two instances. Both of these were oils of unknown botanical origin, one coming from Queensland and the other from Western Australia. The author has, however, observed this behaviour in all the oils so far examined (see Part II.) and has noted the formation of this insoluble body in the oil of *E. salmonophloia* which has stood for four months. It is hoped in the present series of investigations to isolate sufficient of this material to enable a more complete study of it to be made.

EXPERIMENTAL.

Distillation was carried out within eight days of collection, the leaves being green, unwrinkled and in good condition. The oil distilled rapidly, more than half coming over in the first hour; it was pale yellow in colour and had a fairly pleasant odour. The yield of undried oil was 1.75 per cent. by weight. After drying over anhydrous sodium sulphate, the crude oil had the following properties:—

Specific gravity at 20° C.	0.9216
Refractive index at 20° C.	1.4728
Optical rotation	+ 0.32°
Acid value	1.0
Saponification value	3.7
Acetyl value	96

The oil was soluble in 2 volumes of 70 per cent. (by weight) alcohol, indicating a low proportion of terpenes and other hydrocarbons.

The saponification value corresponds to 1.30 per cent. of esters calculated as geranyl acetate, $C_{12}H_{20}O_2$, whilst the acetyl value corresponds to 25.4 per cent. of alcohols calculated as geraniol, $C_{10}H_{18}O$. The cineol content, determined by the method of the British Pharmacopoeia, using *o*-cresol, was 46.2 per cent. It did not restore the colour to Schiff's reagent and therefore contained no aldehydes. An alcoholic solution of the oil gave an intense yellow colour with neutral ferric chloride solution, suggesting the presence of phenolic bodies, and finally, it gave all the characteristic colour reactions of aromadendrene. Thus with bromine vapour, a solution of the oil in glacial acetic acid gave a crimson colour on the surface, which spread through the liquid, changing to violet and then indigo; with a drop of concentrated hydrochloric acid, a similar solution gave a deep crimson colour; on layering with concentrated sulphuric acid, a dark red colour was produced at the junction, which changed to a brownish-red on mixing, whilst with a syrupy solution of phosphoric acid, a brownish-yellow colour, changing to reddish, was formed at the boundary of the two liquids.

FRACTIONATION.

120 grams of the oil were distilled under ordinary atmospheric pressure and the following fractions obtained:—

1.	Up to 150° C.	Nil
2.	From 150°-162° C.	8.5 per cent.
3.	From 162°-182° C.	57.2 ,, ,,
4.	From 182°-195° C.	8.8 ,, ,,
5.	From 195°-230° C.	8.65 ,, ,,
	Residue	16.85 ,, ,,

The separation of the insoluble white solid at the commencement of the distillation has already been discussed (page 103).

The rectified oil distilling below 195° C. (74.5 per cent.) contained 61.5 per cent. of cineol, corresponding to 45.8 per cent. in the original oil.

Fraction 2 was pale yellow in colour and had an odour resembling that of pinene. It had the following physical constants:—Specific gravity,* 0.8908; refractive index, 1.4623; optical rotation, + 25.67°. The fraction fairly obviously consisted largely of *d*-pinene, which was isolable in quantity in the form of its nitrosochloride (m.p. 104° C.).

Fraction 3, which made up the greater part of the distillate, was practically colourless and has a pleasant cineol-like odour. It had the following properties:—Specific gravity, 0.9078; refractive index, 1.4635; optical rotation, + 9.11°. The cineol content was approximately 64 per cent., but almost 85 per cent. of the oil was soluble in 50 per cent. resorcinol solution, indicating the presence of appreciable quantities of oxygenated compounds. The unabsorbed oil (15 per cent.) was taken up in ether, washed alternately with caustic soda solution and water, dried, the ether removed and the residue re-distilled. Somewhat more than half distilled below 164° C. (representing approximately 4.5 per cent. of the original oil); this consisted almost wholly of pinene, identified by its boiling point, odour and refractive index. A very small high boiling fraction was also obtained which slowly gave the reactions of aromadendrene.

Fraction 4 was colourless and gave slight reactions for aromadendrene. It had the following properties:—Specific gravity, 0.9392; refractive index, 1.4691; optical rotation, — 14.25°.

* Physical properties are given at 20° C. unless otherwise stated.

Fraction 5 was very pale yellow in colour and gave all the reactions described above for aromadendrene. It had the following properties:—Specific gravity, 0.9602; refractive index, 1.4888; optical rotation, — 29.60°. A high laevorotation in this fraction is generally considered to be indicative of the presence of aromadendral, cuminal or cryptal, but the fraction gave no reaction with Schiff's reagent, showing the absence of aldehydes.

The residue (16.85 per cent.) was taken up in ether, thus precipitating the white insoluble material discussed above. The precipitate was filtered off, washed with more ether, dried and weighed, 2.7 grams (corresponding to 2.25 per cent. of the original oil) being obtained. From the combined filtrates the ether was removed and the residue, which gave all the reactions for aromadendrene, was again fractionated under reduced pressure.

Two fractions were separated. The first distilled from 98° to 145° C. at 22 mms. pressure and made up 10 per cent. of the original oil. It was a clear yellow in colour and was fairly viscous; its optical rotation was — 15.27° and its refractive index 1.4989. The second fraction distilled from 145° to 165° C. at 22 mms. pressure and made up 3.2 per cent. of the original oil. It was a somewhat brownish-yellow in colour and was very viscous; its refractive index was 1.5044 but there was insufficient to measure its optical rotation. Both fractions were too viscous for their specific gravities to be determined by means of a pyknometer. The final residue consisted apparently of highly polymerised resinous materials which solidified to a dark reddish-brown mass on cooling.

The author wishes to express his thanks to Mr. G. H. Burvill for the collection and forwarding of the original material and to Mr. C. A. Gardner for verifying its identity.

Perth Technical College.

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

9.—THE ESSENTIAL OILS OF THE WESTERN AUSTRALIAN EUCALYPTS.

PART II.

THE OILS OF *E. KESSELLI* AND *E. DUNDASI*,

By G. E. MARSHALL and E. M. WATSON.

Read 14th May, 1935; Published 31st July, 1935.

EUCALYPTUS KESSELLI, Maiden et Blakely.(1)

E. Kesselli occurs in a belt of country extending from Salmon Gums in the north to Scaddan in the south; it does not extend far to the west and its eastern limit has not been defined.

The leaves of the tree are thick, flat and coriaceous, varying somewhat in shape from straight or curved lanceolate to ovate lanceolate. They are up to 1¼ inches wide and from 3 inches to 4½ inches long and are thickly dotted with oil glands. The venation is fairly distinct and resembles closely that of *E. Flocktoniae* (see Part I.), so that the oil might be expected to consist mainly of cineol and pinene.

The material for distillation was collected by Mr. G. H. Burvill, B.Sc. (Hons.), from Fitzgerald Location 422, about 8 miles east of Circle Valley, near Salmon Gums, during the last week in July, and was identified by Mr. C. A. Gardner, Government Botanist. It was obtained from normal mature trees and when distilled was in good fresh condition.

The oil distilled slowly, probably owing to the thick nature of the leaves, and was a pale yellowish-green in colour. The yield was 1.23 per cent. by weight. Its density, refractive index, optical rotation and solubility in alcohol were all very similar to those of *E. Flocktoniae*. The oil contained a little more free acid than that of *E. Flocktoniae* and its ester content (indicated by its saponification value) was also somewhat greater; the proportion of alcohols, however, although still very great, was somewhat less than in *E. Flocktoniae*. The amount of pinene in the two oils is much about the same but there is a little less cineol in the oil of *E. Kesselli*; on the other hand, the rectified oil (boiling below 195° C.) contains somewhat more cineol (64 per cent.) than the rectified oil of *E. Flocktoniae* (61.5 per cent.), but even so this is not sufficient for a medicinal oil. Aldehydes are absent but an intense yellow colour with ferric chloride suggests the presence of phenolic substances. The sesquiterpene aromadendrene is present in fair quantity and no indication was obtained of the presence of phellandrene.

The same separation of white insoluble substance, mentioned in connection with the oil of *E. Flocktoniae* (Part I., page 103), was noted in the fractional distillation of this oil. It was recovered from the residue as before and found to make up 3.45 per cent. of the original oil.

E. Kesselli therefore belongs to the main group of Western Australian eucalypts, possessing an oil of the predominating cineol-pinene type, without containing any aromadendral or phellandrene.

(1) Maiden and Blakely: Jour. Roy. Soc., N.S.W., Vol. 59, 1925, p. 187.

EUCALYPTUS DUNDASI, Maiden.[2]

E. dundasi, known as Dundas blackbutt, is described by Kessell and Gardner.[3] The leaves are fairly leathery and thick, up to ½ inch or a little more in width and from 3 to 5 inches in length. The midrib is prominent and the veins roughly parallel and generally similar to those already described in this series (*E. Flocktoniae* and *E. Kesselli*); the submarginal vein is close to the edge of the leaf but shows the characteristic incurving common to leaves which contain cineol as a main constituent of their oil. The leaves only show minute oil glands.

The material used was collected about the middle of August, 1934, on Fitzgerald Location 930, about 2 miles west of Kumarl, near Salmon Gums, by Mr. G. H. Burvill, and it was identified by Mr. C. A. Gardner. It was obtained from vigorously growing young trees and saplings, from 10 to 20 feet in height.

The leaves were slightly mouldy near the young tips when distilled, but were otherwise in good condition. The oil distilled fairly quickly, but the yield was low, only 18 grams being obtained from 9 kilograms of material. It was pale yellow in colour and had a pleasant odour. Its density and refractive index were lower than those of *E. Flocktoniae* and *E. Kesselli* and its solubility in alcohol also less, suggesting that it contained a higher proportion of terpene, probably pinene. That the pinene present was *d*-pinene was indicated by the fairly high dextrorotation ($+ 10.65°$) of the oil. The acid value was low but the ester value was comparatively high; sufficient oil was not available to determine the acetyl value. The cineol content was 32 per cent. which would correspond to about 45 per cent. in the rectified oil. The oil gave no pronounced reaction with ferric chloride and gave no test with Schiff's reagent, showing the absence of aromadendral. The presence of aromadendrene in quantity was indicated by strong positive tests being obtained with the usual reagents.

Fractionation showed that the oil contained a high proportion of pinene, nearly 15 per cent. being volatile below 162°C.; 71 per cent. of the oil was volatile below 195°C. and from the residue the usual white insoluble material was isolated in 1.3 per cent. yield. No evidence was obtained to suggest the presence of phellandrene.

The oil of *E. dundasi* is therefore of the same type as those of *E. Flocktoniae* and *E. Kesselli*, but the smaller amount of cineol, together with the larger amount of pinene, suggest that the tree is a more primitive species. The oil is, of course, owing to its poor yield, of no commercial interest.

EXPERIMENTAL.

EUCALYPTUS KESSELLI.

The oil was distilled from the leaves within three weeks of collection, the leaves in the centres of the bags being appreciably warm from fermentive changes which had occurred. It distilled very slowly, taking some six hours to complete; 53 mils of the oil were obtained from 4 kilograms of material,

(2) Maiden: Proc. Roy. Soc., N.S.W., Vol. 49, 1915. p. 309.

(3) Kessell and Gardner: A Key to the Eucalypts of Western Australia.

representing a yield of 1·23 per cent. by weight. The oil was a pale yellowish green in colour and had a fairly pleasant odour; after drying over anhydrous sodium sulphate, it had the following properties:—

Specific Gravity*	0.9248
Refractive Index	1.4728
Optical Rotation	Nil
Acid Value	3.38
Saponification Value	9.4
Acetyl Value	79.4

The oil was soluble in 2 volumes of 70 per cent. (by weight) alcohol.

The saponification value corresponds to 3.3 per cent. of esters calculated as geranyl acetate, whilst the acetyl value corresponds to 19.2 per cent. of alcohols calculated as geraniol. The cineol content, determined by the melting point method with *o*-cresol, was 44.2 per cent.

No reaction was obtained with Schiff's reagent, showing the absence of aldehydes. An intense yellow colour was given by an alcoholic solution of the oil when tested with neutral ferric chloride, indicating the presence of phenols. A solution of the oil in glacial acetic acid gave all the usual colour reactions for aromadendrene (see Part I., p. 104).

FRACTIONATION.

100 grams of the oil were fractionally distilled at atmospheric pressure. As the liquid commenced to boil, it gradually became cloudy and finally quite opaque owing to the separation of the white insoluble substance already referred to (Part I., p. 103). The following fractions were obtained:—

1.	Up to 140°C.	1.45 per cent.
2.	From 140°—170°C.	27.7 ,, ,,
3.	From 170°—180°C.	27.6 ,, ,,
4.	From 180°—195°C.	14.9 ,, ,,
	Residue	28.35 ,, ,,

The rectified oil distilling between 140° and 195°C. made up 70.2 per cent. of the original oil and contained 64 per cent. of cineol, corresponding to 44.9 per cent. in the original oil.

Fraction 1 was pale yellow in colour and contained a small amount of water. It gave no colouration with ferric chloride and no reaction with Schiff's reagent. Its refractive index was 1.4644; there was not sufficient oil to measure the density or optical rotation.

Fraction 2 was pale greenish yellow in colour and had the following physical properties:—Specific gravity, 0.8915; refractive index, 1.4632; optical rotation, + 19.35°. It gave no reactions for phenols or aldehydes. Refractionation of the combined fractions 1 and 2 finally gave a colourless distillate, amounting to 5.4 per cent. of the original oil, distilling between 156° and 158° C.; from this fraction, pinene nitrosochloride (m.p. 104° C.) was isolable in quantity. The dextrorotation of the fraction indicates that this is present as *d*-pinene.

* All physical properties are given at 20° C. unless otherwise stated.

Fraction 3 was similar in colour to fraction 2; it had the following properties:—Specific gravity, 0.9103; refractive index, 1.4646; optical rotation, + 5.25°. No reactions were obtained for the presence of phenols or aldehydes.

Fraction 4 was practically colourless and had the following properties: —Specific gravity, 0.9346; refractive index, 1.4704; optical rotation, — 11.35°. It also gave no reactions for phenols or aldehydes.

The residue was taken up in ether, so precipitating the white insoluble compound which was filtered off, washed with a little ether, dried and weighed; the yield was 3.45 per cent. From the combined ether filtrates, the ether was removed and the residue (24.5 grams) tested for phenols, aldehydes and aromadendrene. It gave all the colour reactions for aromadendrene, gave a strong yellow colour with ferric chloride, but gave no reactions for aldehydes; aromadendral was therefore absent.

On fractionation, the residue gave 12.9 grams distilling between 96° and 140° C. at 23 mms. as a pale yellow viscous oil, of refractive index 1.4924, and 8.4 grams distilling between 140° and 163° C. at 23 mms. The second fraction was very viscous and a deep golden yellow in colour and had a refractive index 1.5020.

EUCALYPTUS DUNDASI.

The oil obtained by steam distillation of the leaves and terminal branchlets had, after drying over sodium sulphate, the following properties:—

Specific gravity	0.9075
Refractive index	1.4694
Optical rotation	+ 10.65°
Acid value	1.07
Saponification value	38.4

It was pale yellow in colour and was soluble in an equal volume of 80 per cent. alcohol. Its saponification value corresponds to 13.4 per cent. by weight of esters calculated as geranyl acetate. There was not sufficient oil available to determine the acetyl value. The oil contained 32 per cent. of cineol determined by the *o*-cresol method. It gave very little colour with ferric chloride and gave no reactions for aromadendral; strong positive reactions were obtained for aromadendrene.

FRACTIONATION.

11.3 grams of the oil were distilled at ordinary pressure and the following fractions obtained:—

1.	Up to 162° C.	14.7 per cent.
2.	From 162°-170° C.	32.4 „ „
3.	From 170°-182° C.	17.4 „ „
4.	From 182°-195° C.	6.3 „ „
5.	From 195°-230° C.	9.8 „ „
	Residue	18.6 „ „

As the oil commenced to boil, the separation of white insoluble matter was again noted; this had almost completely redissolved by the time the distillation was stopped.

Fraction 1 was colourless and had a strong pinene odour. Its refractive index was 1.4619, but there was not sufficient to measure the density or optical rotation.

Fractions 2 and 3 were very similar to one another, both being colourless and having refractive indices of 1.4601 and 1.4606 respectively. They gave no reactions for phenols or aldehydes.

Fraction 4 had a very faint yellow colour and its refractive index was 1.4642. With the preceding fraction it made up 70.8 per cent. of the original oil, a figure very close to the corresponding fractions of *E. Flocktoniae* and *E. Kesselli.*

Fraction 5 was pale yellow in colour, had refractive index 1.4752, and gave all the characteristic reactions for aromadendrene. It gave no reactions for aldehydes or phenols.

The residue (2.1 grams, representing 18.6 per cent. of the original oil) was taken up in ether and the white insoluble material filtered off and washed with ether. The amount recovered corresponded to 1.3 per cent. of the oil. After removal of the ether from the filtrate, the residue gave all the tests for aromadendrene, gave a slight colouration with alcoholic ferric chloride, but gave no reaction with Schiff's reagent.

The authors are indebted to Mr. G. H. Burvill for the collection and forwarding of the material used in these investigations and to Mr. C. A. Gardner for verifying its identity.

Perth Technical College.

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

10.—BRACHYURA OF THE HAMBURG MUSEUM EXPEDITION TO SOUTH-WESTERN AUSTRALIA, 1905,

by

PROF. DR. HEINRICH BALSS, MUNICH.

Read 13th June, 1933. Published 23rd December, 1935.

The following paper gives an account of the collections of Brachyura secured by the Hamburg Museum Expedition to the southern part of Western Australia in 1905, under the charge of Drs. W. Michaelsen and R. Hartmeyer.

The fauna of the west coast of Australia is still comparatively poorly known. We have data from Cape Jaubert (Mjoberg Collection, Stockholm), from the Monte Bello Islands (Rathbun, 1914), from Shark Bay (Miers, 1884), and from the Abrolhos Islands (Montgomery, 1931), but every further contribution to the knowledge of this territory will be welcome. I therefore give a complete list of the Hamburg Collection, which was obtained exclusively from the upper littoral ; a few infrequent forms from other Pacific localities have been added, from material belonging to the Berlin Museum (Berl. M.), Hamburg Museum (H.M.), British Museum (B.M.), and the Munich Museum (M. M.). The Hymenosomidae will be otherwise dealt with, and the representatives of *Pilumnus* and *Actumnus* are reserved for fuller treatment of these genera in the *Capita Zoologica*.

Abbreviations additional to the above include Cl (length of carapace) and Cb (breadth of carapace).

As economic conditions preclude the possibility of publication in the same series as previous reports on the collections of the same expedition (*Fauna Südwest-Australiens*), I am much indebted to the Royal Society of Western Australia for having undertaken the publication of this report ; also to Mr. E. W. Bennett for the translation into English.

TRIBE I.—DROMIACEA.

FAM. DROMIIDAE.

Genus DROMIDIOPSIS Borradaile.

Ihle 1913, p. 25.

This genus, distinguished from the closely related *Dromidia* by having epipods on the chelipeds, has hitherto included seven Indo-Pacific species, most of which are tropical. The following species is now to be added.

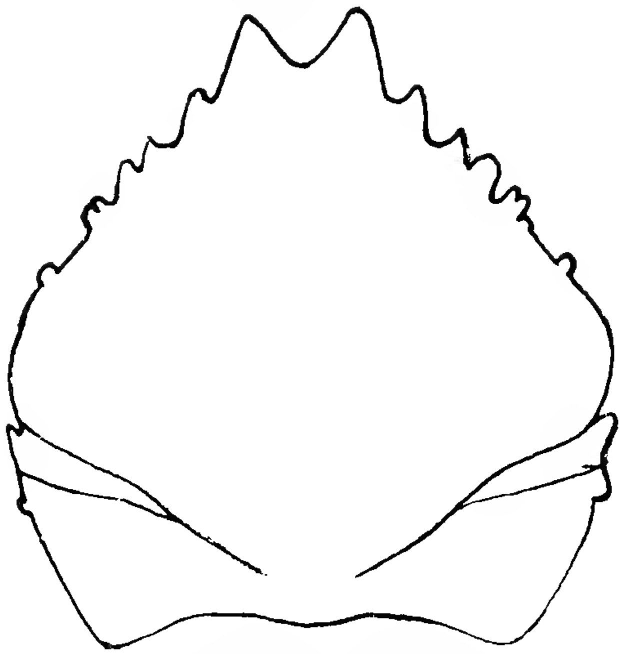
Dromidiopsis michaelseni *sp. nov.

Localities.—Fremantle District : Port Royal, Cockburn Sound, 14·5—18 m., 30/9/05 ; 2 females (type). Warnbro Sound, 12·5—14·5 m., 1 female. Shark Bay · Freycinet Estuary, 7—11 m., 1 male.

Description.—Carapace as broad as long, moderately inflated, covered with fine tomentum. Of the regional markings, only the cervical groove

* Named in honour of the collector, Dr. W. Michaelsen of Hamburg.

is distinct. The upper surface is smooth beneath the tomentum except for some tuberculations above the hepatic region.

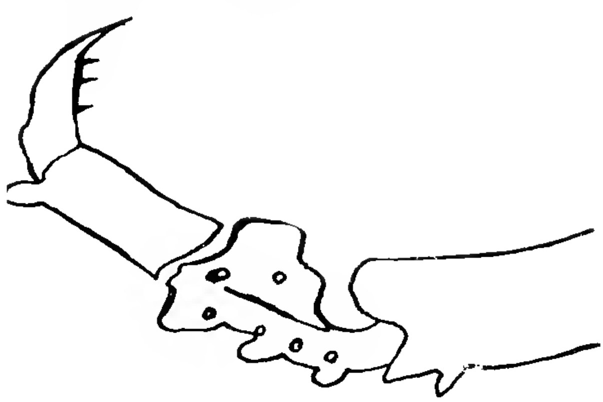


Text-fig. 1.—**Dromidiopsis michaelseni** nov. sp., outline of carapace.

The middle tooth of the front is strongly deflexed and not visible from above; the two laterals are well developed triangular lobes, fused with the supra-ocular spine. The extra- and infra-orbital spines are distinct (Text-fig. 1).

The antero-lateral margin bears five tubercles, of which the first is the largest, while the others decrease in size from before backwards; the fourth is behind the cervical groove, the fifth approximately above the insertion of the second pereiopod. The distance between the 3rd and 4th is the greatest and equals that between the 1st and 3rd.

On the under-surface there are a subhepatic tubercle, a pleural tubercle, and another at the angle of the buccal cavern. The pereiopods are tomentose. The cheliped is a little longer than the first walking leg, the carpus with about 9 tubercles on the outer side, palm with about 8. On the fingers there is a whitish strip above and below, free from hairs; the fingers are toothed and close accurately. The epipod characteristic of the genus is present. The 1st and 2nd walking legs are very characteristic; the meri end distally in a tubercle on the upper margin, the carpi have 3 tubercles on the upper edge and a carina on the outer surface, which terminates distally in a tubercle (Text-fig. 2). Between the carina and the upper edge are



Text-fig. 2.—Outline of the second walking leg (Pereiopod 3).

several other small tubercles. The propods likewise end distally in an upper tubercle, and the dactyli, in addition to the horny terminal claw, bear several small spinules on the lower margin. The 3rd walking leg (Text-fig. 3, P 4,)

Text-fig. 3.—Terminal joints of the fourth (P5) and third (P4) walking legs.

which as usual is shorter than the 4th, is armed on the propod with 5 spinules ; two are placed below, so that the more elongated dactylus can move between them, and the other three are dorsal, above the articulation of the dactylus. Equally distinctive is the armature of the 4th walking leg (Text-fig. 3, P 5) ; here also the propod bears two smaller spinules between which the dactylus can be flexed, and 3 or even 4 more terminally placed on the propod. The sternal grooves of the female end in front in a moderate tubercle between the 2nd pereiopods.

Median Cl. 22 mm.
Cb. 23 mm.

Affinities.—The sculpture of the pereiopods is especially characteristic of the species ; the form is superficially similar to that of *Cryptodromia tuberculata*, but separated by the epipods on the chelipeds.

Cryptodromia tuberculata Stimpson.

Ihle 1913, p. 35.

Locality.—Cossack ; coll. Gale (M.H.).

Distribution.—The species occurs from India to Japan and in the Malay Archipelago.

FAMILY DYNOMENIDAE.

Genus DYNOMENE Latreille.

Ihle's list of species (Ihle 1913, p. 92) should be supplemented by *D.* (*Maxillothrix*) *actaeiformis* Stebbing 1921 (cf. Odhner 1925, p. 85).

Dynomene spinosa Rathbun.

Rathbun 1911, p. 196 ; pl. 17, fig. 1.

Localities.—1 female non-ovig. (Cl. 17mm., Cb. 20 mm.) ; Marquesas Islands (M.H.).

1 juv. (Cl. 12 mm., Cb. 13 mm.) ; Palau (M.H.).

The following may be added to Miss Rathbun's description :—

Although the margin of the front is unarmed, the upper and lower margins of the orbit each bear three small spinules. On the upper surface of the carapace there are four larger spines on each side, near and dorsal to the lateral teeth, save that there is none opposite the last lateral tooth, but instead a number of sharp granules. The post-frontal lobes (2F), the hepatic region (2L), and the branchial region (5L) are also provided with a number of these large granules. On the chelipeds, the upper margin of the merus and the outer surface of the carpus, are armed with a number of sharp spines ; the inner tooth of the carpus is also a long sharp spine. On the outer surface of the palm, there are four rows of small blunt granules, hidden beneath the tomentum, and the upper surface bears two rows of three sharp spines each. The walking legs are beset with a number of large acute spines ; on the last of the larger walking legs (P4) there are four such spines on the upper margin on both merus and carpus, in addition to similar spines at the distal margin of the joint and on the under margin. The propod and dactylus on the other hand are provided with large granules only.

Distribution.—The species has been known hitherto only from Coetivy (Western India).

TRIBE II.—OXYSTOMATA.

FAM. CALAPPIDAE.

Calappa lophos (Herbst).

Alcock 1896, p. 144.

Miers 1886, p. 286.

Rathbun 1923, p. 137.

Locality.—1 male, between Geraldton and Fremantle (M.H.).

Distribution.—Tropical Indo-Pacific, from the east coast of Africa to Japan and Australia, but not further east. In Australia it has hitherto been known only fron the east coast—Port Jackson (Miers) ; Bowen, Queensland ; Sandon Bluff, N.S.W. (Rathbun)

Matuta banksii Leach.

Matuta banksii Alcock 1896, p. 158.

Matuta picta Hesse 1865, p. 158, pl. 6, fig. 13.

Haswell 1882, p. 135.

Locality.—1 male, Cossack, coll. Gale (M.H.).

Distribution.—Throughout the whole of the warmer Indo-Pacific, from the Red Sea to the Marquesas Islands. In Australia it is known from Moreton Bay, Port Jackson, Sydney. etc., but not from the south coast and, hitherto, not from the west.

Matuta planipes Fabricius.

Matuta lunaris Alcock 1896, p. 161.

planipes Rathbun 1922, p. 138.

laevidactyla Miers 1886, p. 296.

lineifera Miers 1876, p. 245, pl. 39, fig. 7.

Haswell 1882, p. 134.

Locality.—1 male, Cossack, coll. Gale (M.H.).

Distribution.—Throughout the warmer Indo-Pacific. In Australia it is known from Nicol Bay, Chowder Bay, Port Jackson, Port Inskip (Rathbun).

FAM. LEUCOSIIDAE.

Genus ACTAEOMORPHA Miers.

Miers 1876, p. 183.
Alcock 1896, p. 172.
Ihle 1918, p. 208.

An Indo-Pacific genus ; the only species hitherto known fron Australia is *A. sculpta* Haswell, originally described from Fitzroy Islands, Queensland, and recorded also by Miss Rathbun (1924, p. 25) from Cape Jaubert on the west coast.

Actaeomorpha erosa Miers.

Miers 1878, p. 184, pl. 14, figs. 1–6.
Chilton 1911, p. 555.
Bouvier 1915, p. 47, pl. 6, figs. 2, 3.
Edmondson 1925, p. 30.

Locality.—1 male juv., Shark Bay, Surf Point, $\frac{1}{2}$–$3\frac{1}{2}$ m. (M.H.).

Distribution.—Port Curtis, Queensland (Haswell), Kermadec Islands (Chilton), Ocean Island, Molokai (Hawaii) (Edmondson), Mauritius (Bouvier). Hitherto not known from the west coast of Australia.

Genus EBALIA Leach.

Alcock 1896, p. 185.
Ihle 1918, pp. 225, 310.

Of the Australian species, of which unfortunately only a little material is at my disposal, the species described by Miers (1886, p 309. pl. 25, fig. 4) from Port Jackson is undoubtedly identical with the original *E. quadridentata*, described from the same locality by Stimpson (1907, p. 155, pl. 18, fig. 6). *E. crassipes* Bell, also from Port Jackson. appears to differ only in the somewhat different chela.

Ebalia (Phlyxia) intermedia Miers.

Ebalia intermedia Miers 1886, p. 308, pl. 25, fig. 2.
Phlyxia intermedia Rathbun 1923, p. 135.
Hale 1927 (a), p. 313 ; 1927 (b), p. 198 , fig. 199.

Locality.—3 males, 2 females, Oyster Harbour (Albany district), $\frac{3}{4}$–$5\frac{1}{2}$ m. (M.H.).

Distribution.—Southern Australia, Port Phillip (Miers), Kangaroo Island (Rathbun, Hale), Oyster Bay, Tasmania (Rathbun).

Ebalia (Phlyxia) quadrata A. Milne Edwards.

(Pl. XIII., fig. 1.)

Phlyxia quadrata A. Milne Edwards 1873 (a), p. 86.
Haswell 1882, p. 125.

Locality.—1 male, Bass Strait (type ; M.H.).

As this species has not hitherto been rediscovered and as Milne Edwards has not figured it, an illustration is here provided. Milne Edwards' description is as follows (translation from German rendering) :—" The species exhibits most of the characters of *Nursia* Leach ; the outer margins of the third maxillipeds are nevertheless but slightly arched. The carapace is rhomboidal ; it is strongly elevated along the median line, and the hepatic regions are much lower than the gastric. The mesobranchial lobes are much more elevated than the epibranchial. The front extends forwards well beyond the eyes, and in the median line is curved inwards. The posterior margin bears two projections. The body and legs are covered with very fine granules, which are close together and become stronger towards the lateral margins. The male chelipeds are moderately long, fingers rather large. The 7th joint of the male abdomen bears at its base a median tooth-like projection, which fits into a notch on the 6th. Breadth of carapace 1 cm., length 1·1 cm."

Relationships.—The species is a true *Ebalia*, and has no relationships with *Nursia*.

TRIBE III.—BRACHYGNATHA.

SUPERFAMILY OXYRHYNCHA.

FAM. I. HYMENOSOMIDAE.

The representatives of this family, collected by the expedition, will be otherwise dealt with.

FAM. II.—MAJIDAE.

SUBFAM. INACHINAE Alcock.

Camposcia retusa Latr.

Alcock 1895, p. 184.

Miers 1884, p. 189.

Localities.—1 male, Useless Inlet, Shark Bay, coll. King (M.H.).
1 female, Freycinet Reach, Shark Bay.

Distribution.—A common species in the Indo-Pacific tropical littoral. It has already been recorded from Shark Bay (Miers), and is also known from the east coast (Cape Grenville and Port Denison). Not known from the south or from New Zealand.

ANACINETOPS Miers.

Anacinetops Miers 1879, p. 3.
Ortmann 1894, p. 38.

Eruma McCulloch 1913, p. 336.

The following is the only species :—

Anacinetops stimpsoni (Miers).

Eucinetops stimpsoni Miers 1879, p. 3.

Anacinetops stimpsoni Ortmann 1894, p. 38, pl. 3, fig. 2.

Paramicippa hispida Baker 1905, p. 126, pl. 24, fig. 6 (fig. poor).

Eruma hispida McCulloch 1913, p. 336, fig. 48.
Hale 1927 (b), p. 131, fig. 130.

Locality.—1 male, N.W. Australia (M.H.) : Cl. 23 m.

An examination of the literature has brought the above synonymy to light.

Distribution.—Thursday Island (Ortmann), N. coast of Australia (Miers) Port Willunga, Port Lincoln (Baker).

EPHIPPIAS Rathbun.

Rathbun 1918 (b), p. 9.

The genus is closely related to *Naxia* Latreille, and is more primitive in that the joints of the male abdomen are free, whereas in *Naxia* joints 4–6 are fused. The following is the only species :—

Ephippias endeavouri Rathbun.

Rathbun 1918 (b), p. 9, pl. 15.

McNeill 1920, p. 109.

Hale 1927 (b), p. 131, fig. 131.

Montgomery 1931, p. 416.

Locality.—1 female non-ovig., N.W. Australia (M.H.), strongly overgrown with algae.

Distribution.—Kangaroo Island, S. Australia (Rathbun), Botany Bay, N.S.W. (McNeill), Abrolhos Islands (Montgonery).

NAXIA Leach.

Naxia Leach in Latr., Encycl. Meth. Entom., X., p. 140.

Rathbun 1897, p. 157.

Hale 1927 (b), p. 127.

(*nec Naxia* H. Milne Edwards 1834, p. 313 ; see under *Paranaxia.*)

Halimus Latr., l.c., 1825, p. 700.

H. Milne Edwards 1834, p. 340.

Haswell 1882, p. 5.

Miers 1879, p. 646.

Baker 1905, p. 119.

(*nec Halimus* Rathbun 1879, p. 158 ; see under *Hyastenus.*)

The type species is *Pisa aurita* Latreille.

Not only the synonymy of the genus—for which see Calman 1913, p. 312—but also that of the various species is very involved, and I therefore quote it here, following McCulloch (1908 and 1913).

The species appear to prefer colder waters, most of them being confined to the south coast of Australia.

There is a subgenus *Microhalimus* Haswell, with a single species, *M. eflexus* Haswell.

Naxia aries (Guérin.)

Halimus aries Latreille in Guérin, Iconographie Règne animal, vol. 3, pl. 9, figs. 2, 2a–c (*sine descriptione*).
H. Milne Edwards 1834, p. 341; Atlas, Cuvier's Règne animal, pl. 28, fig. 2, 2a–c. Crustacées.

Halimus gracilis Baker 1905, p. 124, pl. 23, figs. 4, 4a.

Naxia aries McCulloch 1913, p. 337.
Rathbun 1918 (b), p. 11.
Hale 1927 (b), p. 129, fig. 128.

Distribution.—A fairly common species on the south coast of Australia, Investigator Straits, Flinders Island, Bass Strait.

Naxia aurita (Latr.).

Pisa aurita Latr., Encycl. Mèth. Entom., vol. 10, 1825, p. 140.

Halimus auritus H. Milne Edwards 1834, p. 41; Atlas, Cuvier's Règne animal, pl. 28, figs. 3, 3a–b.
Kinahan 1856, p. 117.
Ortmann 1893, p. 39.

Halimus laevis Haswell 1880, p. 435; 1882, p. 6.
Baker 1905, p. 119, pl. 21, figs. 1, 1a–c.
McCulloch 1908, p. 54.

Naxia aurita McCulloch 1913, p. 327.
Hale 1927 (b), p. 129, fig. 127.
Montgomery 1931, p. 423.

Localities.—1 male Cockburn Sound, Fremantle District, 3–4 m. (M.H.).
3 females (1 ovig.), Princess Royal Harbour, Albany District, 5½–9 m. (M.H.).
1 male, Middleton Beach, Albany District, 5½–8 m. (M.H.).

Distribution.—Commonest of the littoral Oxyrhynchs of the south coast of Australia Victoria, Port Phillip, Tasmania, D'Entrecasteaux Channel; Western Australia, King George Sound, Abrolhos Islands.

Naxia spinosa (Hess).

Halimus spinosus Hess 1865, p. 129, pl. 6, fig. 1.
Haswell 1882, p. 6.
de Man 1887, p. 691 (Haswell's specimen).
McCulloch 1908, p. 53.
Chilton 1911, p. 562.

Halimus truncatipes Miers, 1879, p. 3.
Baker 1905, p. 120, pl. 22, figs. 2, 2a.
Fulton and Grant, 1906, p. 16.

Naxia spinosa Hale 1927 (b), p. 127, fig. 125.

Localities.—1 female without eggs, Koombana Bay, Bunbury District, 14·5–18 m. (M.H.).
1 male, St. Vincent's Gulf, Zeitz coll. (M.M.).

Geographical Distribution.—Sydney, Victoria, Port Willunga, Kermadec Islands.

? *Naxia (Halimus) rubiginosus* Kirk.

Recorded from New Zealand by Filhol (1885, p. 352.)

Naxia tumida (Dana).

Halimus tumidus Dana 1852, p. 115, pl. 4, figs. 2, a–g.
Haswell 1882, p. 6.
Baker 1905, p. 121, pl. 22, fig. 3.
McCulloch 1908, p. 53.
Aurivillius 1889, pl. 2, fig. 6.

Naxia tumida Hale 1927 (b), p. 128, fig. 126.

Distribution.—Moreton Bay, Port Jackson, Port Phillip, St. Vincent Gulf ; common at Kangaroo Island.

Genus ZEWA McCulloch.

McCulloch 1913, p. 332.

The genus consists of two Australian species.

Zewa varians (Miers).

Pseudomicippe (?) *varians* Miers 1879, p. 12, pl. 4, fig. 8a.
1884, p. 97.
1886, p. 68.
Ortmann 1895, p. 40.
Calman 1900, p. 39, pl. 2, figs. 25, 26

(*nec P. varians* Rathbun 1893, p. 92 = *Micippoides longimanus, fide* McCulloch 1913, p. 334).

Zewa varians McCulloch 1913, p. 334.

Localities.—2 males, 2 females, Shark Bay—S.W. of Denham, Useless Inlet, Freycinet Estuary, 3–11 m. (M.H.).

Distribution.—Thursday Island, Torres Straits, Port Denison, Queensland ; not known from the south of Australia.

Genus PARATYMOLUS Miers.

Balss 1924, p. 24.

I have already (*l.c.*) given a list of the species and literary references. The genus is purely Indo-Pacific and occurs especially on Australian coasts, but does not occur in New Zealand.

Paratymolus latipes quadridentatus Baker.

Baker, 1906, p. 107, pl. 1, fig. 2.

Rathbun 1923, p. 95.

Hale 1927 (b), p. 123, fig. 119.

Localities.—1 female, Cockburn Sound, Fremantle district, 6·5–8 m. (M.H.).
1 female, Ponape (M.H.).

Distribution.—The forma typica—Port Denison, Port Jackson (Haswell), Newcastle Bight, Manning River (Whitelegge) ; subsp. quadridentata—south coast of Australia (Baker), Spencer Gulf (Rathbun).

SUBFAMILY ACANTHONYCHINAE.

Menaethius monoceros Latreille.

Alcock 1895, p. 197.

Hale 1929, p. 68.

Montgomery 1931, p. 417.

Localities.—Numerous specimens from Cossack, coll. Gale (M.H.).
Shark Bay—Denham, Freycinet Reach, Useless Inlet, Inner Bar, South Passage, Surf Point, Sunday Island, Browne Station (M.H.).

Distribution.—Common in the tropical Indo-Pacific, from the east coast of Africa to Paumotus. Occurring among seaweed. Australian records: Queensland, Port Denison, Prince of Wales Channel, Port Curtis, Mast Head Island, Cape York, Torres Strait; apparently absent from the south coast.

SUBFAMILY HYASTENIINAE.

Genus MICIPPOIDES A. Milne Edwards.

A. Milne Edwards 1873 (a), p. 78.

The only species is the one below; the second form, *M. longimanus* Haswell (1882, p. 19), has been removed by McCulloch (1913, p. 335) to his new genus *Tumulusternum*.

Micippoides angustifrons A. Milne Edwards.

Micippoides angustifrons A. Milne Edwards 1873 (a), p. 78, pl. 1, fig. 2.
Ortmann 1893, p. 57.
Rathbun 1911, p. 256, pl. 18, fig. 14.
Hyastenus andrewsi Calman, 1909, p. 711, pl. 72, figs. 6, 7.

Localities.—1 male, 1 female, N.E. coast of New Guinea (M.H.).

This form, as Calman remarks, effects a transition from *Hyastenus* to *Naxia*.

Distribution.—Samoa, Upolu (A. Milne Edwards), Christmas Island (Calman), Coetivy (Rathbun).

Genus HYASTENUS White.

Hyastenus White 1847, p. 56.
Miers 1879, p. 658; 1886, p. 55.
Alcock 1895, p. 206.
Calman 1913, p. 313.

Lahaina Dana 1852, p. 92.

Halimus Rathbun 1897, p. 158.
Borradaile 1903, p. 687.
Laurie 1906, p. 376.
Parisi 1915, p. 290.
Balss 1924, p. 32.
Stebbing 1908, p. 5.

Chorinus H. Milne Edwards 1834, p. 316 (*partim*).
Adams and White 1848, p. 11 (*partim*).
(nec *Halimus* Latreille, see p. 119).

(*Chorilia* Dana 1852, p. 11, is usually regarded as a synonym, but has been treated as valid by Rathbun 1925, p. 202).

As the synonymy of the genus is complicated it will be helpful to provide the following list of species :—

Hyastenus agassizii (Rathbun 1922), Maldives, Ceylon.
aries (Latr.), Singapore.
auctus Rathbun 1916, Sulu Archipelago, N.W. Austr.
biformis Rathbun 1916, Sulu Archipelago.
borradailei (Rathbun 1907), Amirante, Cape Jaubert, Funafuti.
brachichirus Nobili 1900, Beagle Bay.
brevicornis Ortmann 1894, Kilwa.
brockii de Man 1871 India, Amboina, Ternate.
calvarius Alcock 1895, India.
consobrinus A. Milne Edwards 1895 (said to be from Straits of Magellan ; according to Laurie 1906 the same as *H. spinosus* A.M.E.).
convexus Miers 1884 (= *subinermis* Zehnter 1894 = *tuberculosus* Rathbun 1916), India, N.W. Australia.
cristimanus (A. Milne Edwards 1865 ; cf. Bouvier 1906, p. 490).
? *dumerilii* (H. Milne Edwards), Polynesia.
elegans Miers 1886, Kei Islands.
elongatus Ortmann 1893, Japan, Amirante.
espinosus (Borradaile 1903), Laccadives, N.W. Australia.
fraterculus Rathbun 1916, Sulu Archipelago.
gracilirostris Miers 1879, Zanzibar, Fiji.
hilgendorfi de Man 1887, Madagascar to Hawaii.
inermis (Rathbun 1911), Seychelles, etc.
irami (Laurie 1906), Ceylon, N.W. Australia.
longipes Dana 1852, Japan, Alaska, California.
minimus Rathbun 1924, N.W. Australia.
orbis Rathbun 1916, Sulu Archipelago.
oryx A. Milne Edwards 1872, Ceylon–Australia.
ovatus Dana 1852, Amirante, Hawaii.
pehlevi (Laurie 1906), Ceylon.
planasius (Adams and White 1847), India to China, Eastern Australia.
pleione (Herbst 1803), India, etc.
scrobiculatus Rathbun 1916, Sulu Archipelago.
sebae (White 1847), Mauritius, Western Australia, Philippines.
sphenocarcinoides (Rathbun 1916), Philippines.
spinosus A. Milne Edwards 1872, Mozambique, Fiji.
tenuicornis Pocock 1890, Red Sea–Hawaii.
tinaktensis Rathbun 1916, Sulu Archipelago.
trispinosus Rathbun 1916, Sulu Archipelago.
uncifer Calman 1909, Cape of Good Hope to Christmas Island.
verrucosipes (Adams and White), Torres Strait.

Hyastenus oryx A. Milne Edwards.

Alcock 1895, p. 214.
Calman 1900, p. 35.
Rathbun 1914, p. 661.

Localities.—Shark Bay–Freycinet Reach, Browne Station, South Passage, 3·5–9 m. (M.H.).
Mactan Islands (M.H.).
Cockburn Sound, Fremantle district, 14·5–18 m. (M.H.).

Distribution.—Common in the tropical Indo-Pacific; Ceylon to the Philippines and China. Torres Strait (Calman), Thursday Island (Miers), Port Molle, Port Denison (Miers), Darnley Island (Haswell), Prince of Wales Channel (Miers), Monte Bello Islands (Rathbun), Shark Bay (Miers). Not known from the south coast.

Hyastenus convexus Miers.

Miers 1884, p. 196, pl. 18, fig. B.
Henderson 1893, p. 344.
Calman 1900, p. 35.
de Man 1902, p. 664, pl. 22, fig. 32.
Borradaile 1903, p. 687.
Grant and McCulloch 1906, p. 32.
Rathbun 1918, p. 15; 1924, p. 3.
(Laurie 1906, p. 377, var. *hendersoni*).

Locality.—1 female, Onslow, Gale coll. (M.H.).

Distribution.—India, Suadive Atol, Ternate, Torres Strait, Queensland, Port Curtis, Masthead Island, Port Molle, Western Australia, Cape Jaubert. Not on the southern Australian coast.

SUBFAMILY MAJINAE.

Genus SCHIZOPHRYS H. Milne Edwards.

Schizophrys aspera H. Milne Edwards.

Alcock 1895, p. 243; Illustrations *Investigator*, pl. 35, fig. 1.
Calman 1900, p. 39.
Rathbun 1918, p. 25; 1924, p. 6.
Hale 1927 (b), p. 134, fig. 139.

Locality.—1 female ovig., Western Australia (no further data), (M.H.).

Distribution.—Common from the Red Sea to Japan and Funafuti. In Australia it is known from Torres Strait (Calman), Cape Jaubert (Rathbun), South Australia (Hale), Spencer Gulf (Rathbun).

Schizophrys dama (Herbst).

Miers 1884, p. 197; 1886, p. 67.
Alcock 1895, p. 245; Illustrations *Investigator*, pl. 35, fig. 2.
Rathbun 1914, p. 662; 1924, p. 6.

Localities.—Onslow, Gale coll. (M.H.).
Heirisson Prong, Useless Inlet, Shark Bay (M.H.).
Between Geraldton and Fremantle.

Many of the specimens are covered with the Hydroid *Corymorpha* (*Euphysa*) *balssi* Stechow.

Distribution.—Straits of Malacca (Alcock); Western Australia—Shark Bay (Miers), King George Sound, Monte Bello Islands (Rathbun), Cape Jaubert (Rathbun).

It is therefore distinctively a western species in Australia, and in contrast to Montgomery (1913, p. 420) I consider the above two species as distinct, on the grounds that their distribution is different.

Cyclax suborbicularis (Stimpson).

Alcock 1895, p. 245.
Calman 1900, p. 39.
Stimpson 1907, p. 18, pl. 4, fig. 1.
Hale 1929, p. 68.
Montgomery 1931, p. 419.

Locality.—1 female with eggs, Surf Point, Shark Bay, 0·5–3·5 m.

Distribution.—From the Red Sea and Zanzibar to Rotuma. In Australia it has hitherto been known only from Dirk Hartog Island, W.A., (Hale), and from the Abrolhos Islands (Montgomery).

Genus LEPTOMITHRAX Miers.

Balss 1929, p. 19 (list of species).

Leptomithrax Sternocostulatus (H. Milne Edwards).

Paramithrax sternocostulatus H. Milne Edwards 1851, p. 291 (name only); pl. X, figs. 3, 4.
Miers 1879, p. 9.
Grant and McCulloch 1906, p. 28, pl. 3, figs. 2, 2a.
gaimardii Miers 1876 (b), p. 6.
Leptomithrax sternocostulatus Rathbun 1918, p. 22.
Hale 1927 (b), p. 137, fig. 137.

Locality.—1 female, Sunday Island, Shark Bay, 5·5 m. (M.H.).

Of the sternal excavations, which are so characteristic of the male, the female possesses only four small ones on the anterior segment; two are larger and transversely oval, and the other two in front, smaller, and triangular.

Distribution.—New Zealand, Masthead Island, Queensland, Port Jackson, Port Phillip, Kingston (S.A.), Kangaroo Island.

Leptomithrax cf. spinulosus Haswell.

Rathbun 1918, p. 20, pl. 9 (refs.).

Locality.—1 male, Cl. 14 mm., Oyster Harbour (Albany district), 5·5 m. (M.H.).

I have unfortunately not seen Haswell's original description of 1880, but Miss Rathbun's key leads to this species. In the specimen examined, however, there are only three instead of four spines on the branchial region, and the last of these is inserted well up on the carapace. The under surface is not hairy; the swellings at the junction on the merus and ischium of the third maxillipeds are distinctly developed on both sides, and the distal spine on the outer edge of the ischium. The palm of the chela is longer than the carpus.

Perhaps this species belongs to *L. australiensis* Miers (Tasmania), of which an adequate description is still required.

Distribution.—*L. spinulosus* is known from New South Wales to Tasmania; Kingston, Kangaroo Island, Eucla, King George Sound.

Genus ACANTHOPHRYS (H. Milne Edwards).

Balss 1929, p. 19 (synonymy).

Acanthophrys aculeatus (H. Milne Edwards).

Chorinus aculeatus H. Milne Edwards 1834, p. 316.
Lanchester 1900, p. 724.

Paramithrax aculeatus var. *armatus* Miers 1884, p. 193, pl. 18, fig. A.
Alcock 1895, p. 241.
Calman 1900, p. 38.

Chlorinoides aculeatus Henderson 1893, p. 345.
Rathbun 1910, p. 318 ; 1924, p. 5.

(*nec Acanthophrys aculeatus* A. Milne Edwards 1865, pl. 4, fig. 4 ; = *A. spatulifer* Haswell, *fide* Bouvier 1906, p. 488).

Localities.—(a) 1 female, non-ovig., Cl. 25 mm. (Rostrum and spine of posterior margin missing) ; Lacepede Islands, N.W. Australia. With the Ascidian *Botrylloides niger* Herdman on the back (M.H.).

(b) 1 female juv., Cl. 15·5 mm. ; Dzushi, Sagami Bay, Japan, 110 m. ; Doflein collection (M.M.).

(c) 1 female ovig., Cl. 38 mm., Gulf of Siam, near mouth of the Menam ; coll. Spraeter (M.M.).

Remarks.—Specimens *a* and *c* agree in that there are only two spines on the orbital edge, and the meri of the walking legs are armed with two spines ; specimen *b* from Japan, however, has three orbital spines, and the walking legs have only one spine on the merus. The latter characteristic is typical of the species, while two spines on the merus are described for the variety *armatus* Miers. I am unable to say, however, what the number of spines may be on the orbit of the typical form.

Specimen *b* agrees in the condition of the orbit with *A. longispina* de Haan, so that it may be the young stage of this species ; but in that case the young stage has only one cardiac spine, in contrast to the two of the adult.

Distribution.—Gulf of Martaban (Henderson), Ceylon (Alcock), Singapore, Malacca (Lanchester), Mergui Archipelago (Alcock), Gulf of Siam (Rathbun), Torres Strait (Calman), Thursday Island (Miers), Port Curtis, Queensland (Miers), Cape Jaubert (Rathbun). Not previously recorded from Japan.

SUBFAMILY MITHRACINAE.

Micippa philyra Leach.

Miers 1884, p. 198.
Alcock 1895, p. 249.
Montgomery 1931, p. 423.

Locality.—1 female, Useless Inlet, Shark Bay, coll. King (M.H.).

Distribution.—From the Red Sea to Australia ; on the west coast it is known from Broome, Abrolhos (Montgomery), and Shark Bay (Miers) ; the var. *nodulifera* Baker occurs on the south coast, but is rare.

Micippa thalia Herbst.

Miers 1884, p. 251.

Alcock 1895, p. 198.

Locality.—1 female, Moreton Bay, Queensland.

Distribution.—From the Red Sea to New Caledonia; in Australia it is known from the Swan River (Miers) and Queensland (Miers).

SUBFAMILY MACROCOELOMINAE.

Genus PARANAXIA Rathbun.

Naxia H. Milne Edwards 1834, p. 313 (*nec Naxia* Leach).
Haswell 1882, p. 20.
Ortmann 1894, p. 42 (*partim*).
Paranaxia Rathbun 1924, p. 6.
Balss 1929, p. 22.

The following is the only species:—

Paranaxia serpulifera (Guérin).

Pisa serpulifera Guérin, Iconographie, Crustacées, pl. 8, fig. 2.
Naxia serpulifera H. Milne Edwards 1834, p. 313.
Haswell 1882, p. 21.
Miers 1884, p. 196.
Ortmann 1894, p. 43.
Calman 1900, p. 37.

Naxioides serpulifera Rathbun 1914, p. 661, pl. 2, figs. 9, 10.
Paranaxia serpulifera Rathbun 1924, p. 7.

Localities.—1 female, Barrow Islands (Cl. 103 mm. exclusive of rostrum). 1 male (Cl. 82 mm.), 1 male (Cl. 47 mm.), 2 small males; Useless Inlet, Shark Bay, coll. King (M.H.).

Distribution.—Torres Strait, Thursday Island, Port Essington, Raffles Bay, Cape Jaubert, Monte Bello Islands, Shark Bay. Nor known from southern Australia.*

III.—FAMILY PARTHENOPIDAE.

Genus LAMBRUS. Leach.

Lambrus Alcock 1895, p. 259.

Parthenope Weber; Rathbun 1925, p. 511.

Subgenus PLATYLAMBRUS Stimspon.

Lambrus (Platylambrus) validus (de Haan).

Lambrus validus Bleeker 1856, p. 17.
Gersteacker 1856, p. 117.
Balss 1922, p. 134 (refs.).
Flipse 1930, p. 92.

*This fine crab is not rare in South-Western Australia.—Ed.

Locality.—1 male (Cl. 37 mm.), Bowen, Queensland, on corals (M.H.).

Contrary to the rule among the Parthenopidae, this specimen has not a naked carapace, but is covered by three large Lamellibranch shells.

Distribution.—Japan, Korea, China, Singapore, Sumatra (Padang), Torres Strait, Samoa. New for Australia.

Subgenus RHINOLAMBRUS A. Milne Edwards.

Rhinolambrus pelagicus (Ruppell).

Alcock 1895, p. 267.
Rathbun 1914, p. 663.

Locality.—1 female, juv., Shark Bay, near Browne Station, 2·5 mm. (M.H.).

Distribution.—Tropical Indo-Pacific, from the east coast of Africa to Samoa. Not known from the south coast of Australia.

Genus THYROLAMBRUS Rathbun.

Thyrolambrus Rathbun (1894) 1925, p. 531.
Parthenomerus Alcock 1895, p. 280.
Parthenopoides Miers 1879 (*partim*) in Bouvier 1915, p. 52.
Flipse 1930, p. 93.

The type of the subgenus *Parthenopoides* Miers (1879, p. 762) is *Lambrus massena* Roux, which, however, belongs to the subgenus *Pseudolambrus* Paulson 1875, which was founded four years previously. *Parthenopoides* accordingly becomes a synonym of *Pseudolambrus*, and can not, as Bouvier would have it, be used, according to the international rules of nomenclature, for other species. Bouvier's two species *Parthenopoides erosus* Miers and *P. cariei* Bouvier therefore belong to the genus *Thyrolambrus* Rathbun. But since the name *Thyrolambrus erosus* Miers 1879 has priority over *Thyrolambrus erosus* Rathbun, I propose the following new name :—

Thyrolambrus rathbunae nom. nov.

New name for *T. erosus* Rathbun, not of Miers.

Thyrolambrus careie (Bouvier), new combination.

Parthenopoides careie Bouvier, 1915, p. 55, text-fig. 20, pl. 7, fig. 6.

Locality.—1 male, Cl. 15·5 mm., Cb. 21 mm. ; Palau (M.H.).

Distribution.—Hitherto known only from Mauritius.

Genus ZALASIUS Rathbun.

Trichia de Haan ; Balss 1922, p. 100.

Zalasius McNeill and Ward 1930, p. 374 (refs.).

I agree with Hale and with McNeill and Ward as to the location of this rare genus in the Lambridae. Among the four specimens belonging to the genus available to me, at least two forms are separable, of which that from Nagasaki, Japan, belongs to *Z. dromiaeformis*, the type species of the genus ; the other I refer to Baker's species, and therefore recall my opinion as previously published that *P. australis* is the juvenile form of *P. dromiaeformis*.

Zalasius australis (Baker).

Trichia australis Baker 1906, p. 115, pl. 3, figs. 1, a–b.

Trichia dromiaeformis australis Hale 1927, p. 142, fig. 145.

Localities.—1 male, Western Australia (no further data) (M.H.).

1 female, Timor (Dresden Museum, the specimen referred to by Thallwitz 1892, p. 54 ; Cl. 30 mm., Cb. 40 mm.).

1 female, Nossy Bé, Madagascar ; Cl. 30 mm., Cb. 41 mm. (M.H.).

These specimens agree with the Japanese specimen in the strong covering of hairs on the carapace and legs, but differ from it in the following characters :—

(1) The two strong tubercles on the first abdominal segment, which are distinctive of *Z. dromiaeformis* (cf. McNeill and Ward 1930, pl. 59, fig. 7) are quite lacking ; yet the specimens agree approximately in size with the Japanese specimen.

(2) The granulation of the carapace and especially of the abdomen is uniform in size, whereas in *Z. dromiaeformis* there are larger tubercles covered with granules.

(3) The conical projections of the palm and carpus of the cheliped are only weakly developed, whereas in *Z. dromiaeformis* they are pronounced.

I consider therefore that Baker's form is a good species and is not merely a subspecies of *Z. dromiaeformis*, as Hale and McNeill and Ward treat it.

The specimen from Madagascar is somewhat different again. The hair on the carapace is not evenly developed, but rather tends to be grouped into tufts. The margin of the carapace moreover is divided by three notches into four lobes, which project below as strongly granulated lobules. Perhaps this represents yet another species.

Distribution.—*Z. dromiaeformis* has hitherto been known from Japan and from Port Denison, Queensland (McNeill and Ward) ; *Z. australis* is known from Port Willunga (South Australia), and now from the above-mentioned localities—Timor, Western Australia, and Madagascar, and therefore cannot be regarded, as Hale has regarded it, as a southern equivalent of *Z. dromiaeformis.*

SUBTRIBE BRACHYRHYNCHA.

Family PORTUNIDAE.

Genus NECTOCARCINUS A. Milne Edwards.

The genus is limited to Australia, New Zealand, and South America. Of the four species, *N. bullatus* (Balss 1923) occurs at Juan Fernandez, *N. antarcticus* (Jacq. and Lucas) in New Zealand, Auckland and Chatham Islands, *N. tuberculosus* A.M.E. in Tasmania and South Australia, and *N. integrifrons* Latr. in the east, south, and west of Australia. The species are therefore fairly distinct in their distribution. Whether this is due to ecological factors, or whether they have but limited powers of swimming as compared with the other members of the family, is a point yet to be determined.

Nectocarcinus integrifrons (Latr.).

Haswell 1882, p. 81 (refs.).
Miers 1884, p. 234.
Filhol 1885, p. 383.
Rathbun 1923, p. 130.
Hale 1927 (a), p. 311 ; 1927 (b), p. 152, fig. 153.
Chilton and Bennett 1929, p. 753.

Localities.—1 female ovig. (Cl. 42 mm., Cb. 53 mm.), Port Royal, Cockburn Sound (Fremantle District) ; pelagic ; with thick tomentum over the carapace.
3 males, 1 female, Warnbro' Sound, Fremantle District ; 12·5–14·5 m. (M.H.).

Distribution.—South Australia (common in St. Vincent's Gulf—Hale), Kangaroo Island ; East Australia—Port Curtis, Port Jackson, Port Phillip (Miers) ; doubtful in New Zealand (Chilton and Bennett) ; new for Western Australia.

Genus NEPTUNUS De Haan.

Alcock 1899, p. 28.

The edible Blue Crab, *N. pelagicus* (L.), is known to be one of the commonest forms of the Indo-Pacific. The closely related *N. sanguinolentus* (Herbst) has an equally wide distribution, but is not so abundant. In Australia the latter species is known from the south coast (Hale 1927 *b*, p. 150) and from the east coast (Port Jackson, Moreton Bay), but not from the west ; nor is it represented in the present collection.

Neptunus pelagicus (L.).

Alcock 1899, p. 34.
Whitelegge 1900, p. 154.
Rathbun 1923, p. 130 ; 1924, p. 22.
Hale 1927 (b), p. 149, fig. 150.
Chilton and Bennett 1929, p. 752.
Montgomery 1931, p. 427.

Localities.—Barrow Island (M.H.).
Freycinet Reach, Denham (Shark Bay) (M.H.).
Warnbro' Sound, Swan River (Fremantle District) (M.H.).

Distribution.—Throughout the Indo-Pacific, but not on the west coast of America ; known already from Western Australia—Swan River, Shark Bay (Miers 1884), Broome (Rathbun 1924), Abrolhos (Montgomery 1931) ; also in South Australia (common in the Adelaide markets—Hale 1927 *b*), and eastern Australia. Not known from Tasmania, and doubtful in New Zealand (Chilton and Bennett).

Genus THALAMITA Latr.

A genus rich in species, and Indo-Pacific in distribution (one species on the west coast of Africa) ; not occurring on the west coast of America. In addition to those recorded below, the following are known from the Western Australian coast :—

T. crenata Ruppell ; Broome (Rathbun 1924).
T. dispar Rathbun ; Monte Bello Islands.
T. admete savignyi A. Milne Edwards ; Nicol Bay (Miers 1884).
T. macropus Montgomery ; East Wallaby Island.
T. dakini Montgomery ; Abrolhos Islands.

Thalamita stimpsoni A. Milne Edwards.

Haswell 1882, p. 80.
Miers 1884, p. 352.
Ortmann 1894, p. 46.
Grant and McCulloch 1906, p. 18.

Localities.—1 female (Cl. 37 mm., Cb. 58 mm.), Turtle Island, 19° 54′ S., 118° 54′ E., coll. Gale (M.H.).
Shark Bay—Browne Station, Denham, Useless Inlet (M.H.).

Distribution.—From the Red Sea to New Guinea and the Philippines, Samoa. In Australia known hitherto only from the east and north coasts—Port Molle, Port Denison, Port Curtis, Thursday Island. Not occurring in New Zealand.

Thalamita intermedia Miers.

Miers 1886, p. 196, pl. 16, fig. 1.
Ortmann 1894, p. 46.
Rathbun 1924, p. 24.
Hale 1927 (b), p. 151, fig. 152.

Locality.—1 female non-ovig. (Cl. 23 mm., Cb. 36 mm.), Onslow ; coll. Gale (M.H.).

The last antero-lateral spine exceeds the others in length.

Distribution.—The distribution is limited ; Torres Strait (Miers), Thursday Island (Ortmann), Cape Jaubert (Rathbun), Great Australian Bight (Hale), ? Ceylon (Alcock 1899, p. 89).

Thalamita integra Dana.

Alcock 1899, p. 85.

Locality.—1 male, Surf Point, Shark Bay ; 0·5–3·5 m. (M.H.).

Distribution.—Warmer Indo-Pacific, from the Red Sea and the Seychelles to the Hawaiian and Paumotu Islands. Not known from New Zealand, and hitherto not from Australia.

Thalamita sima H. Milne Edwards.

Haswell 1882, p. 80.
Miers 1884, p. 231 ; 1886, p. 195.
Grant and McCulloch 1906, p. 19.
Rathbun 1924, p. 24.
Hale 1927 (b), p. 151.
Chilton and Bennett 1929, p. 755.
Montgomery 1931, p. 430, pl. 29, fig. 2.

Localities.—Shark Bay—Brown Station, Heirisson Prong, Useless Inlet, Denham, Freycinet Reach (M.H.).
Fremantle District—Cockburn Sound, Warnbro Sound, near Fremantle (M.H.).

Distribution.—In the whole of the warmer Indo-Pacific, from East Africa to Hawaii. On the east coast of Australia it is known from Queensland to Port Jackson ; also south coast (Challenger). On the west coast : Cape Jaubert (Rathbun), Shark Bay, Swan River (Miers), Abrolhos Islands (Montgomery). Recorded from New Zealand, but authenticity doubtful (Chilton and Bennett).

FAMILY ATELYCYCLIDAE.

Kraussia nitida Stimpson.

Balss 1922, p. 98 (refs.).

Kraussia hendersoni Montgomery 1931, p. 433.

Localities.—Surf Point, Shark Bay ; 1 female, f.o.b. 9 mm., Cb. 14 mm.; 1 male, f.o.b. 7 mm., Cb. 11 mm.

Inner Bar, Shark Bay ; 1 female, f.o.b. 6 mm., Cb. 11 mm. (M.H.).

South Passage, Shark Bay ; 1 female, f.o.b. 7 mm., Cb. 13 m.m.

In the above measurements the first figure refers to the fronto-orbital breadth, the second to the maximum breadth of the carapace. Since the distinction between *K. nitida* and *K. hendersoni* depends on the ratio between the two, it may be pointed out that in the above specimens it varies from 0·53 : 1 to 0·64 : 1, so that the two species merge together.

Distribution.—(1) *K. nitida* : Ceylon, Maldives, Gulf of Siam, Thursday Island, Japan, China Sea. (2) *K. hendersoni* : Coast of eastern India, Andamans, Samoa, Japan, Abrolhos Islands.

Family XANTHIDAE Alcock.

The interrelationships of the various genera and groups of this large family are still very obscure, so that we are still far from a natural arrangement. I shall only remark here that I regard those forms with a four-lobed or four-toothed rostrum as more primitive than those with only two lobes, and that I attach considerable importance to the structure of the copulatory organs, especially of the second pair. The absence of palatal ridges is to be taken as more primitive than their presence, the ridges representing an adaptation to sedentary and perhaps burrowing habits whereby the exhalant passage for the respiratory current is furnished with a more precise boundary. Further primitive characters within the group are the shortness and mobility of the first joint of the antenna, and the seven-jointed condition of the male abdomen.

The two major subdivisions of Alcock, separated by the presence or absence of endostomial ridges, are provisionally admitted here, although in the Section Hyperomerista, which includes the forms provided with such ridges, there are various genera and species which do not possess them. Yet these genera (*Heteropilumnus*) are so close to the others in appearance that I, nevertheless, include them in the Hyperomerista.

Section I.—HYPEROLISSA Alcock.

Alcock 1898, p. 77.

Genus XANTHO Leach.

Odhner 1925, p. 79.

Xantho (*Leptodius cavipes* (Dana).

Alcock 1898, p. 122.
Rathbun 1911, p. 216, pl. 18, fig. 10.
Calman 1909, p. 704.

Locality.—Pearl Bank, Useless Inlet, Shark Bay ; 0·3–5 m. (M.H.).

Distribution.—Western Indo-Pacific. Red Sea, Zanzibar, Peros, Ceylon, Andamans, Mergui Archipelago, Penang, Bonin Islands, Christmas Island, Palau Berhala. New for Australia.

Xantho (Leptodius) exaratus Milne Edwards.

Miers 1884, p. 214.
Alcock 1898, p. 118.
Grant and McCulloch 1906, p. 10.

Locality.—Cossack (M.H.).

Distribution.—The usual form in the warmer Indo-Pacific. Known from Australia already, though from a few spots only ; Port Curtis, Port Molle (Miers), Shark Bay (Miers) ; not on the south coast.

Xantho danae Odhner.

Chlorodius nudipes Dana 1852, p. 209, pl. 11, fig. 12.

Leptodius nudipes A. Milne Edwards 1873 (b), p. 225
Miers 1876 (b). p. 17.
Filhol 1885, p. 374.
de Man 1887, p. 33 ; 1895, p. 521.
Alcock 1898, p. 121.
Borradaile 1902, p. 252.
Rathbun 1906, p. 848, pl. 9, fig. 3 ; 1911, p. 216.
Lenz 1910, p. 548.
Bouvier 1915, p. 105.
Gravier 1920, p. 466.
Sendler 1923, p. 37.
Chilton and Bennett 1929, p. 747.

Xantho exaratus nudipes Ortmann 1893, p. 447.

Xantho danae Odhner 1925, p. 80.

Localities.—Shark Bay, Denham and Smith Island; on the beach (M.H.).

Remarks.—This species should not be confused with *Xantho nudipes* A. Milne Edwards from New Caledonia, Kermadec Islands, etc. I therefore provide the above synonymy in the light of Odhner's investigations.

Distribution.—Madagascar (Lenz, Gravier), Andamans (Alcock, de Man), Peros (Rathbun), Laccadives (Borradaile), Mauritius (Bouvier), Celebes (de Man), Mangsi Islands, China (Dana), New Caledonia (A. Milne Edwards), Palau Islands (Sendler), Hawaii (Rathbun), Carolines (Ortmann). The record from Cook Strait, New Zealand, is questioned by Chilton and Bennett. New for Australia.

Etisus anaglyptus Milne Edwards.

Haswell 1882, p. 55.
Balss 1924, p. 11.

Locality.—1 male, Port Denison, Queensland ; Cl. 30 mm., Cb. 55 mm. (M.H).

Distribution.—Throughout the Indo-Pacific, from the Red Sea to Samoa, Rotuma. Recorded from Australia only by Haswell, who does not specify the locality.

Genus PARAPANOPE de Man.

Parapanope de Man 1895, p. 514.

Hoploxanthus Alcock 1898, p. 125.

The generic name is most unfortunately chosen, as there is no relationship with *Panopeus*; the affinities are rather, as Alcock justly points out, in the neighbourhood of *Xantho* and *Halimede*. Endostomial ridges are completely lacking.

Parapanope euagora de Man.

Parapanope euagora de Man 1895, Vol. IX., p. 514, pl. 12, fig. 4.
Lanchester 1900, p. 737.
Rathbun 1929. p. 100.

Hoploxanthus hextii Alcock 1898, p. 126; Illustrations *Investigator*, pl. 37, fig. 1.
(cf. de Man 1902, p. 595, note.)

Locality.—1 female ovig. (Cl. 11 mm., Cb. 14·5 mm.); Fuchau, China; coll. Siemsen (M.H.). Compared with the type.

Distribution.—Eastern coasts of India, Nicobars (Alcock); Malacca (Lanchester); Java Sea (de Man); China-Tsimei, Amoy, Liuwutien.

Genus XANTHIAS Rathbun (*sensu stricto*).

Odhner 1925. p. 84.

Xanthias lamarcki (H. Milne Edwards).

Xanthodes lamarcki Alcock 1898. p. 157 (refs.).
Grant and McCulloch 1906, p. 12.
Chilton 1911, pp. 44, 556.

Xanthias lamarcki Hale 1929, p. 69.

Locality.—1 female, Surf Point, Shark Bay, 0·5–3·5 m.... (M.H.).

Distribution.—Throughout the warmer Indo-Pacific, from Mozambique to Polynesia. Rare in Australia; Masthead Island, Queensland (Grant and McCulloch), Kermadec Islands (Chilton), not on the south coast; Dirk Hartog Island, west coast (Hale).

Genus PARAXANTHIAS Odhner.

Odhner 1925, p. 85.

Paraxanthias elegans (Stimpson.)

Xanthodes elegans Stimpson 1858, p. 33; 1907, p. 47, pl. 5, fig. 3.
atromanus Haswell 1882, p. 49, pl. 1, fig. 1.
Grant and McCulloch 1906, p. 12; 1907, p. 151.
Rathbun 1914, p. 659.

Paraxanthias elegans Odhner 1925, p. 84.
Montgomery 1931, p. 441.

Xanthias elegans Hale 1929, p. 69.

Localities.—Shark Bay—Surf Point, Inner Bar, South Passage, Sunday Island ; upper littoral (M.H.).

Distribution.— Simoda, Japan (Stimpson), Norfolk Island (Grant and McCulloch), Monte Bello Islands (Rathbun), Dirk Hartog Island (Hale), Abrolhos Islands (Montgomery).

Paraxanthias ? ponapensis (Rathbun).

(Pl. XIII., Fig. 2.)

Xanthias ponapensis Rathbun 1907, p. 44, pl. 7, figs. 5, 5a.

Locality.—1 female (Cl. 21 mm., Cb. 32 mm.), Manus Island, Admiralty Islands ; L. Cohn coll. (M.M.).

Description.—I refer the present species with some hesitation to Miss Rathbun's species, which was described from only a small specimen (Cl. 6·5 mm., Cb. 9·7 mm.).

The upper surface of the carapace is smooth and without granules ; the grooves are sharply impressed, and resemble in their arrangement those of *Xanthias* (*Eudora*) *tetraodon* Heller. In colour it is yellowish, sprinkled with red dots. The front has two middle lobes, rounded and moderately projecting, and two lateral lobes, which are small and pointed, and are distinctly separated from the upper orbital margin by a furrow. On the upper orbital margins the grooves and the extraorbital tooth are not pronounced, but the inner tooth on the under margin projects distinctly. The antero-lateral margin is thick, the first two teeth are small tubercles, the hinder project distinctly as blunt spines.

The chelipeds are somewhat unequal, the left being the larger ; in both the upper surface of the carpus and palm is quite smooth. Both palms have a furrow arising from the upper carpal articulation. The fingers are fairly strong, the inner tooth is only small and flat, so that the fingers can completely close ; they are black in colour except for the whitish tips ; the colour ceases at the palm by an oblique line.

The legs are strongly haired along the margins ; the meri have no teeth along the upper edge.

The present specimen differs from Rathbun's description in the lack of granules on the carapace and chelae and of spines on the meri of the walking legs. I regard it as the adult stage of the same species.

Affinities.—On account of the structure of the front the species must be referred to the genus *Paraxanthias* Odhner.

Distribution.—Hitherto known only from Papete (Tahiti).

Genus CARPILODES Dana.

Odhner 1925, p. 8.

Carpilodes hartmeyeri Odhner.

Ohdner (*l.c.*) has described *C. hartmeyeri* as a new species, from material collected at Shark Bay by the Hamburg Expedition to S.W. Australia.

Genus ACTAEA de Haan.

Odhner 1925, p. 35.

From the material secured by the expedition, Odhner has described :—

A. michaelseni Odhner (as n. sp.) ; Browne Station, Shark Bay ; also recorded by Hale (1929, p. 69) from Dirk Hartog Island.

A. savignyi Milne Edwards ; Shark Bay.

A. peroni occidentalis Odhner (as nov. subsp.) ; Koombana Bay, Bunbury, and Oyster Harbour, Albany District.

A. areolata Dana ; Turtle Island, N.W. Australia.

Actaea scabra Odhner.

Odhner 1925, p. 37, pl. 2, fig. 18.

Localities.—1 female, Cl. 34 mm., Cb. 46 mm. ; Marquesas Islands (M.H.).
1 female, Cl. 25 mm., Cb. 37 mm., Port Denison (M.H.).

Remarks.—Is not this the adult stage of *A. depressa* White ? Or is there a sexual dimorphism, *depressa* representing the male and *scabra* the female ? The occurrence of both forms in the same locality (Marquesas) adds point to the suspicion that the two should be united.

Actaea depressa (White).

Odhner 1925, p. 38, pl. 2, fig. 19.

Locality.—1 male (Cl. 26 mm., Cb. 32 mm.) ; Marquesas Islands (M.H.).

Distribution.—Hitherto known from Natal, Mergui Islands, Andamans, Philippines, Bonin Islands ; the subsp. *abrolhensis* Montgomery 1931 comes from the Abrolhos Islands, Western Australia.

Actaea calculosa Milne Edwards.

Actaea calculosa Haswell 1882, p. 45.
Grant and McCulloch 1906, p. 11.
Rathbun 1923, p. 10 ; 1924, p. 17.
Odhner 1925, p. 52.
Hale 1927 (a), p. 311 ; 1927 (b), p. 159.
Montgomery 1931, p. 437.

Euxanthus tuberculosus Miers 1884, p. 205, pl. 19, fig. A.

Localities.—Barrow Island (M.H.).
Shark Bay (M.H.).
Cockburn Sound, Fremantle District (M.H.).

Distribution.—Red Sea to Tahiti. In Australia known from the east coast (Sydney, Port Curtis, Port Denison), from the south (Adelaide, Kangaroo Island, Cape Jervis, Spencer Gulf), west (Holothuria Bank), north (Torres Strait), and from the Abrolhos Islands.

Genus ATERGATOPSIS A. Milne Edwards.

Klunzinger 1913, p. 153 (refs.).

On account of the arrangement of the antennal joints the genus comes nearest to *Neoliomera*.

Atergatopsis signata (Adams and White).

Carpilius signatus Adams and White 1848, p. 37, pl. X., fig. 1.
Atergatopsis signata A. Milne Edwards 1865 (a), p. 253.
Hilgendorf 1878, p. 787.
Rathbun 1911, p. 214, pl. 17, fig. 7.
Klunzinger 1913, p. 154, pl. 5, figs. 8, 8 a–b.
Bouvier 1915, p. 114.
Balss 1924, p. 6.
Atergatopsis flavomaculatus A. Milne Edwards 1865 (a), p. 254, pl. 12, fig. 1.
Lenz 1905, p. 349; 1910, p. 546.
Atergatis frauenfeldi Heller 1861, p. 311, pl. 1, fig. 10.
Atergatopsis frauenfeldi A Milne Edwards 1865 (a), p. 258.
Nobili 1906 (b), p. 234.

Locality.—1 male (Cl. 62 mm., Cb. 90 mm.), reputably from Sydney (M.H.).

Distribution.—Hitherto known only from the western part of the Indo-Pacific; Red Sea, Mozambique, Island of Europe, Coetivy, Pondicherry, Mauritius.

Atergatopsis lucasii Montrouzier.

Atergatopsis Lucasii Montrouzier 1865, p. 160.
A. Milne Edwards 1865 (a), p. 256, pl. 13, fig. 1; 1873 (b), p. 190.

Locality.—1 male, Paulau, Cl. 25 mm., Cb. 38 mm. (M.H.). The first rediscovery of this species.

Distribution.—Hitherto known only from New Caledonia.

Atergatopsis granulatus A. Milne Edwards.

A. Milne Edwards 1865 (a), p. 255, pl. 13, fig. 2.
Miers 1884, p. 529; 1886, p. 123.
Kossman 1877, p. 22.
Nobili 1906 (b), p. 235 (name only).
Klunzinger 1913 (name only), p. 156.

Locality.—1 female (Cl. 28 mm., Cb. 40 mm.), Macclesfield Bank (B.M.).

Distribution.—Red Sea, Zanzibar, Marie Louise Island (Amirante), Philippines, New Guinea.

Atergatopsis (?) globosa sp. nov.

(Pl. XIII., fig. 4.)

Locality.—1 female, Freycinet Reach, 10–13 m. depth (M.H.).

Description.—The carapace is strongly inflated in both directions, that is, from front to back and from side to side; it therefore resembles many species of *Actaea* (such as *A. subglobosa* Stimpson). The upper surface is evenly and moderately granulated, the lateral margin sharp. The antero-lateral margin is very long, and passes by a well arched curve into the strongly curved postero-lateral margin. On the upper surface a few fine but distinct grooves bound several regions; 3M is especially clear, at least in front, and is distinct from 2M, while the boundaries between 4M and 1P are less sharply defined. Also 1L, 2L, and 3L are distinctly visible ; the groove separating 4L and 1R is faintly impressed. A wider faint furrow separates the orbital region from 2M and the frontal region. In the branchial region there are two moderately deep notches on each side ; teeth are quite absent from the antero-lateral edges.

The front consists of two median and two lateral lobes ; the former project out sharply and the frontal margin passes from them in a concave arc to the two smaller lateral lobes, which are likewise sharp and are marked off from the upper orbital margin by a notch. The frontal margin and the upper margin of the orbit are finely granulated. The two upper grooves continue well on to the latter ; there is no extra-orbital tooth, but in its place on the under margin there is a fine notch ; the lower margin itself is again finely granulated.

The antennal region corresponds to that of *Atergatopsis*, in that the second joint unites with the lower frontal process by an inner process, and the very short flagellum lies within the orbit. The lower side of the carapace is smooth, not granulated, but in front it is strongly haired, as are also the third maxillipeds.

The chelipeds are of equal size. The merus and carpus have a sharp upper edge and their inner surface is smooth and flat, so that they can lie close against the under side of the carapace ; the swollen outer surface on the other hand is somewhat granulated and hairy. The chelae are massive, the palm has a sharp upper margin, and its fairly flat though inflated outer surface is finely granulated over the upper half, whereas the lower half is smooth ; the lower margin is rounded. The fingers are short ; the upper or movable finger is strongly deflexed, and the tips of the two fingers cross. The upper margin of the movable one is at first granulated, but the outer surfaces of both are smooth and shiny. There are only two small teeth on the movable finger, but the cutting edge is sharp ; the immovable finger bears two small teeth also, at the middle of its length, and the cutting edge is also sharp ; the fingers are therefore of the *Baraneia* type.

The legs are comparatively short ; the joints are high and the concave naked anterior side fits against the convex granulated posterior side of the preceding limb. The upper and lower margins are sharp, and those of the meri are furnished with long hairs.

Affinities.—This form is very similar to *Actaea* (*Baraneia*) *inconspicua* Miers 1884 from Port Darwin, which differs however in the hairs on the carapace and chelae ; its carapace also appears to be broader and the front and chelae are different in form. Since the present species has the antennary region as in *Atergatopsis*, I place it in the latter genus ; *Actaea* and *Atergatopsis* are in fact connected through this species, as also through *Actaea inconspicua*.

Measurements :—

Length of Carapace, 19 mm.

Breadth of Carapace, 25 mm.

Chelipeds —Merus : Length of upper margin, 7·5 mm.

Carpus : ,, ,, ,, 8 mm.

Palm : ,, ,, ,, 5 mm.

Palm : Length of lower margin (including finger), 11 mm.

Palm : Height, 7·5 mm.

Atergatis ocyroe (Herbst).

Alcock 1898, p. 207.

Grant and McCulloch 1906, p. 9.

Rathbun 1914, p. 657.

Localities.—2 males, 2 females, Turtle Island, coll. Gale (M.H.).
1 male, Abrolhos Islands (M.H.).

Distribution.—Throughout the warmer Indo-Pacific, from East Africa to Tahiti. In Australia known from the east coast—Port Denison, Queensland, Torres Strait (Calman). Port Essington (Miers, Haswell, Grant, and McCulloch); and from the west coast—Monte Bello Islands (Rathbun), Swan River (Miers). Not known from the southern coast nor from New Zealand.

Chlorodopsis areolata (H. Milne Edwards).

Alcock 1898, p. 116.

Balss 1922, p. 131.

Sendler 1923, p. 38.

Hale 1929, p. 70 (refs.).

Montgomery 1931, p. 443.

Locality.—Surf Point, Shark Bay; 0·5–3·5 mm. (M.H.).

Distribution.—Throughout the warmer Indo-Pacific, from the east coast of Africa to Polynesia and Japan. In Australia known already from Port Essington (Miers), Port Jackson (Haswell). Dirk Hartog Island (Hale), Abrolhos Islands, Swan River (Montgomery). Not known from the south coast.

Cymo andreossyi (Audouin).

Alcock 1898, p. 173.

Grant and McCulloch 1906, p. 13.

Nobili 1900, p. 259.

Locality.—Surf Point, Shark Bay, 0·5–3·5 mm. (M.H.).

Distribution.—A common form of the coral reefs of the Indo-Pacific, from the Red Sea to Tahiti. In Australia known from Port Curtis district, Queensland; Norfolk Island (de Man), Beagle Bay (Nobili).

Section II.—HYPEROMERISTA Alcock.

Most of the representatives of this section belong to the genera *Pilumnus* and *Actumnus*. I have dealt with the species from Western Australia in the course of a larger work in the *Capita zoologica*.

Trapezia cymodoce (Herbst).

Haswell 1882, p. 76.
Alcock 1898, p. 219 (refs.).
Nobili 1900, p. 260.
Rathbun 1923, p. 129.

Localities.—Shark Bay, Surf Point, Sunday Island, South Passage (M.H.).
Green Island, off Rottnest Island (beach), Fremantle district (M.H.).

Distribution.—The usual form of the coral reefs of the Indo-Pacific, from the Red Sea to Tahiti. In Australia hitherto known chiefly from the east coast (Queensland). Not present on the south coast.

Eriphia laevimana Latreille.

Miers 1884, p. 534.
Haswell 1882, p. 75.
Grant and McCulloch 1906, p. 14.

Locality.—1 female, non-ovig., N.W. Australia ; without further data (M.H.).

Distribution.—Widely distributed in the warmer Indo-Pacific. In Australia hitherto known chiefly from the east coast ; Moreton Bay, Queensland (Miers), Mast Head Island (Grant and McCulloch), Port Denison (Haswell). Absent on the south coast.

FAMILY OCYPODIDAE.

Genus OCYPODA Fabr.

Ortmann 1897, p. 359.

The genus includes the well known Sand Crabs of the tropics. No species are known from South Australia, but some spread down the east coast. The only other species, in addition to the two below, recorded from Western Australia is *O. kuhli* de Haan (Miers 1884) from Shark Bay.

Ocypoda aegyptiaca Gerstaecker.

Balss 1924, p. 14.

Locality.—1 male (Cl. 35 mm., Cb. 53 mm.) (M.H.). Compared with specimens from the Red Sea.

Distribution.—Previously known only from the Red Sea and Madagascar.

Ocypoda pygoides Ortmann.

O. pygoides Ortmann 1894, p. 766, pl. 23, fig. 19.
O. pygioides (*sic*) Montgomery 1931, p. 451, pl. 25, fig. 1 ; pl. 27, figs. 5, 5a.

Localities.—2 males (Cl. about 45 mm., Cb. 52 mm.) ; Dongarra, Geraldton.
1 female (Cl. 46 mm., Cb. 52 mm.), Barrow Island (M.H.).

Distribution.—Hitherto known only from Naturaliste Channel, Cottesloe (N. of Fremantle), and the Abrolhos.

Ocypoda ceratophthalma (Pallas).

Alcock 1900, p. 345.
Grant and McCulloch 1906, p. 20.
McCulloch 1918, p. 2.

Locality.—2 males, Barrow Island (M.H.).

Distribution.—A common form of the Indo-Pacific, but uncommon in Australia. Eastern : Cape Grenville (Cape York Peninsula) (Haswell), Rain Island (Challenger), Port Curtis district, Queensland (Grant and McCulloch), Friday Island, Moreton Island, N.S.W. (Miers). Northern : Beagle Bay (Nobili), King Sound (McCulloch). Not on the southern coast.

Uca dussumieri (H. Milne Edwards).

Haswell 1882, p. 93.
Alcock 1900, p. 61.
Grant and McCulloch 1906, p. 20.
Rathbun 1924, p. 8.

Locality.—Abrolhos Islands.

Distribution.—In the whole of the Indo-Pacific, from east Africa to Tahiti. In Australia known from Moreton Bay, Queensland (Grant and McCulloch), Port Darwin (Haswell), Broome (Rathbun).

Mictyris longicarpus Latr.

McNeill 1926, p. 102, pl. 9, fig. 1 (refs.).

Localities.—Abrolhos Islands (M.H.).
Cossack (M.H.).

Distribution.—Tropical Indo-Pacific ; east, north, and west coasts of Australia, New Caledonia, New Guinea, Singapore, Andamans, Bay of Bengal, etc. (cf. McNeill). Not known from the South Australian coast.

Macrophthalmus (Euplax) boscii Audouin.

Euplax boscii Tesch 1918, p. 60 (refs.).
Macrophthalmus boscii Kemp 1919, p. 383, pl. 24, fig. 6.

Localities.—1 female, Cossack, coll. Gale (M.H.).
1 female, Port Hedland, coll. Gale (M.H.).

Distribution.—Common in the whole of the tropical Indo-Pacific from Natal to the Riu-Kiu Islands and Fiji Islands. Not in British India. New for Australia.

FAMILY GRAPSIDAE.

Grapsus strigosus Herbst.

Tesch 1918, p. 71, pl. 4, figs. 1, 4.
Locality.—3 specimens, Cossack (M.H.).

Distribution.—Common in the whole of the warmer Indo-Pacific but rare in Australia—recorded only by Haswell 1882, p. 97, without mention of precise locality.

Metopograpsus messor (Forskall).

Miers 1884, p. 245.
Nobili 1900, p. 265.
Grant and McCulloch 1906, p. 23.
Tesch 1918, p. 79.
McCulloch 1918, p. 2.
Rathbun 1902, p. 13.

Localities.—Cossack, Onslow, Shark Bay (M.H.).

Distribution.—In the whole of the warmer Indo-Pacific ; known in Australia both from the east coast (Moreton Bay, Queensland) from the north—King's Sound (McCulloch), Broome (Rathbun), and from the west Shark Bay (Miers). It is not however recorded in Hale's catalogue of the South Australian forms.

Leptograpsus variegatus (Fabr.).

Grapsus variegatus Haswell 1882, p. 97.
Filhol 1885, p. 388.

Leptograpsus variegatus Stimpson 1907, p. 117.
Grant and McCulloch 1917, p. 154.
Chilton 1911, p. 560.
Borradaile 1916, p. 101.
Rathbun 1918, p. 234, pl. 56.
Hale 1924, p. 69; 1927 (b), p. 180, fig. 181.
Chilton and Bennett 1929, p. 763.
Montgomery 1931, p. 451.
Miers 1876 (b), p. 36.
Whitelegge 1900, p. 160.

Localities.—3 specimens, Shark Bay (M.H.).
2 juv., Cottesloe; 7 males, 3 females, Rottnest Island, beach (M.H.).
Several, Rockhampton, Queensland, coll. Salmin (M.M.).

Distribution.—West coast of South America (Peru, Chile), Easter Island, Juan Fernandez, New Zealand, Norfolk Island, Australia (east, south, and west coasts). The old record from Shanghai by Heller, and that from Pernambuco by Kingsley, are erroneous. The species thus prefers colder waters; on the coast of Western Australia it does not spread to the north (Monte Bello Islands, Cape Jaubert). On the east coast the most northern locality from which it has been recorded appears to be Rockhampton.

Brachynotus octodentatus (H. Milne Edwards).

Tesch 1918, p. 106.
Hale 1924, p. 69; 1927 (a), p. 312; 1927 (b), p. 182, fig. 183.

Localities.—Princess Royal Harbour, Albany district; beach (M.H.).
Cave Point, Albany district; beach (Cl. 43 mm., Cb. 55 mm.) (M.H.).

Remarks.—*Leptograpsodes webhaysi* Montgomery 1931, p. 452, is evidently identical with this species, as the differences quoted are very slight.

Distribution.—Southern half of Australia; Sydney, King Island, Port Phillip, Kangaroo Island, Nuyts Archipelago, Tasmania.

Genus CYCLOGRAPSUS H. Milne Edwards.

Tesch 1918, p. 125 (Revision).

Tesch has omitted *C. becarii* Nobili (1900, p. 270) from New Guinea. *C. tasmanicus* Jacquinot and Lucas (1853, p. 76, pl. 6, fig. 6) from Hobart, Tasmania, has been quite lost from our ken.

Cyclograpsus punctatus audouinii H. Milne Edwards.

Cyclograpsus audouinii Tesch 1918, p. 126 (refs.).
Hale 1924, p. 70; 1927 (a), p. 312; 1927 (b), p. 176, fig. 176.
Edmondson 1925, p. 56.
Montgomery 1931, p. 456.
lavauxi M.E. in Chilton 1911, p. 560.

Localities.—Shark Bay; Browne Station, Dirk Hartog beach (M.H.). North Fremantle, beach (M.H.). Princess Royal Harbour, Albany District, beach (M.H.).

Remarks.—I regard this form as a subspecies of *C. punctatus* from the Cape of Good Hope and South America. The differences from this *forma typica* have been best analysed by Rathbun (1918, p. 329).

Distribution.—The subsp. *audouinii* occurs at Port Jackson (Stimpson), Flinders Island, Kangaroo Island (Hale), New Zealand (Miers, etc.), Stewart Island (Filhol), Kermadec Islands (Chilton), Wake, Fanning, and Palmyra Islands, New Guinea (Edmondson). The forma typica occurs in Chile, Juan Fernandez, and the Cape of Good Hope.

Cyclograpsus whitei H. Milne Edwards.

Cyclograpsus whitei Chilton and Bennett 1929, p. 789.

Epigrapsus politus Lenz 1901, p. 471 (not of Heller).

Chilton and Bennett (1929, p. 762) state that they have not seen specimens of *Epigrapsus politus* Heller from New Zealand, though Lenz recorded it from French Pass. I have before me one of Lenz's male specimens (M.M.), and it now appears that both genus and species were incorrectly determined, and that the specimen belongs to the above species, previously known from New Zealand. The tropical Indo-Pacific *Epigrapsus politus* is therefore to be erased from the New Zealand list.

Plagusia depressa tuberculata Lamarck.

Tesch 1918, p. 128.

Locality.—West of Lagoon Point, Shark Bay; on sandy bottom; coll. Gale (M.H.).

Distribution.—Warmer Indo-Pacific and Atlantic. In Australia it has hitherto been known only from Port Jackson (Haswell 1882, p. 110); not present on the south coast.

Plagusia capensis de Haan.

Plagusia capensis Tesch 1918, p. 129 (refs.).
Rathbun 1923, p. 96.

Plagusia chabrus Haswell 1882, p. 111.
Chilton 1911, p. 558.
Hale 1927 (a), p. 333; 1927 (b), p. 185, fig. 186.
Chilton and Bennett 1929, p. 774.

Plagusia capensis Montgomery 1931, p. 457.

Localities.—1 juv., east coast of Rottnest Island, Fremantle district (M.H.).
1 specimen, Casuarina Point, Bunbury district; beach (M.H.).

Distribution.—A circum-subantarctic cold-water form; South Africa, South Australia, Tasmania, New Zealand, Kermadec Islands, Tongatabu, Juan Fernandez, Chile. In Australia only on southerly coasts—Bass Strait (?) (Rathbun), Kangaroo Island (Hale), New South Wales (Haswell). The nearest relative is *P. dentipes* de Haan from Japan, Bismarck Archipelago, etc., a form which spreads to the Kermadecs, Norfolk and Lord Howe Island, but not to New Zealand or northern Australia.

Percnon planissimum (Herbst).

Tesch 1918, p. 130.

Grant and McCulloch 1907, p. 153.

Hale 1929, p. 70, pl. 5.

Montgomery 1931, p. 457.

Locality.—Surf Point, Shark Bay ; sandy and rocky bottom : 0·5–3·5 m. (M.H.).

Distribution.—Common in the warmer part of the Indo-Pacific and Atlantic. There are remarkably few Australian records : Torres Strait (Haswell), Norfolk Island (Grant and McCulloch), Dirk Hartog Island, W.A. (Hale), Abrolhos Islands (Montgomery). Absent from the south coast.

OBSERVATIONS ON THE ZOOGEOGRAPHY OF WESTERN AUSTRALIA.

Before entering upon a discussion of the zoogeographical results I provide a list of the most important of the various collecting stations repeatedly referred to in the above report.

Turtle Island, 19° 54′ S., 118° 54′ E.

Monte Bello Islands, about 20° 30′ S.

Cossack, 20° 39′ S., 117° 13′ E.

Barrow Island, about 21° S.

Onslow, about 21° 30′ S.

Shark Bay and Dirk Hartog Island, about 26° S.

Geraldton, 28° 45′ S.

Fremantle and Swan River, 32° S.

Bunbury, about 33° 15′ S.

Albany, about 35° S., 118° E.

The editors of *Die Fauna Südwest-Australiens ; Ergebnisse der Hamburger Südwestaustralischen Forschungsreise* 1905, ed. by W. Michaelsen and R. Hartmeyer (G. Fischer, Jena) have given in Vol. 1 of that work (Vol. 1, 1907) a physico-physiognomical description of the chief collecting stations, to which, and especially to the map, attention may here be drawn. It need be remarked here only that the material secured was taken from the upper littoral to a depth of 18 m. at the most.

1. Onslow and Cossack District.

The following species were collected :—

Turtle Island :—

Atergatis ocyroe.

Pilumnus forskalii coerulescens.

Barrow Island :—

Paranaxia serpulifera.

Ocypode pygoides.

O. ceratophthalma.

Pilumnus vespertilio.

Cossack :—

Cryptodromia tuberculata.
Matuta banksii.
M. planipes.
Menaethius monoceros.
Xantho exaratus.
Mictyris longicarpus.
Macrophthalmus boscii.
Grapsus strigosus.
Metograpsus messor.
Pilumnus vespertilio.

Onslow :—

Hyastenus convexus.
Schizophrys dama.
Thalamita intermedia.
Pilumnus longicornis.
P. semilanatus.

These are all tropical forms, and most of them are widely distributed in the Indo-Pacific ; *Atergatis ocyroe*, both spp. of *Matuta*, *Xantho exaratus*, *Hyastenus convexus*, *Pilumnus longicornis* and *P. vespertilio* are for example widely distributed species.

There is however a small number of forms endemic to Australia and particularly to the west coast : *Pilumnus semilanatus*, *Thalamita intermedia*, *Ocypode pygoides*.

II. Shark Bay.

The following were found here :—

Cymo andreossyi.
Trapezia cymodoce.
Cryptocoeloma haswelli.
Actumnus setifer.
Pilumnus longicornis.
P. semilanatus.
P. fissifrons.
Ocypoda aegyptiaca.
Metopograpsus messor.
Leptograpsus variegatus.
Cyclograpsus punctatus audouinii.
Plaguisa depressa tuberculata.
Percnon planissimum.
Actaea michaelseni.
A. savignyi.
A. peroni occidentalis.
Carpilodes hartmeyeri.

Tropical forms still preponderate here by far ; the water at Shark Bay is still warm enough to permit of coral reefs and pearl oyster beds. Typically warm-water forms for example are *Cymo andreossyi*, *Trapezia cymodoce*, *Plagusia depressa*, *Actaea savignyi*. But we come across some species here which are more common on the southern coast and are therefore to be regarded as cold-water forms reaching here their most northerly point ; they are *Leptograpsus variegatus*, *Pilumnus fissifrons*, *Cyclograpsus punctatus audouinii*.

III. GERALDTON.

Only a small collection was secured from the Geraldton district; they included *Calappa lophos* and *Schizophrys dama*, both tropical species, and *Ocypoda pygoides*, the endemic species of the west coast.

IV. FREMANTLE.

In this district the collections were more numerous, viz.:—

Rottnest Island:
Trapezia cymodoce.
Plagusia chabrus.
Leptograpsus variegatus.

Cockburn Sound:
Dromidiopsis michaelseni.
Naxia aurita.
Paratymolus latipes quadridentata.
Hyastenus oryx.
Nectocarcinus integrifrons.
Thalamita sima.
Actaea calculosa.
Pilumnus fissifrons.

Swan River:
Micippa thalia.
Neptunus pelagicus.
Atergatis ocyroe.
Chlorodopsis areolata.
Pilumnus etheridgei.

We have here a typical mixed fauna; *Hyastenus oryx*, *Micippa thalia*, *Atergatis ocyroe*, *Trapezia cymodoce*, *Chlorodopsis areolata*, *Actea calculosa*, and *Thalamita sima* are tropical forms reaching in this district the southern limit of their distribution on the west coast; but in general it is the cold-water element of the south coast which mainly decides the *facies* of the fauna, *e.g.*, *Plagusia capensis*, *Naxia aurita*, *Nectocarcinus integrifrons*, *Pilumnus etheridgei*, and *Leptograpsus variegatus*.

In the Bunbury district again there come to light some cold-water forms such as *Plagusia capensis* and *Naxia spinosa*, and intermixed with them still a tropical element in *Actaea peroni occidentalis*.

V. ALBANY DISTRICT.

Oyster Harbour:
Ebalia intermedia.
Leptomithrax aff. *spinulosus.*
Actea peroni occidentalis.
Litocheira bispinosa.

Princess Royal Harbour:
Naxia aurita.
Litocheira bispinosa.
Brachynotus octodentatus.
Cyclograpsus punctatus audouinii.
Pilumnus etheridgei.

Middleton Beach:
Naxia aurita.

These are all typical South Australian forms, as recorded in Hale's Catalogue ; the tropical element has quite disappeared.

The physical characteristics of the waters of the western and southern coasts of Australia are distinctly reflected in their animal population. A characteristic of the western coast is that the cold current from the south which courses up the western coasts of the other southern hemisphere continents (Benguela Current in South Africa, Peru Current in South America) is in this case lacking, so that on this coast the warm-water forms spread well down towards the south. The average temperature of the water at 28° S. is about 20° C., and on the south coast about 17–18° C., about corresponding to that of the Mediterranean and the coast of Portugal (cf. Schott, *Valdivia Oceanographie*, Atlas, pl. 9). It can readily be understood therefore how it is that the tropical and temperate faunas of the west and south coasts gradually intermingle, without showing such a sharp boundary, as for example, occurs in south-western Africa.

ADDENDUM.

By D. L. SERVENTY.

Since Dr. Balss has prepared the foregoing paper, further contributions by him bearing on the Hamburg Expedition's collections have appeared.

The paper on *Pilumnus* and allied genera referred to on page 113 has been published as "Beiträge zur Kenntnis der Gattung *Pilumnus* und verwandter Gattungen," in *Capita Zoologica*, Deel 4, Afl. 3, pp. 1–47, S' Gravenhage, 1933. The Western Australian representatives dealt with, distributed among the genera *Pilumnus, Actumnus, Cryptocoeloma and Litocheira*, are enumerated on pages 144–146 of the present paper.

In "Ueber eine neue Art der Gattung Glabropilumnus," *Ann. Mag. Nat. Hist.* (Ser. 10), vol. XV, pp. 664–666, 1935, Dr. Balss describes as a new species, *Glabropilumnus gordonae*, a crab from the Abrolhos Islands which Montgomery in 1931 had referred to *Pilumnus edamensis de Man.* The genus *Glabropilumnus* was erected by Balss in his former paper in *Capita Zoologica.*

A brief zoogeographical review of the collection is given in "Die brachyuren Dekapoden der Reise Michaelsen-Hartmeyer nach Südwestaustralien 1905," in the *Zoologischer Anzeiger*, bd. 111, Heft 1/2, pp. 35–42, 1935, together with descriptions of two further new species recognised in the collections after the main paper had been prepared. *Planotergum mirabile* (p. 36, text-figures 1–3), is a new genus and species from Shark Bay. The species represents an extremely aberrant member of the Oxyrhyncha whose more precise classification is difficult. There are resemblances to the Acanthorychinae and in some features to *Hemus* and *Eucinetops.* The author considers that possibly the genus stands near to *Crossotonotus* A. Milne-Edwards. The other species described is not from Australian seas.

Department of Biology,
University of Western Australia.

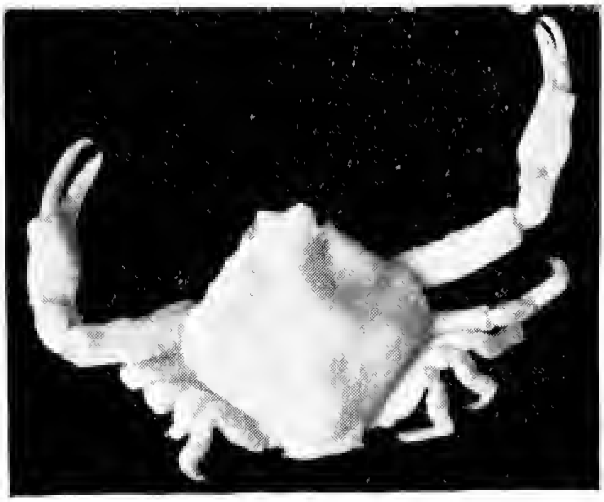


Fig. 1.

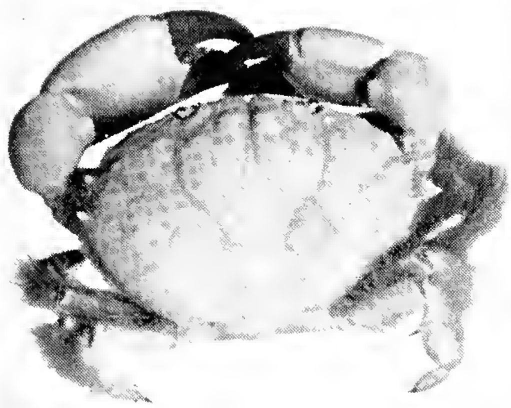


Fig. 2.

Fig. 3.

Fig. 4.

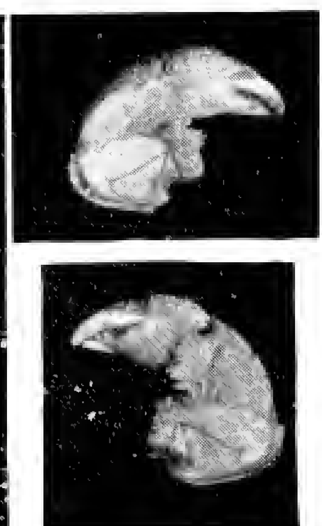


Fig. 5.

Fig. 1.—**Ebalia quadrata** A. Milne Edwards, Type, x 2·3, Bass Strait.

Fig. 2.—**Paraxanthias ponapensis** Rathbun, ♀, from above, x 1, Manus Island.

Fig. 3.—The same, from below, x 1.

Fig. 4.—**Atergatopsis globosa** nov. sp., ♀, from above, Type (M.H.), x 1·5, Freycinet Reach.

Fig. 5.—The same, inner view of chelipeds.

PLATE XIII.

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11.—THE GENUS CHEILEA IN AUSTRALIAN WATERS.

By BERNARD C. COTTON.

(A Contribution from the South Australian Museum.)

Read 11th December, 1934; Published 18th December, 1935.

Pritchard and Gatliff[1] record *Mitrularia equestris* Linn. from Flinders Victoria, in 1899. Twenty-four years later Hedley[2] records *Cheilea undulata* Bolten, remarking "I have seen *C. undulata* from the Sow and Pigs Reef in Sydney Harbour and have gathered it at intervals between the Capricorn Islands and Torres Straits . . . . This seems to be the proper name for a shell erroneously recorded from Australia by various authors as *Calyptraea equestris*."

Tryon,[3] after trying to determine what *Mitrularia equestris* Linn. really is, remarks "I have interpreted this species in accordance with general usage, the Linnean species being indeterminable."

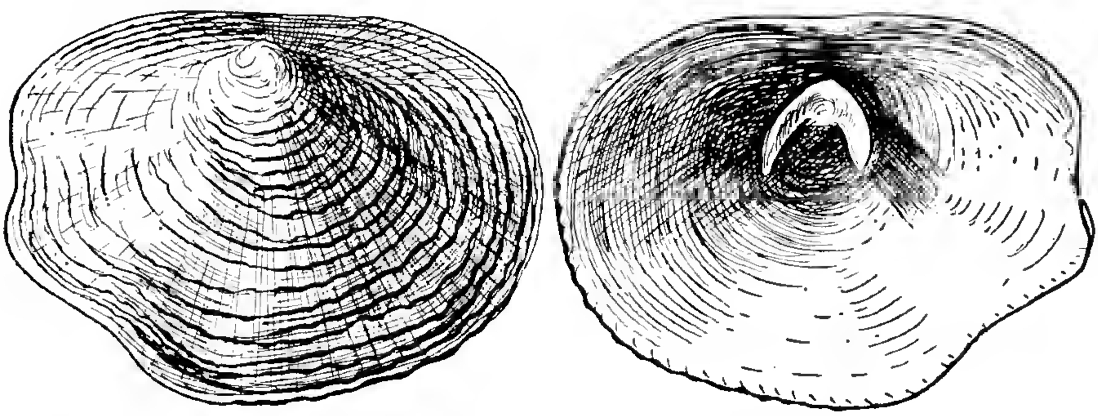
However Woodring[4] designated *Patella equestris* Linn as type of the genus *Cheilea*.

None of the innumerable synonyms of the so-called tropical *Cheilea equestris* are applicable to the species which occurs along the South Coast of Australia, so that the only course seems to be to describe them as new species.

CHEILEA UNDULATA Bolten.

A series of *Cheilea* in the South Australian Museum from the Northern Territory agree fairly well with the figure and description of *Calyptraea dormitoria* Reeve, from the Philippines, a synonym of *Cheilea undulata*, though the Australian specimens have more delicate radial sculpture. A series of Queensland specimens are even more delicately sculptured. The specimens from Queensland recall the Tertiary fossil *Cheilea plumea* Laws from New Zealand.

Cheilea flindersi.



1 2

Fig. 1.—**Cheilea flindersi**, sp. nov. — dorsum. × 1.

Fig. 2.—**Cheilea flindersi**, sp. nov. — venter. × 1.

Shell large, fairly solid, semicircular in outline, irregular, elevated; posterior slope convex, anterior steeper and straighter; apex nearer anterior end, only slightly curved; pure white colour with but a slight yellow tinge;

(1) Proc. Royal Soc. Vict. N.S. XII., pt. 2, p. 198, 1899.
(2) Proc. Linn. Soc. N.S.W., pt. 3, p. 309, 1923.
(3) Mon. Conch. XIII., p. 137, 1886.
(4) Carnegie Inst. Wash. Pub. No. 385, p. 374, 1928.

surface covered with strong irregular growth lines, breaking the fine flexuous close-set radials; margin irregular, finely denticulate within. Internal appendage long, delicate, narrow, convex in front, basal margin semicircular, posterior margins slightly thickened. Holotype; height 22 mm.; diameter major 53 mm., minor 39 mm.; Daly Head, Spencer Gulf, South Australia (Dr. Torr) Reg. No. D.11290, S.A.M.

Location: South Australia:—Spencer Gulf, Gulf St. Vincent, St. Francis Island beach, Beachport 25,110 fathoms, 150 fathoms; Neptune Island 45 fathoms; Midchannel between Cape Borda and Wedge Island 60 fathoms, Victoria:—Port Philip.

The large species is readily distinguishable from the tropical *Cheila* by the size and rugged irregular growth lines. The shape is variable, the basal margin being sometimes almost circular.

Cheilea occidua.

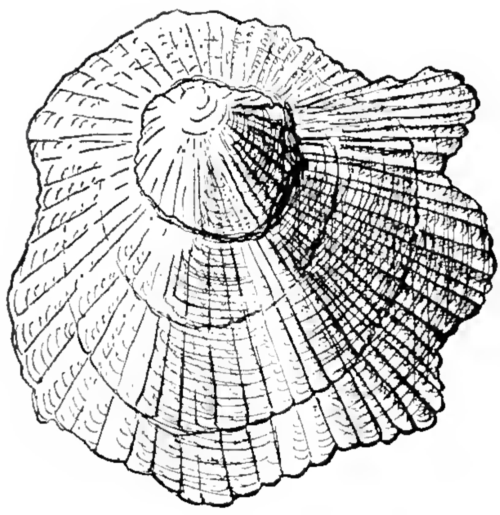


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Fig. 3.—**Cheilea occidua**, sp. nov. — dorsum. × 2.

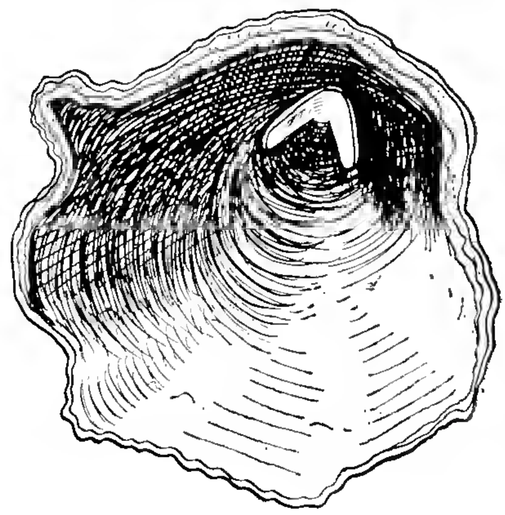

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Fig. 4.—**Cheilea occidua**, sp. nov. — venter. × 2.

Shell medium size, rather solid, very irregularly circular in outline, elevated at the apex; posterior slope slightly convex near the apex, flatter towards the margin; anterior straight and steep. Apex near anterior, blunt, smooth and scarcely curved; first third of the shell always forming a cap which appears as though mounted on top of the shell. Growth lines very irregular, coarse irregular radial ribs and also very fine radial ribs visible under lens. Margin very irregular but smooth internally. Internal appendage, delicate, long and narrow, basal margin semicircular, posterior margin slightly thickened. Holotype; height 11 mm.; both diameters 25 mm.; Ellensbrook, Western Australia (Sir J. C. Verco), Reg. No. D.11291, S.A.M.

Localities: Esperance, Hopetoun, Albany, Ellensbrook, Yallingup, Hopetoun 35 fathoms. Of fifty specimens taken at Ellensbrook the largest does not reach half the size of *C. flindersi*. The Western Australian species is easily distinguished from the South Australian by the smaller size, the coarse radial ribs and the peculiar "capping" of the early shell.

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