THE AUSTRALIAN ZOOLOGIST

Issued by
The Royal Zoological Society of New South Wales

Vol. 3.—1922-1924.

WITH FORTY-ONE PLATES,
And Twenty-five Text-figures.

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INDEX TO VOLUME 3.

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Issued by
The Royal Zoological Society of New South Wales

Edited by
LAUNCELOT HARRISON, B.Sc., B.A.,
Acting Professor of Zoology at the University of Sydney.
And A. F. BASSET HULL, C.F.A.O.U.

Vol. 3—Part 1
(Price, 4/6.)

Sydney, September 15, 1922.

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Royal Zoological Society of New South Wales.

Established 1879.

REGISTERED UNDER THE COMPANIES ACT, 1899 (1917).

SUBSCRIPTION: Ordinary Member, £1 1s. per annum
(Entrance Fee £1/1/-).
Associate Member, 7s. 6d. „ „

PRIVILEGES:

Ordinary Members—Free admission to Taronga Zoological Park; Additional Tickets admitting 20 Adults or 40 Children; Free Copy of "Australian Zoologist."

Associate Members—Free Copy of "Australian Zoologist."

"THE AUSTRALIAN ZOOLOGIST."

Communications intended for "The Australian Zoologist" should preferably be type-written.

Authors should state whether proofs and reprints are desired when submitting MS. Fifty reprints of any article appearing under a separate title will be supplied gratis. If more are required, terms may be ascertained on application to the Editor.

Royal Zoological Society of New South Wales.

ANNUAL REPORT, 1921-2.

The fifth annual general meeting of the Society was held at the rooms, Bull's Chambers, Martin Place, on Wednesday, 12th July, 1922, at 8 p.m.

Members were present.

The President (Mr. J. H. Campbell, M.B.E.) read the following report:—

Membership.

There has been a very satisfactory increase in the number of members on the register, the net increase amounting to 55 members. The following are the details:—

	1920-1.	1921-2
Honorary	8	7
Ordinary	291	311
Associate	39	75
Totals	338	393

In addition there are 21 ordinary and 6 associate members whose names are still on the registers, but who have failed to renew their subscriptions or to notify their desire to resign. Under Article 13 these members are not entitled to any right or privilege in the Society.

The Council.

Nine meetings of Council were held during the year, the attendances at which were as follows: Mr. Campbell, 8; Dr. D'Ombrain, 5; Dr. Ferguson, 6; Mr. Finckh, 8; Mr. Froggatt, 4; Mr. Goldfinch, 5; Mr. Halloran, 5; Professor Harrison, 4; Mr. Hedley, 7; Mr. Hull, 8; Mr. McCulloch, 1; Mr. Musgrave, 7; Mr. Rolin, 5; Mr. Shipway, 4; Mr. Shiress, 6; Mr. Stewart, 5; Dr. Walkom, 8; Mr. Waterhouse, 9.

Mr. Hedley, who is on a visit to America, was granted leave of absence from March, 1922, and Mr. McCulloch was absent at Lord Howe Island for some months.

Finances.

The Capital Fund has been increased by £96, and now stands at £541/5/-. The Income Account is well in credit, but the Handbook Publication Fund is temporarily exhausted.

Australian Zoological Handbooks.

The feature of the year's operations has been the issue of the first "Australian Zoological Handbook," being Mr. McCulloch's "Fishes and Fish-like Animals of New South Wales." This work was a very costly one on account of the

large number of illustrations, each of which required the copying of the original type illustration by photography; the reduction to approximately uniform size; the making of half-tone blocks, and the use of an expensive paper for the printing. It was found impossible to defray the whole cost of this work from the Handbook Publication Fund, which at the best never reached £300, while £500 was the amount originally estimated for the establishment of the Fund. It was therefore decided to bring out the work in sections in the "Australian Zoologist," debiting part of the cost of production to the Income Account. This arrangement has been found to work satisfactorily, inasmuch as it has given publicity to the subject dealt with by Mr. McCulloch, and has enabled the Council to complete the work at a much earlier date than otherwise would have been possible. The complete work, well bound and copiously indexed, is now being sold at the nominal price of five shillings, thus giving effect to the object of the Fund, namely to provide reliable information in respect to Australian Fauna at a price within the reach of all. It is a source of gratification to the Council that the sales of the Handbook have already been considerable, and that the Walter and Eliza Hall Trust has shown its continued appreciation of the Society's work by donating a further sum of £20 to the Fund, making a total contribution of £70. This additional sum was received after the books had been closed for the financial year, but it will appear on the balance sheet for next year.

The Australian Zoologist.

Two numbers of this journal were issued, being Parts 3 and 4 of Volume 2, which is now completed.

Obituary.

The Society has lost by death one of its oldest members. Mr. Albert Gale was a constant visitor at the old Zoological Gardens in Moore Park, and he voluntarily supervised the establishment of freshwater aquaria there, devoting a great deal of his private time to directing operations and looking after the exhibits. In recognition of his services he was elected an Honorary Member of the Society. Mr. Gale contributed an interesting paper on the breeding habits of the Purple-striped Gudgeon to the first number of the "Australian Zoologist." The Society has also lost by death Mr. C. J. Alderdice, Mr. P. G. Black, Mr. W. A. Gullick, Mr. W. G. Hearne, and Mr. Mark Mitchell.

Sections.

The establishment of Sections, consisting of members interested in special subjects, promises to have very useful results. Sections of Entomology and Ornithology are in full operation, and other subjects are under consideration.

General Meetings.

At an inaugural general meeting held on 29th September, 1921, it was decided to hold similar meetings in the months of March, May, July, September and November in each year. At the meeting of 9th November, 1921, only 10 members attended; the meeting of 8th March was better, 16 members being present, but the May meeting lapsed for want of a quorum. The experiment has not worked satisfactorily, a noteworthy fact being that those members who had most frequently asked for more regular meetings were amongst the absentees. The question of continuance of these meetings will be submitted for discussion to-night.

PRESIDENTIAL ADDRESS.

By J. H. Campbell, M.B.E.

When last year your Council conferred on me the highest honour it can bestow by electing me to be your President I felt that in accepting office I was shouldering no light responsibility, and I at the same time fully recognised that the selection was governed by conditions somewhat different from those obtaining in many other scientific societies. A glance at our membership roll will show that our ranks are largely recruited from persons whose connection with Zoology is not very close, and it is only fitting in a democratic country like Australia that those who pay the piper should have a right to call the tune, and that the higher administrative functions of this Society should not entirely be confined to the small sections more immediately engaged in research. I am now able to assure anyone who may in later years hesitate to accept nomination to the Presidential Chair on the ground that his zoological equipment is limited that he will at all times of difficulty have at his disposal the advice of men thoroughly conversant with the various matters calling for decision, and he should further remember that even specialists can often benefit by the views of one whose interests are more general. My twelve months' experience as first among equals on your Council has been one of unalloyed happiness, the relations between myself and my colleagues have at all times been most harmonious, and I hope this lame dog has negotiated the several stiles he has encountered without unduly betraying that his efforts to surmount them owed no small part of their success to the ever ready help of your Secretary and Treasurer. To Messrs. Hull and Waterhouse I would express my most hearty thanks for their personal assistance, and the Society is indebted to them and to Mr. Finckh and Mr. Stewart for services generously rendered. It now becomes my duty to give an account of my stewardship, and, on the eve of laying aside the dignity and responsibility of office, to submit for your consideration a few impressions which remain.

The outstanding feature of the Society's year has been the publication of McCulloch's "Check List of the Fishes of New South Wales," which had already been placed in possession of members by its appearance in the "Australian Zoologist." In its book form it is the first step towards attainment of the Council's ambitions to issue a series of works, by recognised authorities in their several subjects, containing more or less popular, but always accurate, information on the fauna of Australia, at a price which should be within the means of everyone interested in Natural History. That the book can be sold at five shillings, a price much below the cost of production, is due to the generosity of subscribers to the Handbook Fund, and to them I would once again express the Society's sense of its indebtedness, but more especially would I place on record our deep debt of gratitude to Mr. McCulloch for the very valuable help to Australian Zoology which has been given by this tangible result of his study of our fishes. I know that with him it has been a labour of love, but while the love of his subject has been great the labour involved has been such as to overstrain the patience and resource of any but the true scientific enthusiast.

This Handbook is No. 1 of a series, but the publication of later volumes is almost entirely a matter of finance. The Handbook Fund is for the present exhausted and must await replenishment by the proceeds of sales of the "Fishes," so far satisfactory I am glad to note, before we can venture further, but meantime the Council is not overlooking the need to have everything ready for the time

that money is forthcoming. Need I say that we foresee no difficulty in getting specialists to write on their particular groups? Scientific workers are ever ready, even anxious, to expend themselves in spreading a knowledge of their subjects. Money is no easier to raise for the advancement of science than it is for many less worthy objects, and Australia has not so far, with some most noteworthy exceptions, produced men prepared to spend a portion of their Australian-earned surplus in avenues which must sooner or later lead to an increase of national wealth and prestige. The appeal for funds for scientific purposes can I think be made with a clear conscience, especially when the expenditure is to be in the hands of one or other of our scientific societies. I would venture the statement that in no activity of our modern life is there so much honorary service for the general advancement of knowledge, which after all is the advancement of human happiness, as is given by scientific workers, and it is indeed hard that men who, themselves seldom well-to-do, give such important and generous service to the community, should be constantly hampered in their work by the want of means which could so easily be provided by their richer brethren. They are not seeking personal benefits, they can carry on if only provision be made for the material necessary for their investigations, and for the proper publication of the results of their work. Surely among the successful merchants, pastoralists, or manufacturers of New South Wales there are a few who will follow the fine example of Sir William Macleay by fittingly endowing the acquirement and dissemination of a knowledge of the animals of their country. Natural conditions here are rapidly changing and we have already lost too much time in finding out all that is to be found out about our interesting, our unique, fauna. Later I shall refer to means *of* doing this, but the means *for* doing it should be provided by the wealthy among our fellow citizens, and we give them our assurance that all funds entrusted to the scientific societies of Australia will be carefully administered, and will be applied to the best advantage in the interests of science.

Meantime until the financial position of the Zoological Society is stronger what can we do to expedite the publication of our Handbooks? My own connection with science has been chiefly on the finance side, and that must be my excuse for devoting so much time to consideration of ways and means, a department of scientific activity in which I have had some experience. To publish an annual volume costs must be incurred not only for plates, printing, and paper (printing charges), but also for the general expenses of the publishing society such as rent, administrative, and office expenses (overhead charges), and an increase in the size of the annual volume need not mean any expense other than extra printing charges. On the other hand any increase in the number of separate publications means that besides the printing charges for the extra matter additional overhead costs must be incurred. It then remains to consider whether workers in Natural Science in Australia have a sufficient number of publishing societies for their needs, or whether an increase or decrease is desirable, a publishing society being defined as one confining its publishing activities to the issue of papers, written or communicated by its members, containing the results of original research. Now it appears to me that the existing societies are sufficient not only for the immediate future, but for some time to come, that any addition to their number would mean economic waste, and that in New South Wales the two senior societies, the Royal and the Linnean, can easily handle the output of papers. The highest claim the Zoological Society has upon the scientific community is its scheme of Handbooks, and I would, entirely on my own responsibility, suggest most serious consideration of the discontinuance of the publication of the "Australian Zoologist," at least for the present, and the allocation of the savings thus effected to the Handbook Fund. Taking first the

rights of our members to a medium for publishing their work I submit that most, if not all, of those engaged in original research already possess such a medium through their membership of one or other of the senior societies, while it is questionable whether it is the province of a society like this to publish the more popular type of paper recording facts, new or otherwise, in a form more suited for a magazine article. In my view, quite possibly a wrong one, a publication including between the same covers technical descriptions of new species, and "chatty" notes on, say, the domestic habits of the wombat in captivity, can never rank with others confined to results of research, and authors may sometimes find their work overlooked by their co-workers who, deceived by the "chatty" papers, miss those of more serious import. Accepting these considerations our working members would suffer no injustice by the discontinuance of the "Zoologist," and as to members generally, ordinary and associate, the Society's contract with them would call for some revision. This "contract" entitles all members to a free copy of the "Australian Zoologist," and ordinary members have in addition certain privileges of admission to Taronga Park. The large majority of our members are, I regret to say, more concerned with the Park than with the publication, and it should be quite possible to work out an equitable scheme of compensation by giving members some concession in regard to the Handbooks. A third "privilege" not set out in our advertisements, but nevertheless a most important one, is the right to attend meetings of the Society, and were these meetings more widely known, and more largely attended, many discussions of interest to naturalists would be possible. The ordinary meeting of a scientific society is concerned primarily with the discussion of papers, but even in a complete volume of the "Zoologist" there would hardly be enough new material to fill up a single evening, and in order to make the meetings attractive it would be desirable to discuss papers read elsewhere. The entomologists, always enthusiastic, have already in full operation a Section whose meetings are recognised as the place where all insect-men, local or visiting, foregather, and there is no reason why the ordinary meetings of the Society should not equally become the centre for that exchange of ideas and observations so necessary for broadening the specialist's outlook, but so difficult to obtain amidst too formal surroundings. And perhaps these meetings would in time be accepted by those of our members who now appreciate the "Zoologist" as full compensation for the cessation or suspension of that publication, knowing that the Society was giving them the opportunity to hear discussed by experts the various difficulties and problems presented by their work.

There is no doubt that many of our members are not alive to the importance of the Handbooks, though to some of us their issue ranked high among our reasons for joining the Society. There has hitherto been in Australia a great dearth of handy works of reference dealing scientifically with our fauna, and for identification of specimens the naturalist has frequently to wade through a quite considerable mass of literature. To have for each group a list of at least the commoner species, with descriptions and plates as in McCulloch's "Fishes," would not only be an encouragement to the budding scientist, but would enormously help the more experienced workers in the several fields, and should even be welcomed by the trained specialist. The Council has already approved of the preparation of an almost indispensable adjunct to the Handbooks in the form of a "Collector's Guide," which generally will be designed to help the collector to find what he is looking for, and to teach him how, when found, so to preserve it as to have most value afterwards. The assistance thus given should gradually produce for us an army of more or less trained collectors prepared to take an active share in the zoological survey of Australia, the importance of which has been so

much stressed by several of my colleagues, when that great work has been commenced in all seriousness.

A general zoological survey differs in many essentials from the research work for which I have already claimed the co-operation of our wealthier citizens, and it calls for a personnel far exceeding anything our societies could place in the field, and for equipment much beyond the resources of trained amateurs. It could only be efficiently carried out as a national work, and under the auspices of the Federal Government, and the difficulties of impressing its importance upon those whose function it is to assume responsibility for its finance and administration are so great that one fears much valuable material throwing light on the development of our peculiar fauna will have gone forever before these difficulties are overcome. Much is of course possible by combined team-work on the part of the several Museums, but the results even from this would be small without a substantial subsidy for expenses, and above all legislation to protect our rarer animals not only against the thoughtless "sportsman," but against the trained collector from overseas. The voice of the Australian naturalist has been lifted up time and again in protest against our heritage going to strangers never to come back to us, but it has only been as of one crying in the wilderness. Worse still, they who would despoil us include amongst them men of our own household. Not being germane to my subject it is only in passing that I would voice the protest of every true naturalist against general trading in our wild animals and birds, for I can conceive of no object sufficiently worthy to justify its support by money derived from the depletion of our rarer animals. I do not wish to criticise statements appearing in the press about recent transactions, for I do not know the facts, but I do claim that all the facts should be published, and that all such trading whether domestic or foreign should be closely supervised by an Authority on which naturalists should be fully represented. But the point I wish to make is that we are in grave danger from collectors about whose scientific *bona fides* there can be no question, but whose confessed object is to house our types on the other side of the world, and to describe them in non-Australian publications. I cannot see that a type deposited in the British Museum is in these days any more accessible to us than one in an American Museum, or that a description published in England is necessarily better than an Australian description. Still against our visitors, whom we heartily welcome apart from their habits of acquisitiveness, we have a very poor case so long as we ourselves leave the work of the survey in the hands of unco-ordinated bodies. It is too big for any single society, but surely combined representations from all scientific societies and Museums in Australia should have some weight, particularly if these were accompanied by a working scheme carefully drawn up by a competent body of workers prepared to undertake, if called upon, the complete direction of the survey.

Underlying all science are certain general ideas, the absolute truth of which we can never hope to prove, but without which we cannot establish any relation between observed facts. One of these is the idea of continuity, the idea that the same natural laws have held good since the beginning of time. We are gradually accumulating knowledge of these laws, and perhaps to us as zoologists the most interesting and the most important are those which determine the evolution of the forms of life as we now know them. There are several more or less conflicting hypotheses framed to explain what evolution is and how it operates, but till research follows research, and fact is piled upon fact, we cannot look for any hypothesis attaining the final dignity of a theory. The attention of biologists was early directed to the imperfection of the palaeontological record, but none now questions that the imperfections are only gaps in the re-

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES.

Room 10, First Floor, Bull's Chambers, Martin Place, Sydney.

Dates of Meetings.

Year 1922-3.

1922.	p.m.
9 August, Wednesday— Entomological Section	7.30
13 August, Friday— Ornithological Section	7.30
13 September, Wednesday— General Meeting	7.30
11 October, Wednesday— Entomological Section	7.30
20 October, Friday— Ornithological Section	7.30
8 November, Wednesday— General Meeting	7.30
15 November— Economic Zoology Section	7.30
1923	
9 February, Wednesday— Entomological Section	7.30
18 February, Friday— Ornithological Section	7.30
9 March, Wednesday— General Meeting	7.30
13 April, Wednesday— Entomological Section	7.30
15 April, Friday— Ornithological Section	7.30
11 May, Wednesday— General Meeting	7.30
18 May— Economic Zoology Section	7.30
8 June, Wednesday— Entomological Section	7.30
17 June, Friday— Ornithological Section	7.30
13 July, Wednesday— General Meeting	7.30

cord, and not breaks in the continuity of life. We know that we can never have the complete record, but just think for one moment how we should stand in regard to our Theory of Evolution had we zoological records by competent observers covering only the historical period, say 10,000 years. What new light would be thrown on problems of variation, on our own relations to our environment! And yet we in Australia, in the absence of a national scientific conscience, are allowing one more gap to form. There is gradually disappearing before the advance of settlement a series of animals the study of which is of the highest scientific importance in connection with problems of variation and environment, and as helping us in some degree to more accurate views of a fauna which has in other parts of the world become the special province of the palaeontologist. This Society will have justified its existence, even if it never published a Handbook, if in time to come it can be said of it that it helped in the achievement of the goal towards which every Australian zoologist should strive—the complete Record of the Animals of Australia.

THE TREASURER'S STATEMENT.

Mr. A. G. Hamilton moved the adoption of the Report, and that a vote of thanks be accorded to the President for his able address. The motion was seconded by Dr. T. Storie Dixson, and supported by Messrs. Halloran, Hull, McCulloch, and Waterhouse.

Mr. Neville Cayley exhibited a number of lantern slides of Australian Birds from photographs taken by Messrs. Gaukrodger and Mouse.

A selection of photographs of animals in the Taronga Zoological Park was exhibited by Mr. Ennor.

In moving the adoption of the balance-sheet, the Honorary Treasurer said:—

"During the financial year that has just closed the capital of the Society has been increased by £96 by the purchase of one hundred pounds stock in the Diggers Loan; the capital now standing at £541/5/-, which represents the actual cost of the Society's investments. The nominal value of these stocks is £550, whilst the market value to-day (12th July, 1922) is just under the nominal value.

"The total interest received from our investments is £36/1/9, exclusive of the sum of £6/14/9 Savings Bank interest for the Handbook Fund.

"As is usual in a Society of this kind, no account is taken of the value of the library or the back numbers of our publications, a conservative estimate of these, together with the office furniture we possess, would be £250.

"On account of our first handbook 'The Fishes and Fish-like Animals of N.S. Wales,' during the past two years the sum of £359/1/- has been paid for printing text and plates, as, with the exception of the index, the whole of the text and plates had already appeared in 'The Australian Zoologist,' and the General Fund has so far borne the initial cost of the photographs, blocks and setting the text. There is still a sum of £48/6/3 owing to the General Fund, against which the sum of £6/14/9 still remains in the Savings Bank, and we have just received a further amount of twenty pounds from the Walter and Eliza Hall Trust towards the Handbook Fund. I am sorry that no further donations were received during last year to this fund, but hope that now we have successfully launched the first handbook, that the fund will be speedily built up again. It will be seen from the figures supplied that a fund of £500 is none too large with which to work, if we are to make a yearly issue of some form of handbook."

G. A. Waterhouse,
Hon. Treasurer.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES.

BALANCE SHEET AT 30th JUNE, 1922.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.	£	s.	d.
Capital	541	5	0	Investments at Cost				541	5	0
Income Account at 30th June, 1922	146	18	11	Cash—						
				Current Account	14	16	2			
				Savings Bank	77	1	9			
								91	17	11
				Handbook Fund—						
				Owing to General Account	48	6	3			
				Savings Bank	6	14	9			
								55	1	0
	£688	3	11					£688	3	11

RECEIPTS AND EXPENDITURE FOR YEAR ENDED 30th JUNE, 1922.

RECEIPTS.	£	s.	d.	£	s.	d.	EXPENDITURE.	£	s.	d.	£	s.	d.
Balance from 30th June, 1921				118	14	11	Publication "Australian Zoologist."						
Subscriptions				374	16	6	Printing	136	14	6			
Life Subscriptions				21	15	0	Blocks	89	1	8			
Sales "Zoologist"				2	11	7					225	16	2
Government Grant				49	19	10	Appropriation to Capital Account				96	0	0
Interest—							Books (Mathew's Birds)				16	16	0
Commonwealth Loans	27	2	6				Office Furniture				15	0	0
N.S. Wales Loan	2	15	0				Printing				28	2	6
Savings Bank	6	4	3				Office Accommodation				39	0	0
				36	1	9	Petty Cash—						
Exchange					8	6	Postages	18	9	11			
							Stationery	4	3	9			
							Sundries	2	6	4			
											25	0	0
							Advertising				6	15	0
							Sundries				4	19	6
							Balance to 1st July, 1922				146	18	11
				£604	8	1					£604	8	1

HANDBOOK FUND ACCOUNT FOR YEAR ENDED 30th JUNE, 1922.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Balance from 30th June, 1921	196	3	7	"Fishes" Handbook—			
Sales	26	0	0	Printing Plates	94	6	0
Savings Bank Interest	6	11	2	Printing Text and Binding	179	15	0
Balance to 1st July, 1922	48	6	3	Index	3	0	0
	£277	1	0		£277	1	0

Sydney, 7th July, 1922. G. A. Waterhouse, Hon. Treasurer.

We have examined the books and vouchers of the Society for the 12 months ended 30th June, 1922, and certify the above statements of Receipts and Disbursements and Balance Sheet to be in accordance therewith.

(Sgd.) L. S. Drummond & Co., Incorporated Accountants.

REPORTS OF THE SECTIONS.

Entomological Section.

The Committee beg to report on the operations of the first session of the Section's activity.

The first meeting was held in the Society's room on Wednesday, 12th October, 1921, the President of the Society occupied the Chair, and outlined the rules governing the formation of sections. It was decided to form an entomological section and to meet on the second Wednesday in the months of February, April, June, August and October. Mr. G. A. Waterhouse was elected Chairman of the Section, and Dr. E. W. Ferguson, Vice Chairman, and Mr. G. M. Goldfinch, Hon. Secretary.

During the year five ordinary meetings with an average attendance of thirteen were held. A special meeting in addition was held on 15th November, 1921, for the purpose of welcoming Mr. A. J. Nicholson, the newly appointed lecturer in Entomology at the University of Sydney, and M. A. Tonnoir, the Belgian Dipterist, who was passing through Sydney on his way to study the flies of New Zealand. The section also had the pleasure of welcoming at its meetings Mr. Clinton, of Victoria, Dr. Pemberton, of Honolulu, and Mr. O. W. Tiegs, of South Australia.

The exhibits at all the meetings were numerous and important. It was decided to recommend to the Council of the Society that cards be printed and issued to all members giving the dates on which the meetings of the Society and Sections are held.

It was also suggested that a short circular be printed giving the aims and objects of the Section, this circular to be handed to members of the Section for distribution amongst those interested in Entomology.

G. M. GOLDFINCH, Hon. Secretary. G. A. WATERHOUSE, Chairman.

Ornithological Section.

The inaugural meeting of the Section was held in the Society's rooms on April 21st, 1922, and there was an attendance of eleven members. The following officers were appointed:—

Chairman: Dr. E. A. D'Ombrain.
Vice-Chairman: Mr. P. A. Gilbert.
Hon. Sec.: Mr. N. W. Cayley.

Messrs. E. Nubling and C. W. Chisholm were elected to act with them as an Executive Committee.

The present membership of the Section is 34; this number we hope will be greatly increased in the near future, when the work and objects of the Section become better known.

Meetings are to be held on the third Friday in the months of February, April, June, August, October, and December. Special and executive meetings to be held when necessary.

The following items have been discussed and action taken thereon:—

- The establishment of permanent camps in suitable localities for bird observation purposes.
- The exhibition at sectional meetings of specimens of birds, nests, eggs, or photographs bearing on bird life.
- The action of the Trustees of the National Park in allowing the timber to be cut down for milling purposes.

The Wild Life Preservation Act and Gun License, and the appointment of Hon. Rangers.

All these matters have been thoroughly investigated, and action has been taken relative to the timber felling in National Park. A deputation has been arranged with kindred societies—Royal Society of N.S.W., Linnean Society of N.S.W., Wild Life Preservation Society, and the Australian Museum—to meet the Trustees of the National Park on Wednesday, July 26th, to protest against the continuance of their action.

A number of the members have offered their services to act as hon. rangers, and on enquiry I find the Department will be pleased to avail themselves of this offer.

Action has been delayed relative to the Wild Life Preservation Act and the Gun License Act, awaiting the new clauses which, it is understood, are being prepared by the authorities.

It is our intention to arrange a series of lectures, illustrated with lantern slides, and members of the affiliated societies who are not already members of this Section are invited to join up and help to make the section a big factor in furthering its objects, i.e., to popularize and further the study and protection of our native birds.

NEVILLE CAYLEY,
Hon. Secretary.

WHY NOT PROTECT THE FUR SEAL HERDS OF THE SOUTHERN HEMISPHERE.

By G. Dallas Hanna,

California Academy of Sciences, San Francisco, U.S.A.

(Communicated by A. F. Basset Hull).

The northern hemisphere has developed an enviable reputation as a producer of fur seals, but in all, it contains only four herds. The three most important of these resort to islands in the possession of the United States, Russia and Japan. The fourth, now practically if not entirely exterminated, is that of Guadalupe Island, off the west coast of Mexico.

In contrast with this condition the southern hemisphere contains a large number of islands which are known to have been fur-seal breeding grounds. Through relentless slaughter, the larger herds were exterminated soon after their discovery, and many of the smaller ones are visited and raided at irregular periods. It appears that, as soon as a herd increases so that it has a start toward recovery, some vessel visits it for skins and kills every animal which can be found.

Many of these islands belong to the colonies of Great Britain—Australia, New Zealand and South Africa. Once they contained rookeries which rivalled the largest and finest in the world. A few of the many examples will suffice to demonstrate the point.

The South Georgia Islands furnished 1,200,000 skins. Mas-a-fuero and Juan Fernandez Islands furnished over 3,000,000 which shows that their herds were originally as large as, or larger than, the famous Alaska herd. 400,000 animals were killed on Antipodes Island in one year, while Macquarie Island provided 40,000 skins. The Auckland Islands, South Shetland Islands, the islands south of Australia, and along the west coast of South Africa, have furnished hundreds of thousands of fur-seal skins in years gone by, but the wholesale slaughter commercially exterminated each rookery soon after it was discovered.

To-day, the best these once mighty herds can produce is an irregular and insignificant number of pelts. They appear to be taken and prepared by persons who are inexperienced in the work and merely as a side issue to other pursuits, such as fishing. The quantity and quality of the few pelts which filter into the fur markets are small and poor, and they usually bring inferior prices. History has shown that if proper protection had been given the great herds and all slaughter confined to regulated land killing, the world would have been provided with peltries a thousand fold greater in number than the original slaughterers secured. Or, if the herds were given absolute protection in the sea from this date on, and killing on land were confined exclusively to surplus males, there is no doubt but that in a few decades the rookeries of the south would grow to rival the largest in the world, not only in size, but also in commercial importance.

The most famous herd in the world to-day is that which resorts to the

Pribilof Islands in Alaska. It has had its ups and downs, and a brief account of what has been done with it may serve to illustrate what can doubtless be done with the herds of Australia, New Zealand and elsewhere, if prompt but decisive measures be taken.

No one knows how large the Alaska herd was when the Russians discovered it in 1786, but from a careful study of all existing records and seven years' experience on the ground the writer does not believe that it was then any larger than when the United States obtained it in 1867. During the first period of 80 years, the herd was almost exterminated once through injudicious killing of females on land. Yet it regained its full strength. In 1872-73 there were approximately 2,500,000 animals there, and for 20 years preceding 1890 the annual catch was about 100,000 skins.

Three years after it obtained the herd the American Government made the serious mistake of letting out the sealing privilege on a 20-year lease. Rival bidders, thwarted on land, outfitted vessels for hunting in the sea, and they were so successful that a law was passed which made the work illegal. The hunters, however, merely transferred their flags and made Canadian ports their home.

Then ensued a long period of litigation and arbitration, but not one action which was taken proved beneficial to the herd. The animals were protected for many years inside a zone of 60 miles radius about their breeding grounds, but the females went outside the line to feed and were slaughtered in large numbers. This zoning agreement was only between the United States and Great Britain. Other countries could hunt right up to the territorial three-mile limit with immunity, and Japanese subjects availed themselves of the opportunity.

The herd was reduced steadily from 2,500,000 in 1867 to the remnant of 127,000 in 1911. The last lease of the sealing privilege expired in 1909, and the Government has undertaken the operation of the industry since. When it became evident to those concerned that a continuation of pelagic sealing meant only ultimate loss to all and the removal of fur seals from commerce forever, diplomatic machinery began to move and the result was the treaty of December 15, 1911. Ten years have elapsed since it was signed by Great Britain, the United States, Russia and Japan, and the effectiveness of the legislation is fully demonstrated by the following official census records:—

1912	215,738	1917	468,692
1913	268,305	1918	496,432
1914	294,687	1919	524,235
1915	363,872	1920	552,718
1916	417,281	1921	581,457

The herd has increased from 215,000 to 581,000 in the short space of ten years. The class of breeding cows has shown an annual increase on the average of 8.9 per cent. and it is this element in the herd which controls absolutely the growth of the herd.

In addition to the very satisfactory condition shown by the above table of census figures, commercial sealing on land the last four years by the Government has resulted in the taking of 113,026 skins of surplus males. 42,109 of these were sold up to the end of 1920, and the total receipts were 3,584,059 dollars. It is very evident from this that a fur-seal herd may be considered a financial asset of no mean proportions to any country. It must, however, be given protection and careful management.

While the treaty referred to has been very successful in increasing the size of the herd it has some weak points. These can be brought up for con-

sideration and correction in 1926 or thereafter upon written notice, given one year in advance by one of the contracting parties.

In the first place, the treaty gives protection in the sea only to the fur seals of the Pacific Ocean north of north latitude thirty degrees. All those of the rest of the world are left open to attack at any time. This should be corrected at the very earliest opportunity and general protection extended to all oceanic waters in order to permit the herds of the southern hemisphere to develop to their fullest extent.

Under the treaty, only the subjects of the four countries named are forbidden to hunt in the protected zone north of thirty degrees. Citizens of any other country might go there at any time and cause a repetition of the near catastrophe so recently seen. Moreover, the subjects of any of the countries party to the treaty might go to the vicinity of southern herds and kill as much as they please up to the three-mile limit of territorial waters. In fact, it does not seem that in many, if any, of the countries which own herds are there laws which would forbid a foreign vessel hunting in territorial waters or on the breeding rookeries themselves. The herds can never be expected to become more than insignificant remnants under such management.

It is acknowledged by the laws of nations that all animal life of the open sea is common property. Therefore, in order to give worth while protection to any valuable species such as fur seals, requires treaty action. To insure a protection which will protect, it is necessary that all maritime countries sign any measure which may be drafted. Therefore, the present North Pacific treaty should be extended to include other countries than the present four and those States of the south which own islands where seals breed should insist upon becoming parties to it in order to insure protection to their own herds.

Since the animals which resort to the high seas are common property during that part of their existence, any country might put in a claim for a share of the land catch for the relinquishment of its right to take its share of the property in the open. This was done in the four power treaty referred to, and as a consequence the United States divides its land catch with Great Britain and Japan; Russia divides hers with the same countries and Japan shares with the other three. Since, however, it would manifestly be an impossibility to divide with all the maritime countries of the world this matter should receive adjustment at the first opportunity. The United States, for instance, could claim a share in the Australian or New Zealand land catch, and any other country might do the same, whether it owned a fur seal herd or not. The time may well come when any country which owns a breeding ground, in order to insure protection to the animals which resort there, would have to divide its land catch with so many other countries that it would have nothing left for itself if the policy of the present treaty be continued.

By following the same general plan in the southern hemisphere which has been adopted in the north, it is believed the vanishing herds can be preserved and eventually increased to their original enormous size. Fur seals are so polygamous in habit that there is a large surplus of males which, in the north, can be taken without disturbance of the breeding grounds. Presumably, the same could be done in the south. The sealing on land should not be leased to private parties, but should be retained as a government industry, operated by duly appointed agents. Only as a government monopoly can competition and trade jealousy be avoided. The first and primary requisite of any legislation should be the absolute protection of the females at all times and everywhere.

It is hoped that the southern species may receive careful consideration by the proper authorities in the near future, and that the very existence of them may not much longer continue in jeopardy.

Dr. Dallas Hanna's paper has come at a most opportune time, and it affords me the greatest pleasure to communicate it to the Society. During a visit to the Archipelago of the Recherche, Western Australia, in December, 1921, I was enabled to gather a good deal of information relative to the Fur Seals found in that locality.

Last year an expedition collected some 300 skins of a Fur Seal, and sent them to America for sale. I was informed by the agents that they realised a very small price, so that the venture was a financial failure. It was stated that they were not the true fur seal, but there seems to be some doubt as to whether this was the actual reason for the low prices realised, it being considered that the impossibility of having the skins treated for market by Russian experts was the true explanation.

Although I visited many islands in the Archipelago, and saw numbers of the hair seal, I did not see a single fur seal, but many bones were seen. These animals are not protected so far as the Archipelago is concerned, and no permit is required to take them there. Doubtless on the outlying islands, which are very difficult of access, fur seals may still be found, but unless strict measures are taken for their protection they will soon disappear.

The question of their protection is, it is understood, occupying the attention of the Commonwealth Government.

A. F. Basset Hull.

NOTES ON THE NESTING AND BREEDING HABITS OF THE HOUSE BUILDING RAT (*CONILURUS CONDITOR*) AND BANFIELDS RAT (*UROMYS BANFIELDI*).

By A. S. Le Souef, C.M.Z.S.

Plates I. and II.

The nesting habits of the House-building Rat have long been known to Naturalists, as they were observed by Captain Sturt, the first white man to penetrate the West, on his expedition to Central Australia. He described the nests as made in the form of a beehive, with a diameter of about four feet and about three feet high. Sir Thomas Mitchell further noted that the structures are built round a small tree.

I met with this species during a visit to the Nullarbor Plain in July, 1921, and noted that in that part of the country its habits were different from those previously described. The rodent is an inhabitant of the plain proper, and does not approach the tree line. Its characteristic heaps of sticks are to be observed about 10 miles out from Ooldea, and are very numerous from thence on, especially round Fisher, where there is nothing to be seen but Salt and Blue-bush, with a few herbaceous plants and a little grass. The nests are rather irregular, flat structures, and made up of about a barrow-load of sticks and foliage of the surrounding bushes, in the centre of which is a well lined living chamber. If sticks are scarce, or the position of the home exposed, the rats show some little thought and engineering ability in placing numerous stones, from one to two inches in diameter, over and through the sticks, thus giving the structure greater weight and solidity. The little creatures have also learnt to appreciate the value of and the security afforded by a somewhat large excavation below them, for the nest is invariably placed over a rabbit warren, with connecting bolt-holes leading into the rabbits' quarters; this apparently provides greater safety than the central bush, and I certainly found the inmates by no means easy to secure.

Sir George Grey first noted the peculiar habit of this genus of carrying the young attached to the nipples. He states "The specimen of a female had three young attached to the teats when caught; the mother has no pouch, but the young attach themselves with the same or even greater tenacity than do the young of the Marsupialia." I am glad to be able to confirm this statement. A female, caught in July, 1921, had four young attached to her nipples, they were little hairless things about an inch long, and were dragged along on their backs. It was extraordinary that, although the mother ran with great rapidity over some rough stony ground, the young did not become detached; further, she travelled in a small wire trap which was packed away in my suit case, all the way to Sydney without any harm to herself or to her family, two of which are alive to-day in Taronga Park. The young grow very fast, and at two months are right side up, and upon their own feet, though still holding on to the nipples and following the mother's every movement.

A pair of these young ones bred again at eight months old. The young was first noted on March 18th, 1922, when about an inch and a half long, and in two months it was one third the size of its parents and darker in general colouration.*

This species has the habit of whipping the tail quickly and spasmodically against the ground or any intervening object, which is apparently a signal of danger as they only do it when alarmed.

This extraordinary method of carrying the young is also followed by Banfield's Rat (*Uromys banfieldi*), and probably by all the members of the genus. Mr. Banfield, the well-known author, and resident of Dunk Island, Queensland, has kindly sent me the following note on this species: "Soon after birth, the young, then the tint of a half ripe tomato of the red variety, cling to the teats and are borne about by the mother until they are able to take care of themselves. I have frequently seen my dogs kill the parent with the young attached to her." This rat makes a nest of shredded bark or dry grass placed in a hollow log or at the base of the adventitious roots of the Pandanus palm.

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* Two more young were born on May 8th, just 7½ weeks after the first family. It is interesting to note that the young are born in a much more forward state than those of ordinary muridae.

ON THE BREEDING HABITS OF SOME AUSTRALIAN FROGS.

By Launcelot Harrison, B.Sc., B.A., Department of Zoology, University of Sydney.

With a Text-figure.

Introduction.

Except for a valuable paper by Fletcher (1889) on oviposition and breeding habits, the description of tadpoles of a few Central Australian species by Baldwin Spencer (1896), an account of the spawning of some Tasmanian species by English (1910), and a recent account of the breeding of *Heleioporus* by Dakin (1920), no attention has been given to the life histories and development of Australian Batrachia. Since Australia possesses a rich frog fauna, and since the varying environmental conditions would lead one to expect interesting adaptations, it may seem a matter for surprise that Australian zoologists have not given their attention to such a promising subject. But, for one thing, zoologists are few and problems are legion, and for another, the cryptozoic habits of most of our frog species tend to make their study difficult.

Two factors are responsible for my interest in the subject. On my return from active service in 1919, the problem of respiration in the *Pseudophryne* larva, in the absence of external gills, to which my attention had first been directed by the late D. B. Fry some years before, recurred to me; and an examination of the series of sections of tadpoles contained in the collection of the Zoology Department at the University of Sydney showed that most of the material had not been accurately determined, and that most of the sections were of a species of *Limnodynastes*, which is not a very favourable form for class study, as it does not correspond at all closely with the descriptions of *Rana* tadpoles available in text-books. So I set out to study the development of *Pseudophryne*, and to look for a type more generally suitable for class purposes.

In the course of field work extending over two years and a half, I have accumulated a considerable amount of material and information, and the present paper constitutes the first of a series of contributions to a knowledge of the life-history and development of Australian Batrachia. It will be followed by a description of the tadpoles of a number of species of frogs, after which I hope to deal *seriatim* with a number of individual developments.

I have to thank Mr. Allan R. McCulloch, of the Australian Museum, for assistance in verifying my determinations of a number of frog species.

Methods.

To one commencing the study of the breeding habits of Australian frogs, the wealth of species is in itself an embarrassment. The identification of voices

when a number of species are collected together in a single body of water is difficult, and the accurate determination of the deposits of spawn still more so. To attempt the latter from daylight observations only is certain to lead to error, as the spawn is almost invariably deposited at night, and the parents have usually retired to secure hiding places by morning, so that any determination can only be a guess.

I have found it satisfactory to work at night with an electric torch, visiting at first only temporary pools formed after rain, in which the presence of frogs was indicated by their croaking. A number of such pools occurred on vacant lots close to my house at Mosman, and these I was able to keep under nightly observation.

In one of these, when I first began to visit it in September, 1919, three species of frog were present, *Crinia signifera, Limnodynastes tasmaniensis,* and *Hyla ewingi.* The spawn of *Crinia* I knew, that of the *Hyla* was easily recognised from Fletcher's description, so that when *Limnodynastes* spawned a little later than the other two, I was able to make certain of my identification. At a later date three other frogs were added to the fauna of the vacant lot in which this pool lay, *Hyla coerulea, Pseudophryne bibronii,* and *Uperoleia marmorata.* The first of these spawned, but I learned nothing of the breeding habits of the remaining two species at this place.

Having gained a nucleus of frog lore by means of observations on this pool, I was gradually able to extend my operations, and came to recognise the voices of a dozen species of frog. But this knowledge was not of much avail when, as at Thirroul, in January, 1920, I found five species of *Hyla,* viz., *H. coerulea, H. aurea, H. peronii, H. ewingi,* and *H. dentata,* all apparently engaged in breeding in the same swamp.

As a check on field observations, samples of spawns were carried through as far as metamorphosis—a period varying from one month in *Pseudophryne australis* to upwards of six months in *P. bibronii,* and averaging about two months for most species—in aquaria in the laboratory. I found all the tadpoles dealt with quite hardy, and they did well in quite small aquaria with a little *Elodea* growing in the sand of the bottom, with a few bread crusts for food. At metamorphosis means must be provided for the frogs to leave the water, otherwise they drown. Eggs should be left in the pond water in which they are brought to the laboratory. Tap water causes maceration within 48 hours. As the tadpoles hatch, they should be removed to the aquarium.

For preservation I have tried most of the methods recommended, and find the most satisfactory to be:—

For eggs and early stages in jelly, 10% formalin, which leaves the jelly perfectly clear, so that details of segmentation, etc., can be observed very easily. Stages fixed in this way, and put into small glass tubes, are very suitable for class work, as they may be rapidly examined with a hand lens.

For later stages, I find the formula recommended by Bles (1905, p. 792) excellent. It kills instantly, penetrates rapidly even in the cold, so that mitotic figures are observable in the internal tissues, and has the advantage of acting as a preserving fluid also, so that no changing is necessary. It preserves colours and markings in a more life-like condition than any other fluid of which I have had experience, chiefly owing to its quality of leaving almost unaltered the transparency of tissues, so that the chromatophores are not obscured by the opacity of the epidermis. It is clean, and forms no precipitates. For histological detail it is also excellent. The relations of the most delicate endothelia are preserved without distortion, and the cell outlines and nuclear structures are delightfully crisp and clear in my sections.

The later stages in jelly are easily fixed satisfactorily in the following way. Two or three at a time are thrown into a petri dish containing Bles' fluid, a pair of sharp needles is thrust quickly through the vitelline membrane at opposite poles, and pulled apart. The elasticity of the living tissues of the larva allows of a considerable amount of stretching, and, as soon as a break occurs in the vitelline membrane and surrounding jelly, the larva slips out, shortens to its normal proportions, and fixes in a natural state of extension. If the spawn be fixed as a whole, and dissection out made after the death of the contained larvae, not only are the latter considerably flexed, owing to their cramped position within the vitelline membrane, but they are very brittle, and in dissection it is difficult to avoid breaking them.

After fixation with any fluid in ordinary use, and preservation in alcohol for some months, eggs or larvae may easily be dissected from the jelly; but Kallius' Zenker method, mentioned by Graham Kerr (1919, p. 568), I have not found satisfactory.

I have cut perfect series of sections of the difficult earlier stages, without double embedding, by use of the cedar-oil method. The eggs and young larvae, after carrying to absolute alcohol, are floated on the surface of a small vessel of cedar-oil, and the time that they take to sink, usually about ten minutes, is noted. They are then passed into melted paraffin of 52° melting point in the bath for the same period of time, and immediately embedded.

General Considerations.

Fletcher (1889, pp. 361-365) has given an admirable discussion of the causes which determine the breeding season with Australian frogs. The stimulus to oviposition is the fall of rain. Bles (1905) has shown that this is the case even with a wholly aquatic frog like *Xenopus*, which never leaves the water. It is certainly so with all the Australian frogs of which I have experience. Species like *Crinia signifera* and *Hyla ewingi*, which breed indifferently all through the year, and which may be heard calling in bodies of permanent water at any time, rarely oviposit except after rain. Other species, the breeding season of which would appear to lie within definite limits, have their opportunities for breeding determined by the times at which rain falls within these limits.

Although my information is hardly sufficient to justify dogmatic statement, Australian frogs would appear to be roughly divisible into three categories, having regard to their breeding habits.

The first of these includes certain small frogs, spawn of which may be found in any month of the year, after rain. These are *Hyla ewingi, Crinia signifera,* and *Pseudophryne australis.*

The second comprises the two species of *Limnodynastes* with which I am familiar, namely *L. tasmaniensis* and *L. peronii,* spawn of which may also be found throughout the year. But while in the case of the three frogs placed in the first category, I believe that the same individuals breed more than once through the year, with *Limnodynastes* I believe that each individual only breeds once, but that there is no definite breeding season, and individuals breed when they are ready to do so.

The third category includes those species which have a definite breeding season, usually a fairly extended one, stretching over some months according to weather conditions.

Thus *Hyla coerulea, H. aurea, H. peronii, H. phyllochroa, H. latopalmata, H. freycineti* and *H. dentata* would all appear to breed in the early summer, from October to January. Concerning *Uperoleia marmorata* my information is not sufficiently definite, but I have taken recently metamorphosed frogs in January,

at the same time as other summer-breeding forms were metamorphosing, so this species may also be a summer breeder only.

Pseudophryne bibronii, Philocryphus australiacus, and *Heleioporus albopunctatus,* on the other hand, are autumn breeders, and would appear to have a single and somewhat limited breeding season centering about the month of April.

Frogs would appear to use some discrimination in choosing water in which to oviposit, but I have rarely been able to fathom the reasons for their choice. It is obvious enough that fast running streams are not suited to the purpose, and where these constitute the only available water the frogs naturally choose quiet backwaters with grassy or sedgy margins, the spawn being placed on or among the vegetation, which prevents its being washed away down stream. Many frogs appear to prefer temporary pools, formed after rain, to permanent water. On the vacant lot at Mosman where I began my observations three such pools occurred, but for some months only one of these was resorted to for spawning. The two in which no spawn was observed drained rapidly, and were dry three or four days after the rain ceased. To say that frogs refrained from spawning in them because they knew that these particular pools did not hold water for a sufficient time to allow larvae to develop would be to credit the creatures with remarkable powers of observation and memory. But the pools were of precisely the same extent, depth, and general character when full, and the fact remains that these two were not used.

During the three months, September, October, and November, 1919, four falls of rain occurred, three of which filled the pools in question. On each of these three occasions spawn was deposited in the third pool, but each time it dried up before the resulting larvae were fully developed, and they were all destroyed. The same fate overtook all the other temporary pools which I had under observation in the neighbourhood, and of all the tens of thousands of tadpoles hatched out in this locality during these three months not a single one attained to metamorphosis. Heavy rains during the last days of December and the early part of January, however, followed by falls at reasonable intervals, kept the ponds full until well into March, and at the end of February tadpoles of several species were undergoing metamorphosis in large numbers.

Spawn collected early in the morning, and examined in the laboratory between nine and ten o'clock, was usually found to be in the early stages of segmentation, and very often in two-cell and four-cell stages, so it would seem that oviposition usually takes place early in the morning. A pair of *Hyla dentata,* captured *in amplexu* at night, spawned between six and eight the following morning. But this is not invariably the case. I have seen *Limnodynastes tasmaniensis* in the act of spawning in the middle of the afternoon; and have found spawn of the same species already deposited at nine o'clock at night; while I have occasionally collected eggs of other species showing advanced segmentation, indicating that they must have been laid several hours before.

Little attention has been paid to the oecological relations of Australian frogs, but these are occasionally of considerable importance, as in the case of *Pseudophryne* discussed below. A feature of outstanding interest is that, while Sydney possesses a frog fauna numbering upwards of twenty species, less than a quarter of these are found in the gullies of the Hawkesbury Sandstone which are the most conspicuous landscape feature of the district. On the shale caps of the ridges, and on the flats which occur along the shores of the various branches of Port Jackson, and of the Pacific itself, a varied frog fauna, numerous in species, flourishes. But in the smaller creeks of the gullies three species only are found, *Pseudophryne australis, Crinia signifera,* and *Philocryphus australiacus,* while in the deeper gullies, where run larger and more permanent streams, *Hyla phyllochroa* also occurs.

Breeding habits of individual species.

1. *Hyla coerulea* white.

Fletcher (1889, p. 381) states that, although this is one of our commonest species, he had never been able to catch it breeding. He captured tadpoles about to metamorphose in March, and males with breeding rugosities in January.

I spent somewhat more than two months investigating frog life at Mosman without having any reason to suspect that this frog occurred there. Following upon heavy rain in the middle of October, however, the frog began to call, and I found that it was very generally distributed both in gardens and in the bush-land surrounding them.

Hyla coerulea hides by day among heavy-foliaged creepers, and similar vegetation, in crevices among foundations and heaps of rubble, in storm-water pipes, and a variety of like situations, often at considerable distances from water. It visits the water solely for breeding purposes, arriving after night-fall, and usually leaving before daylight. On the first occasion upon which I found spawn, at half past six in the morning, a pair of the frogs were still in the water, but this is the only time I have seen them in the water by day. The limits of the breeding season would appear to lie between the first day of October and the last of January. Before the former date, the frogs do not call; while, after the latter, though individuals may be heard croaking on damp nights, I have not observed any migration to water.

This migration is a remarkable phenomenon, and may be observed any night within the limits mentioned, immediately after two or three days' rain. Apparently the frogs which have their habitation close to a breeding pool find their way to the water first, usually a little after eight o'clock. The ordinary note of the frog is a single gruff *"crawk,"* repeated slowly and deliberately—*"crawk-crawk—crawk—crawk" ad lib.* As soon as two or three are gathered together, however, the single note is changed to a double, as the rhythmic breeding chorus is begun. It then sounds like *"craw-craw, craw-craw, craw-craw—"* the second beat not being so loud as the first, and, from a distance, resembles the sound of a cross-cut saw passing backwards and forwards through a damp log. As far as I can make out, each individual utters both notes, the first on inflation, the second on deflation of the vocal sac. The latter is internal, sub-gular, the swelling not reaching to the chin as it does in the case of *Limnodynastes*. This chorus seems to stimulate and attract all the frogs of the same species in the neighbourhood, and for the next three hours they may be observed converging from all directions towards the water from which it is issuing. If an individual frog be watched, it will be seen to advance for a few yards by means of rapid hops, then stop and join in the chorus for a moment or two, then more hops, and so on. When it arrives within thirty or forty yards of the pond it seems to become very excited, and races for the water at top speed. On arrival it settles down to swell the chorus as if its very life depended upon the amount of noise it could produce. I have noticed frogs on their way to water fully a quarter of a mile in a direct line away from the nearest pond, and, as they had to find their way round blocks of houses, the distance they had to travel would be considerably more.

By nine o'clock perhaps a hundred frogs will have assembled, and the noise of the chorus is, at close range, almost deafening. Just how mating occurs amid this pandemonium I am not sure, but one isolated observation, made at Thirroul in January, 1920, seems to indicate that the female exercises some choice. I was sitting on the bank of a small pond in which a number of *Hyla coerulea* were calling, idly watching a male at my feet. Suddenly a vigorous splashing began on the further shore, and presently a large female dashed through the submerged grass, ranged alongside this particular male, and was immediately embraced. She

had passed several croaking males on her way, so would appear to have deliberately selected the one I was watching. In any case the males of this species do not appear to pursue the females as does the male of *Hyla aurea.* The chorus is continued, with intervals of rest, all through the night, but in the morning not a frog is to be seen, and deposits of spawn alone remain as evidence of the nights' gathering.

Hyla coerulea does not swim about in the open water, but sits, half-submerged, along the margins of pools. When disturbed, it will take to the water, but it is singularly indifferent to disturbance when preoccupied with its breeding chorus, and an electric torch may be held within an inch of the nose of a croaking frog without causing it to cease, or move away.

The spawn is disposed in more or less circular patches, a couple of inches in diameter, each containing between one and two hundred eggs, and each probably representing one "charge" of the ovisacs. The total deposit for a single female covers a space of about two feet square, and numbers between two and three thousand eggs. The eggs of each patch float in a single layer, each surrounded by a clear sphere of jelly, these spheres being again embedded in a scanty matrix of jelly. The spawn is on this account quite inconspicuous, for the jelly is invisible, and the dark brown upper poles of the eggs hardly show against the depth of the water. The general appearance is as if the eggs themselves had been peppered over the surface. The patches of spawn break up easily when an attempt is made to handle them, and I have found that the most convenient way of collecting the spawn is to allow it to float with the inrush of water into a jar submerged alongside it. Spawn floated into a jar in this way sinks to the bottom, and I have noticed that spawn in the field tends to sink after about twenty-four hours. Whether there is any intrinsic cause for this in the spawn itself I cannot say, but I think it probable that the spawn is deposited at the surface, and held there by surface tension, and that any subsequent disturbing influence, such as wind, rain, or the drinking of animals, may cause it to sink. The sinking of the spawn, which would appear to be common to a number of species of *Hyla,* explains why it has so generally escaped observation. On several occasions, when I have had reason to know that species of *Hyla* have been breeding in certain pools, I have not been able to find a trace of spawn, though tadpoles have subsequently appeared.

Fletcher (1889, p. 366), discussing the method of entanglement of gas-bubbles in frothy spawns, considers it improbable that these bubbles are produced by decomposition at the bottom of the pond, and accidentally entangled in the jelly surrounding the spawn. Observations on the spawn of *Hyla coerulea* show that this surmise is correct. Gas bubbles rising from the bottom under this spawn are caught in the alveoli between the separate spheres of jelly enclosing each egg, so that each sphere becomes surrounded by a mass of bubbles which are kept from reaching the surface by the scanty matrix in which the spheres are embedded. But the gas bubbles do not succeed in making their way into the jelly.

The egg measures 1.44 mm. in diameter, and the sphere of jelly surrounding it 2-2.5 mm. The pigmented pole is blackish-brown, the lower pole yellowish-white. As segmentation and overgrowth proceed, the egg becomes lighter in colour, until, at the yolk-plug stage, it is comparatively light brown. The larva hatches out in three days, at a stage when the rudiments of the first two external gills are just showing. Metamorphosis occurs in the field two months after hatching, but in my aquaria the larvae took over three months.

Actual dates on which spawning took place in 1919 were:—At Mosman, 16th October, 13th November, 24th November, 1st December; at Thirroul, 3rd January. Spawning must have occurred about Sydney on this last date, as, on my return

there on 9th January, I found all the ponds full of tadpoles. These tadpoles were metamorphosing during the last days of February. Those that hatched from the previous spawnings all perished, owing to the drying up of the pools. In 1920 I observed spawn at Gordon on various dates in November, December, and January (1921), and obtained metamorphosing frogs in the first week of the last month.

2. *Hyla aurea* Less.

The breeding chorus of this species, probably our best-known frog, has been known to me since childhood, and I was surprised to find that the species did not occur in the area which I had under investigation at Mosman. At Gordon, too, I know of only one colony, which is outside my ordinary beat.

At Thirroul, in January, 1920, I found the species breeding, and had the opportunity to make some observations which are not so complete as I could wish.

Fletcher states (1889, p. 365) that *H. aurea* produces white frothy spawn, but mentions two pages below that spawn laid in captivity was not frothy, and attributes this to the unnatural conditions under which it was deposited. Deckert (1915, p. 29) has repeated this statement, having apparently adopted it from Fletcher, but, as will appear later, Fletcher was in error, and all the white frothy spawn commonly produced in open waters belongs to some species of *Limnodynastes.*

Hyla aurea is, as compared with other species of the genus, distinctly an aquatic frog, and is commonly found either in the water or upon the aquatic vegetation in or about it. Fletcher (*loc. cit.*) gives the breeding season as "from about the middle of spring through the summer." The breeding chorus consists of four notes, the first long drawn out, the second somewhat shorter, and the last two quite short—"*craw-awk, crawk, crok, crok.*" Each note is uttered during inflation of the vocal sac, no sound issuing during deflation, so that four separate inflations occur. The vocal sac has the same general relations as in *H. coerulea.*

At breeding time the frogs play about the surface of the water, swimming and floating, the males calling at intervals, and pursuing and trying to embrace any frog which comes near them, whether male or female, of their own species or another. On one occasion, hearing a call at that time strange to me, coming from some feet up the trunk of a *Banksia,* I flashed my torch, which drove the frog to the ground, along which it hopped fairly rapidly. While I was pursuing, a second frog dashed at the first, and proceeded to embrace it. On capturing the two, the former proved to be a male *H. peronii,* while the latter was a male *H. aurea.* The frogs keep to the water by day, as well as night, and the chorus is continued at intervals through the day.

The spawn has the same general character as that of *H. coerulea,* eggs in spheres of jelly in a common matrix; but the egg is smaller and darker, the upper pole being black, the sphere of jelly surrounding it is also smaller, while the matrix is more profuse. I have not found this spawn floating at the surface, but believe it may do so. The deposits I have seen were submerged, and entangled among grass stems, etc., in a quite irregular fashion. The egg measures 1.4 mm. in diameter, and the surrounding sphere 2 mm.

Spawn brought from Thirroul to the University did not stand the journey well, and only a few tadpoles hatched. Of these one alone survived to metamorphosis, five months after hatching. I do not think that this lengthy period is normal. Owing to press of work, my aquaria were, in the middle of 1920, a good deal neglected. Probably the normal period is much the same as that of *H. coerulea,* about two months in summer weather.

3. *Hyla peronii* D. & B.

I first met with this frog at Thirroul, in January, 1920, where it was calling both from the trees and the water of the swamp. The following December it was vociferous at Gordon, but I never heard it in the Mosman area.

Deckert (1915, pp. 27-8) describes its call as follows:—"When the plants in the Reptile House are being syringed in the morning and evening, the sound of the splashing water stimulates this tree-toad to giving voice to its loud call. This call resembles the noise of the pneumatic drill used by structural iron workers, and might be described as a loud metallic rattling. The throat pouch is expanded into a large globe, larger than the tree-toad's head, while the entire body vibrates with the force of the exertion used in producing the call."

I have not succeeded in watching the frog call, but I noted, at the time of first hearing it, that the call sounded like *"cook-cook, cook, cook—cook, cook, cook"*; the first note being deliberate and explosive, and the triplets shorter and even. From the sound of it, I should think that the vocal sac is kept inflated during the whole call, and serves as a resonator in the same way as it does with *Limnodynastes*. The nature of the call precludes anything like a rhythmic breeding chorus.

I have not determined the spawn with certainty, but believe that deposits of floating spawn, closely resembling that of *H. coerulea*, but with eggs a little smaller and darker, are attributable to this species. These I have observed several times at Gordon Railway Station during November and December, 1920; and I noted metamorphosing tadpoles in the first week of January, 1921, in the same place.

4. *Hyla latopalmata* Gthr.

The only adult individuals of this species which I have seen were brought me from the Brisbane River by one of my students, Mr. T. M. S. Hall. I know nothing of the economy of the frog beyond the fact that I collected a series of young ones, which had just completed their metamorphosis, on the edge of a large heath swamp at Nelson's Bay, Pt. Stephens, in January, 1920.

5. *Hyla phyllochroa* Gthr.

This pretty little frog is extremely common in the deeper gullies running down to Middle Harbour from the North Shore line, and in similar gullies running to the Lane Cove valley from the main northern line. In the winter months it may be found hibernating under stones in creek-beds, sometimes half-a-dozen together.

My observations on its breeding habits are not extensive. Some frogs captured *in amplexu* at Beecroft on 18th September, 1919, by Miss B. Somerville, spawned during the night in the laboratory. On the 21st of the same month I saw large numbers of this frog in the Stony Creek, close to the suspension bridge, at Gordon, at eleven o'clock in the morning. They were calling vociferously, the note being a somewhat deliberate *"kuk-kuk-kuk."* On going down to the creek, I found many frogs sitting about on the mud, or on logs lying in the water, singly or in pairs, but none actually in the water. I could see no sign of spawn, but a pair, caught *in amplexu*, spawned during the night.

I cannot reconcile the two deposits of spawn which I obtained from captive frogs with Fletcher's description. He says (1889, p. 382)—"The pigmented pole of the ova and the young tadpoles themselves are rather pale yellow." The eggs I obtained have a black upper and white lower pole. My determination of the frogs has been verified by Mr. Allan R. McCulloch, of the Australian Museum, and an examination of the ovaries of other females of this species proves that

the eggs are black and white. The eggs which Fletcher describes would appear to be those of *Hyla ewingi,* which vary somewhat in colour according to the state of segmentation.

One of my deposits of spawn was apparently not fertilised, as it did not develop. The other segmented, but macerated during my temporary absence from town, so I have no information about the later stages.

The egg measures 1.2 mm., and the surrounding jelly sphere 2 mm. There is a matrix as in the other species of *Hyla.* I have not observed spawn in the field, but, from the appearance of that laid in captivity, should think that it is deposited, or immediately sinks, beneath the surface, and becomes adventitiously entangled in weeds and submerged grasses.

6. *Hyla dentata* Kef.

I first became acquainted with this frog at Thirroul in January, 1920, and have subsequently found it common in the Richmond River and Gosford districts. A small colony lives in the quarry in Avenue Road, Mosman, but I have not come across it elsewhere in the northern suburbs of Sydney.

At Thirroul, the frog was breeding in large numbers, and its ear-piercing call was almost deafening. The vocal sac is external and very delicate, and swells out to a size almost twice that of the head of the frog as it utters its long drawn-out, single note, *"cree-ee-ee-ee-ee,"* which is tremulous at close quarters, and almost amounts to a scream. *H. dentata* sits round the edge of the water, among grasses, and its spawn, which resembles very closely that of *H. phyllochroa,* is deposited in an irregular mass tangled about the grass in extremely shallow water. The tadpole at hatching is very bright yellow, and the much branched external gills are rapidly developed at, or immediately after, hatching.

I found spawn during the first week in January, and a pair captured *in amplexu* on the 4th spawned between 6 and 8 a.m. on the 5th.

7. *Hyla ewingi* D. & B.

This little frog is perhaps the most generally distributed member of its genus about Sydney. On wet days I hear it calling under the windows of my Department at the University, though the building is about a quarter of a mile from the University Pond, the nearest available water. And wherever I go about Sydney at night I hear its high, hurried, piping, *"cree-cree-cree-cree-cree."*

It may usually be heard in water at night, whether breeding or not, and it calls and breeds throughout the year. By day it hides under stones, logs, and bushes, usually close to water.

I have found spawn in every month of the year. It is attached in a cylindrical mass numbering upwards of a hundred eggs to grass stalks and similar submerged objects. Each egg is surrounded by a relatively large jelly sphere, the whole being embedded in a common matrix. The latter is not obvious, and the spawn has the appearance of being composed of separate spheres, but when an attempt is made to handle it, the true nature of it is seen. In clean stagnant water the jelly remains clear, but in running streams a fine deposit of flocculent silt soon covers it, when the contained egg is rendered invisible.

The eggs have the pigmented pole a light brownish yellow, and the vegetable pole light yellow. They measure 1.2 mm. in diameter, and the surrounding jelly sphere 3-4 mm.

I have watched this species spawning, but the actual process of oviposition could not be observed as the frogs refused to carry on operations in the full light of the electric torch. The paired frogs swim rapidly under water to a suitable grass stalk, rest for a few moments, then the eggs are extruded apparently

in a single mass, the female passing right round the stalk at the moment of laying.

The tadpoles metamorphose in the field in summer weather in seven to eight weeks, but those in my aquaria required upwards of three months. English (1910, p. 633) describes the young tadpole as black, but this is an error, as it is light yellowish brown.

I have not succeeded in observing how the vocal sac is used in uttering the call. There is no continuous breeding chorus, but when one frog commences calling, all those in the neighbourhood immediately join in.

8. *Hyla rubella* Gthr.

Baldwin Spencer (1896, p. 171) records this species as breeding after rain in Central Australia, and took tadpoles in February, 1895, between Oodnadatta and Charlotte Waters.

9. *Hyla citropus* P. & L.

Fletcher (1889, p. 383) records spawn in September from Waterfall.

10. *Hyla freycineti* D. &. B.

Fletcher (1889, p. 386) records metamorphosing individuals from Botany in March and April; and suggests that the species breeds in the spring and summer like the others of the genus. I found one deposit of spawn in a quarry pool at Killara, which I believe to have belonged to this species, as an individual was present in the water. This was in January, 1922. The spawn was similar to that of *H. phyllochroa.*

11. *Pseudophryne australis* Gray.

12. *P. bibronii* Gthr.

The specific distinction between these two forms has been but grudgingly admitted by European authorities. Boulenger (1882, p. 278) thinks that *P. bibronii* may prove to be a mere variety of *P. australis.*

Fletcher (1889, p. 376) writes:—" . . . . this view will not I think commend itself to anyone who is familiar with the frogs in their natural conditions. Not only is there a well-marked and very constant difference in colour and pattern, but the frogs differ more or less in temperament, in habits, and in regard to the breeding season."

Clunies Ross (1908, p. 147) details certain constant differences in colour-pattern between the two forms, *P. bibronii* having red or yellow spots behind arm and thigh, while these are dead white in *P. australis*; and the latter always has a white tip to every finger and toe, a marking that does not occur in the former.

Andersson (1913, pp. 17-19) is mildly satirical concerning Fletcher's differences in temperament and habit, but confesses to having seen no specimens of *P. australis.* This is quite obvious to anyone who knows the latter, and most of the author's discussion of colour pattern is, on this account, quite wide of the mark.

I cannot pretend to any herpetological experience, and would not wish to pit any conclusions of my own against those of competent herpetologists, but my study of these two forms shows that the systematist has a pretty problem to face.

I have examined some hundreds of each form in the field, as well as the large series of each contained in the collections of the Australian Museum. *P. australis* is absolutely constant in its distinctive markings, which are:—A T-shaped *orange* or *red* (never yellow) mark upon the forehead, the bar embracing the upper eyelids, and the stem extending forwards for a short distance between the eyes; a stripe of a similar colour along the urostyle; *white* spots behind

the arm and thigh; white tips to the toes and fingers. It may have, in addition, more or fewer red spots upon the dorsal surface. *P. bibronii may* have an indistinct *yellow* spot on the snout; has, at metamorphosis, a tri-radiate *yellow* mark along the urostyle and the back of each thigh, part or all of which may disappear later; has the spots behind arm and thigh *red* or *yellow*; and has not the white tips to the fingers and toes.

Whatever be the value of these markings, there is never the slightest difficulty in separating *P. australis,* which is quite constant, from any of the colour phases of *P. bibronii.* When the oecology and breeding habits of the two forms are studied, a number of differences are apparent. Fletcher (1889, p. 381) makes no distinction between the eggs and larval stages of the two forms. He writes:—"The ova and tadpoles of the two species are indistinguishable as far as I can see at present, the larval frogs not acquiring the colours of the adults." My observations absolutely contradict these statements. The eggs of *P. australis* are fewer in number and larger in size than those of *P. bibronii*; the tadpoles have a very different appearance, due mainly to three transparent lymph spaces, one anterior, and two antero-lateral, in the head of the latter; and both species develop the characteristic adult markings before the absorption of the tail begins. I can but think that Fletcher has reared the tadpoles of *P. bibronii* only.

The differences that I have noted between the two forms are many, and strongly contrasted, and may be summarised in tabular form as follows:—

P. australis.	*P. bibronii.*
(1) Confined to Hawkesbury Sandstone.	Widely distributed, but not found on Hawkesbury Sandstone.
(2) Breeds throughout the year, after rain.	Breeds once a year, in the autumn, April to June.
(3) Lays about 20 large eggs in a definite nest.	Lays about 100 smaller eggs, without definite nest.
(4) Tadpole larger at hatching, though the same size at metamorphosis.	Tadpole smaller at hatching.
(5) Tadpole self-coloured, slaty brown.	Tadpole mottled, brown.
(6) No transparent lymph spaces in head.	Transparent lymph spaces present.
(7) Metamorphosis in 4 weeks, after hatching.	Metamorphosis in 5-6 months after hatching.
(8) Orange markings appear on head and urostyle before metamorphosis.	Yellow or creamy stripe appears on urostyle before metamorphosis.

Those who are familiar with the geology of the Sydney district will realise that the majority of the characters which distinguish *P. australis* are direct adaptations to its habitat on the Hawkesbury Sandstone. This Triassic formation weathers into deep precipitous gorges, the bottoms of which are occupied by fair-sized creeks, torrential after rain, usually a series of pools in dry weather, and fed by innumerable laterals of varying size and permanence. The heads of these laterals are the main habitat of *P. australis.* During rain the bed is filled by a miniature torrent, which carries down masses of twigs and leaves, and piles them up to form temporary dams holding back small pools, or falls over miniature precipices to wear pot-holes in the rock below. On the borders of the pools, hidden among the debris, or among the masses of bead-fern (*Gleichenia*) and grass which surround the pot-holes, *P. australis* hollows out its nesting-chamber, and deposits its eggs. The tadpoles develop within the egg to

a fairly advanced stage, in which the buds of the hind-limbs are already present, and then enter upon a nesting stage until the next rainfall. The eggs are washed by the rain into pool or pot-hole, the larvae hatch, and, growing rapidly, leave the water while still almost fully tailed in four weeks.

This rapid completion of the life history is very necessary, as these small creeks soon dry up, especially in hot weather. The large amount of yolk contained within the egg would appear to serve the double purpose of allowing the tadpole to reach a more advanced stage of development in anticipation of rain, and of forming a reserve supply of nutriment in case the rain is long in coming. The tadpole is thus able, on hatching, to pass quickly through to its metamorphosis before the pools and pot-holes dry up. The more frequent breeding may be due to the fact that only a small number of eggs is produced at a time, or may be a provision for ensuring that some broods at least will meet with sufficiently favourable conditions to allow of their reaching maturity.

P. bibronii, on the other hand, which lays its eggs about the margins of the sluggish streams and stagnant ponds on the flat shale country, has no need of undue haste. I have stated above that *P. bibronii* is not found on the Hawkesbury Sandstone, but this is not strictly accurate. It does extend its range from the shale on to the tops of grassy sandstone ridges, but I have never found it on the slopes, or among typical sandstone flora. On the heights of Mosman it occurs sparingly, but, though I know one spot where the two forms may be found within two hundred yards of one another, I have never found them overlapping.

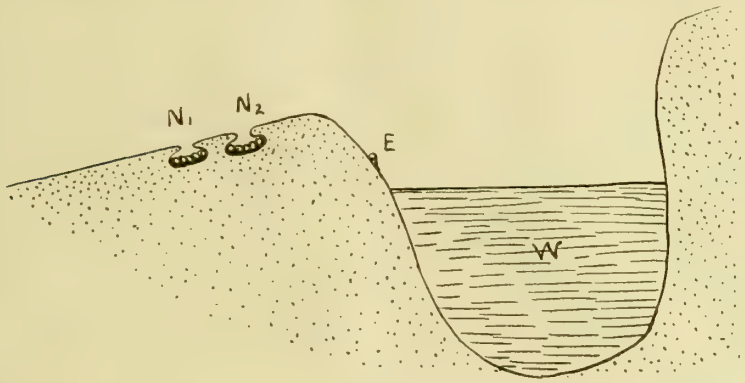
I leave to professed herpetologists the task of deciding upon the status of the two forms, but, as they differ so remarkably in both pattern and economy, I shall continue to refer to them by specific names. I would also suggest that the genus is not happily included in the Bufonidae. If *Crinia* belong to the Cystignathidae, it is my conviction that *Pseudophryne* should be placed there too.

Pseudophryne australis is a common frog along the courses of all the small creeks draining towards Middle Harbour. It announces its presence by a harsh, grating *"creek,"* sometimes repeated twice or three times, and uttered by day as well as night, especially in the afternoons. I have found the eggs in every month of the year, in cavities hollowed out among debris in the course of a stream, or hidden under the vegetation surrounding a small pot-hole. The species is socially inclined, and usually a number are found together.

Most of my observations were made during the latter end of 1919 on a colony which inhabited the border of a small pot-hole close to Central Avenue, Mosman. This hole was situated in a grassy hollow, dotted with clumps of sedge, and measured some three feet in diameter, with two feet of water in it when full. Long grass drooped down over the lower edge of the hole into the water, and among the roots of this grass the colony of frogs had their nests. Each nest was a sub-circular depression about 1½ inches in diameter, and a little over half an inch deep, scooped out in the damp soil, with the floor and sides tamped hard by the constant movement of the frog's body against them. Before oviposition, both male and female occupy the nest, but after the eggs are laid the female alone remains, and occasionally the nest is untenanted.

Owing to the disturbance caused by lifting the grass from above the nests, direct observation as to normal happenings in the latter have not been possible. This is to be regretted, as the frog would appear to have interesting nursing habits, and no such habits have hitherto been recorded amongst Australian Batrachia. Text-figure I. shows a diagrammatic section of the pot-hole and a couple of nests. These are below the level of the lower rim of the pot-hole, so that it is not possible during a fresh for the eggs to be washed into the hole. Yet I have frequently found them there, and also caught among the grass about

the lower margin, at a time when the pool was not flowing over. I am quite convinced, though I have never succeeded in viewing the operation, that the female, who remains with the eggs in the nest, pushes them to the water's edge and rolls them in at what she considers the right time. When the egg is first laid, it is surrounded by a thin coat of jelly, which is hygroscopic, and imbibes water until



Diagrammatic section of pot-hole at Central Avenue, Mosman. E, egg which has been rolled over the lower lip into pot-hole; N1, N2, nesting chambers of Pseudophryne australiis, with eggs; W, water in pot-hole.

it is enlarged to a comparatively large sphere. During this operation a change takes place in the peripheral layer, which loses its viscid adherent properties and forms a tough outer coat, which may be handled without sticking to fingers or forceps. Such an egg will roll freely down an inclined surface.

I think that the female must also keep the eggs moist with fluid from her own body. After a month of dry weather, eggs in the nests under observation were still turgid, while eggs kept in the laboratory shrunk rapidly in three or four days, and required moistening.

The eggs are laid after rain, and I believe the laying of the full complement, an average of twenty for the nest, takes four or five nights. I judge that this is the case from the partial clutches I have taken; the smallest being five eggs in the first division stage, and others being such numbers as nine, thirteen, fourteen, etc., suggesting that they are laid in batches of four and five. I have never carried my observations on an individual nest right through, as segmenting stages were too few and precious to be spared, and the removal of eggs puts an end to oviposition for the time being. For this reason I cannot state the minimum time which elapses between oviposition and hatching, but, as originally described by Fletcher (*loc. cit.*), the tadpole, having reached a certain stage of its development within the egg, can remain in a resting condition for several months, awaiting the rain that will release it. I use the word tadpole advisedly, for it possesses, before hatching, a fully formed mouth with frilly lips and horny jaws. a spirally coiled gut, and fairly large buds of the hind-limbs.

The segmenting egg measures 2.6 mm. in diameter, and the surrounding jelly sphere 7-8 mm. mm.

The pigmented pole is black, the pigment forming a small cap only at the upper pole of the egg, while the lower pole is dull white. When the egg reaches the

overgrowth stage, it becomes very light grey, owing to the distribution of the pigment over a larger surface, but new pigment is developed with the formation of the embryo, which is very dark in colour.

Pseudophryne bibronii has a wide distribution in Australia, but, as I have pointed out above, does not occur in the actual localities where *P. australis* is found. Its note is not so harsh as that of its congener, and is repeated up to six or seven times in succession. It does not croak so regularly during the day. The eggs are laid under logs, etc., close to water, in an irregular mass, but it does not dig a nest. On one occasion I found spawn exposed in a hole made by a cow's hoof in the muddy margin of a stream. I have found spawn commonly at Gordon during April and May. A pair of these frogs captured in embrace laid 130 eggs in twenty-four hours. The frogs are generally found in the same situations as the egg masses, but as these constitute their hiding places at all times, the association probably has no significance. The eggs are not kept turgid, as are those of *P. australis,* and I do not think the parent frogs take any further interest in them once they are laid.

Egg and embryo are similar to those of *P. australis,* but both are smaller. The egg measures 2 mm. in diameter, and the jelly 4 mm.

I have kept considerable numbers of these eggs in the laboratory, in petri dishes under small bell-jars, the atmosphere being kept moist. I have kept eggs containing fully developed larvae for just over four months, when, owing to an incautious flooding of the eggs for too long a period, hatching occurred. This accident, however, led to some rather interesting observations on the method of hatching.

The latter would appear to be brought about mainly by a process of osmosis. The jelly surrounding the egg imbibes water greedily, and, when moisture is present, is always in a turgid condition. When the tadpole is ready to hatch, it apparently either excretes or secretes something into the fluid within the vitelline membrane which raises its tonicity above that of the water contained in the jelly, with the result that the latter passes through the vitelline membrane, and the cavity containing the embryo becomes enlarged. If no external water is present, nothing further happens. But if water is introduced, the jelly takes up again what it has lost, with the result that a relatively great pressure is brought to bear upon the toughened outer coat (mentioned above), which finally bursts at one point, and the whole of the jelly is forced out in the form of a compact sphere. The tadpole is thus left within the two thin sacs formed by the vitelline membrane and the outer coat, out of which it easily works its way. In many cases the tail comes out first, and the tadpole wriggles round for some time with both these envelopes about its body.

This observation explains how rainfall brings about hatching under natural conditions. I was too busily occupied at the time to conduct any precise experiments, but I found that eggs put into normal salt solution did not hatch, so that the concentration of the fluid within the vitelline membrane is apparently not very great. But the fact that we have to deal with two membranes complicates matters, and it may be that the salt solution simply withdrew water from the jelly, and so prevented the pressure that would bring about hatching, in which case its tonicity would not necessarily have any relation to that of the fluid within the vitelline membrane. I hope later to conduct some further experiments which may afford a closer analysis of the hatching process. As to what the substance may be that increases the density of the fluid surrounding the larva, I have no precise information. But sections show that the cement glands are in a state of very active secretion at this stage, and it is possibly this secretion that has the effect of increasing the concentration; or the excretory products of the larva may have the same effect; or both factors may operate.

The secretory activity of the cement glands is interesting, as the stage at which these glands are functional in the majority of Anura is here passed within the egg, and the normal function is not exercised at all. The secretion may have the action indicated above. It certainly has the power to act upon and liquefy the jelly. If a small group of eggs be left in close apposition, and one happen to hatch, the remainder soon lose their spherical shape and collapse. This capacity for attacking jelly is shared by the cement gland secretion of most Australian frogs, and is particularly noticeable in the genus *Limnodynastes*, with which the intractable jelly matrix dissolves rapidly away as the tadpoles hatch.

The hatched tadpoles of *P. bibronii* are exceedingly hardy and tenacious of life. I kept several for three months after hatching in a petri dish, the bottom of which was just wet, so that the tadpoles were covered only by a film of water due to capillarity. They lived without food for the whole of this period, and, when transferred to the aquarium later, grew to metamorphosis quite successfully. During this period of deprivation, the tadpoles decreased slightly in bulk, but kept a healthy appearance except for the tail. This organ, contrary to what occurs during metamorphosis, retained its full length, but the dorsal and ventral fin-folds developed a white and necrosed appearance, traces of which survived right up to metamorphosis in the individuals transferred to the aquarium. I have not yet cut sections of these abnormal specimens, so cannot say what the actual condition of the tissues is.

13. *Crinia signifera* Gir.

This species is very common about Sydney, and is found in all kinds of situations, showing no preference for any particular environment. It breeds throughout the year after rain, and it and *Hyla ewingii* continue to call when all other frogs are silent. The note is an insect-like chirrup—*"crick-crick-crick,"* which becomes double in chorus—*"crick-ik, crick-ik, crick-ik."* The vocal sac is small, and swells out like a small pea in the middle of the throat as the call is uttered.

The eggs are deposited in all kinds of water, from shallow temporary pools to fast-running streams. In quarry pools where there was no grass or twigs I have found the eggs rolling about free on the bottom, but they are generally attached quite irregularly, sometimes in fairly large clumps, sometimes singly at intervals, to submerged grass, roots, or twigs, or to aquatic plants. The egg is black, with a creamy white lower pole, and measures 1.3 mm. in diameter. The jelly sphere measures 4 mm.

In captivity, two pairs of frogs each produced about 150 eggs, laid during the night. The development is much slower than that of *Hyla*, and the larva takes ten days to hatch. Owing to an accident to the aquarium in which these tadpoles were kept, I did not succeed in carrying them through to metamorphosis, but I judge, from their rate of growth, that this would follow about three months after hatching.

14. *Crinia laevis* Günth.

English (1910, pp. 630-631) gives an account of the spawning habits of this species, which makes a nesting chamber of the same type as I describe for *Pseudophryne australis*. This fact affords additional indication that the genera *Crinia* and *Pseudophryne* are closely related, and should not be separated in different families.

15. *Uperoleia marmorata* Gray.

Fletcher (1889, p. 376) states that a female of this species laid over 200 eggs, which had the pigmented pole black, the other cream-coloured, in the month of September. He also records clasping in August.

I have not up to the present been able to discover anything about the breeding of this species; though I did collect at Pt. Stephens, in January, a considerable series of just metamorphosed frogs. These were found along the margins of a large heath swamp.

I saw no sign of this frog at Mosman until the third week of November, when I was attracted by its call coming from some rubble alongside a fence. For three days I was not able to locate the frog, but was finally successful, my failure being due to the fact that I did not go deep enough, the frog being six inches below the surface. A few weeks later I observed it once or twice in the open, calling from under bushes. But I never found it in the water, and I obtained no information as to its breeding habits.

The ordinary call-note is remarkably un-froglike, and consists of a short, sharp, rather high-pitched *"akh,"* explosive in character, and very difficult to locate. It sounds more like the note of some limicoline bird than that of a frog. The internal sub-gular vocal sac swells to the size of a small pea during utterance.

16. *Philocryphus australiacus* Shaw.

Fletcher (1894, p. 235) describes the spawn of this frog as a frothy mass laid in a hole in the bank of a creek at water level. The individual ova are unusually large, like those of *Pseudophryne*, and the embryo has a large yolk-sac. Large external gills are developed before hatching, such not being the case in *Pseudophryne*. This spawn was found in April.

I have not succeeded in finding spawn of *Philocryphus* in a fresh condition, though I have kept a careful watch upon creeks in which tadpoles of the species are always to be found. In July, of 1920, however, while at Jervis Bay, I noticed a cavity passing under a flat stone lying on the mud of what had been a pond, which appeared to be worn by the body of an animal. On lifting the stone, I found a hollow about the size of a tennis ball; on the floor of which was a mass of dried spawn, which had obviously been of a frothy nature, and which contained eggs of almost the same size as those of *Pseudophryne bibronii*. I think that this cavity must have been a spawning place of *Philocryphus*.

Owing to its cryptozoic habit, the adult frog is rarely taken, but its tadpoles are amongst the commonest in small sandstone creeks. They may be distinguished quite easily by their large size, slaty colour, and sluggish movements. I have carried them through to metamorphosis in the laboratory, and have taken them metamorphosing in the field. Metamorphosis occurs only during October and November, so there is apparently only a limited spawning season in the autumn.

Fletcher (*loc. cit.*) states that he can not attribute any note to this frog. I suspect that a soft hooting note—*"oo-oo-oo-oo"*—which I hear quite commonly in the autumn in places where I know *Philocryphus* to be found, is uttered by this frog. The note is more like that of an owl, than that of any frog with which I am familiar, but it is, nevertheless, somewhat similar to the harsher, more staccato call of *Limnodynastes tasmaniensis*.

17. *Heleioporus albopunctatus* Gray.

An interesting and fairly complete account of the breeding habits of this frog is given by Dakin (1920). In the case of the colony of frogs observed, a mass of frothy spawn was deposited at the bottom of a vertical shaft about eighteen inches deep, dug in the damp sandy soil of a Perth garden. The individual eggs were large, and the larva developed to a fairly advanced condition within the egg. The external gill stage was passed through while the larva was still within the egg.

18. *Heleioporus pictus* Peters.

Baldwin Spencer (1896, p. 169) gives a description of the tadpole of this species, found at Ayer's Rock, Central Australia.

19. *Limnodynastes tasmaniensis* Gthr.

I have found the spawn of this widely distributed species in almost every month of the year, both in running creeks and stagnant ponds. The spawn of this and the two following species has the same general character, a patch of foam like soap suds, rising to a height of about an inch above the level of the water, and composed of a gelatinous matrix in which large bubbles of air are entangled, and in which the eggs in their separate jelly spheres, are embedded. The mass, in the case of *L. tasmaniensis,* measures from 2½ to 4 inches in diameter, and is notably smaller than that of *L. peronii,* and *L. dorsalis.*

At Bowral, in September, 1919, I watched a pair of these frogs apparently engaged in spawning in broad daylight, in the middle of the afternoon. They were floating under the mass of spawn already produced, and I was not able to get a clear view of their actions. But beyond a few feeble movements of the limbs, apparently simply to keep position, I could see no indication of beating up the matrix to entangle air in it, and the spawn appeared to be extruded from the ovisacs in the condition in which it is found.

Although this frog usually spawns only after rain, I was surprised to see a fresh deposit of spawn in Warrah Creek, near Willowtree, on 8th November, 1919, in the middle of a prolonged drought.

The note of *L. tasmaniensis* is very characteristic, and is uttered in two keys, a lower—*"cook-cuk-cuk-cook,"* and a higher—*"kuk-ku-kuk."* The vocal sac extends forwards to the chin, as in *Bufo,* and is kept inflated for long periods at a time, the four call notes merely causing a quiver of the tense surface.

The eggs are small, 1.3 mm. in diameter, intensely black with a small white lower pole, and the tadpoles in their early stages are very densely pigmented. Only rudimentary external gills are developed. It is a curious fact that the lungs are developed, and become filled with air, five days after hatching, although metamorphosis does not occur until four or five months from hatching.

20. *Limnodynastes peronii* Dum. & Bibr.

The spawn of this species much resembles that of *L. tasmaniensis,* but the patches are larger, measuring 4 to 6 inches in diameter. The frog seems to prefer shallow grassy ponds, and the egg-mass is usually deposited about the margins of clumps of sedge, in which it becomes more or less entangled. Consequently it often happens that the spawn is left high and dry as the water subsides, and becomes desiccated and destroyed. At Austinmer this species spawns regularly after rain in the gutters of the streets, in depressions made by the hoofs of tradesmen's horses, a situation in which no tadpoles can hope to win through to metamorphosis.

The note of *L. peronii* is an explosive *"toc,"* the vocal sac being used as a resonator, as in the case of the last species. When a number are gathered together at breeding time, they make a quite pleasant and noisy popping chorus, like a not very skilfully executed *feu-de-joie,* heard from a little distance.

This and other, *Limnodynastes* tadpoles are easily recognised by the pineal body appearing as a white spot on the surface of the head.

21. *Limnodynastes dorsalis* Gray.

I know nothing of the breeding economy of this species, never having chanced upon it at breeding time. Fletcher (1889, pp. 374-375) gives an ac-

count, which agrees in the main with what I have recorded for the other two species of the genus.

22. *Limnodynastes ornatus* Gray.

Baldwin Spencer (1896, p. 158) gives a description of tadpoles taken in water-holes between Oodnadatta and Charlotte Waters, Central Australia.

23. *Chiroleptes platycephalus* Günth.

Baldwin Spencer (1896, p. 161) describes the tadpole and conditions of larval life in Central Australia.

24. *Chiroleptes australis* Gray.

Anderson (1913, p. 15) records this species as spawning in the Kimberley District of Western Australia during the months of January and February.

25. *Mixophyes fasciolatus* Günth.

All I know of the breeding habits of this species is that I collected a number of metamorphosing individuals in a small creek running through a grass paddock at Lismore, in September, 1920. This would indicate that spawn was deposited in the autumn.

Conclusion.

This paper deals only with breeding habits and oviposition. I have accumulated material for the working out in detail of the life-histories and embryology of 12 out of the 25 species here enumerated. An examination of this series indicates that there will be quite a wide range of problems for investigation. Over 60 species of frogs have been described from Australia, so that there still remains much to be done in ascertaining breeding habits and life histories. Nothing is as yet known of the breeding economy of interesting genera such as *Myobatrachus, Notaden,* and *Chiroleptes* of the interior; and the same must be said of many interesting species inhabiting the rain-forests of Queensland and northern New South Wales.

The task of observing breeding habits is both interesting and easy, and it is hoped that those who are favourably situated to study frog species about which nothing is as yet known will continue to add to the small nucleus of precise knowledge which we now possess.

References.

Anderson, 1913.—*Results Swed. Sci. Exp. Aust.* 1910-1913.—Batrachians, *Kungl. Svens. Vet. Handlingar,* lii., pp. 3-26, Pl. I.

Bles, 1905.—The Life-history of *Xenopus laevis,* Daud., *Trans. Roy. Soc. Edin.,* xli., 3, pp. 789-821, Pl. i.-iv.

Boulenger, 1885.—Catalogue of Batrachia Salientia, London, British Museum.

Clunies Ross, 1908.—*Australian Naturalist,* p. 147.

Dakin, 1920.—Notes on the habits and reproduction of the Great Western Burrowing Frog, *Aust. Zool.,* I. 8, pp. 241-244, Text-fig.

Deckert, 1915.—Review of two series of Amphibians. *Zoologica,* II., pp. 3-34.

English, 1910.—Some notes on Tasmanian frogs. *Proc. Zool. Soc. Lond.,* 1910, pp. 627-634, Pl. li.

Fletcher, 1889.—Observations on the oviposition and habits of certain Australian Batrachians. *Proc. Linn. Soc. N.S.W.,* (ii.), iv., pp. 357-387.

Fletcher, 1894.—Description of a new Cystignathoid frog from New South Wales. *Proc. Linn. Soc. N.S.W.,* (ii.), viii., pp. 229-236.

Kerr, 1919.—Text-book of Embryology, Vertebrata, London, Macmillan.

Spencer, 1896.—Horn Expedition to Central Australia, Zoology. Amphibia, pp. 152-174, Pl. 13-15.

DESCRIPTIONS OF TWO NEW AUSTRALIAN SPECIES OF *PSYCHOPSIS* (ORDER NEUROPTERA PLANIPENNIA).

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(Plate III., and one Text-figure).

The archaic family Psychopsidae has its head-quarters in Australia, no less than eight species having already been described from that region, included in three genera. The systematic study of the family has recently (1919 *a*) been brought up to date by myself, and the life-history of *Psychopsis elegans* Guér. has been dealt with fully in a further paper (1919 *b*). Since these papers were published, two fine new species of the genus *Psychopsis* have been discovered, one by Miss Margaret Waterhouse at Woodford, Blue Mts., N.S.W., and the other by Mr. E. J. Dumigan, at Clermont, Central Queensland. These two species are described in this paper, and each is dedicated to its discoverer.

Before proceeding to give the actual descriptions of these species, it will be necessary to emphasise one or two special points in the venational scheme for which a special terminology has been adopted in my previous paper (1919 *a*).

The *gradate series* are series of cross-veins arranged in a step-like formation between the closely contiguous branches of the main veins in this family. Special names have been given to them as follows:—

(1). The *costal gradate series* connects the enlarged costal veinlets which arise from Sc and cross the very broad costal space.

(2). The *terminal gradate series* runs between the apical margin and the disc, from apex to tornus, and is a continuation of the costal series round the outer margin of the wing in those forms where the costal series is complete.

(3). The *discal gradate series* is more or less parallel to the terminal, and separates the disc from the marginal area.

(4). The *internal gradate series* crosses the disc near its middle. In a few species, either scattered cross-veins or portion of a further gradate series may be found between the internal and discal series, but such do not occur in either of the species dealt with in this paper.

Navás (1916) used the presence or absence of the various gradate series as one of his principal characters for dividing the genus *Psychopsis* Newman into several new genera. A further character which he made use of was the presence or absence of a fusion or anastomosis of M_{3+4} with Cu_1 in the forewing. In my previous paper, I showed not only that these characters were very variable, but also that, even if they could be used, they would separate closely allied species into distinct tribes and genera. In the descriptions of the two new species in this paper, their closest allies will be indicated, and it will be shown that, in

each case, the condition of the gradate series and fusion of media with cubitus differs radically from that of these latter; thus proving, if additional proof were needed, that my suppression of the Navásian tribes and genera was fully justified.

I should like here to thank Mr. G. A. Waterhouse and Mr. E. J. Dumigan for presenting to me the types of these beautiful insects, which are now placed in the Cawthron Institute Collection; and Mr. W. C. Davies, Curator of the Cawthron Institute, for the excellent photographs which he has made of the types, which are shown on Plate .

PSYCHOPSIS DUMIGANI, n.sp.

(Plate III., fig. 1; Text-fig. 1*a*.).

♂. *Total length* 9.4, *abdomen* 5.5, *forewing* 15, *hindwing* 13, *expanse* 32 mm.

Head:—*Epicranium, frons* and *eyes* blackish, with some irregular brown markings on occiput and three pale brown patches behind antennae, as shown in Text-fig. 1*a*. *Antennae* 3 mm., segs. 1-2 pale testaceous, the rest fuscous, 3-10 with fine whitish basal annuli. *Face* and *mouth-parts* testaceous.

Thorax:—*Pronotum* dull brownish with a thin transverse blackish band and carrying numerous long hairs, some greyish, some blackish. *Mesonotum* brownish, hairy. *Metanotum* testaceous, with two large dark fuscous blotches. *Sides* and *underside* testaceous. *Legs* pale testaceous, tarsi slightly infuscated.

Abdomen short, cylindrical, very hairy, dark brown above, slightly paler along the middle line, pale testaceous beneath; last segment paler. *Appendages*:—both superiors and inferiors broad, hairy, held in a nearly vertical plane; inferiors somewhat larger than superiors and partially overlapping them from below.

Wings very hairy. *Forewing* with brownish venation, the membrane tinged with pale brown and heavily marked with a complicated pattern of very dark brown, almost black, as shown in Plate III., fig. 1; a tinge of mauve on the inner side of the spot situated at the tornus. The most conspicuous markings are four transverse dark fasciae, the first incomplete and forked posteriorly below the vena triplica, the second incomplete and simple, the last two complete and converging posteriorly to meet in the large blotch at the tornus; there are also a number of irregular, oblique dark blotches along the posterior margin. *Hindwing* with pale testaceous venation, the membrane subhyaline, slightly clouded with brownish, especially at the end of the vena triplica; a rather small and indistinctly outlined brown spot, about 0.5 mm. diameter, is situated near end of Cu, about 1.5 mm. from margin. In the forewing, M_{3+4} is fused with Cu_1 from about half-way onwards. *Radial sector* with 12-14 branches in forewing, 9 in hind. *Gradate series*:—Forewing with costal, discal and internal series complete, terminal series almost complete. Hindwing with discal series complete, costal and terminal almost complete, internal series incomplete, consisting of only 4 cross-veins.

Types:—Holotype and paratype males, in Cawthron Institute collection.

Habitat:—Clermont, Central Queensland, taken at light by Mr. E. J. Dumigan. (Holotype, Nov. 11th, 1919; paratype Nov. 1st, 1920).

The paratype is somewhat smaller than the holotype, and is only in mediocre condition.

The name is given as a dedication to the discoverer, Mr. E. J. Dumigan of Clermont, Queensland.

This species forms a collecting link between the *elegans*-group of species with pinkish markings and a definite angle at the tornus, and the *insolens*-group of smaller-sized species with black, brown or grey markings and rounded tornus.

In structure and venation it comes closest to *Ps. elegans* Guér., the condition of the gradate series being the same, as also the fusion between media and cubitus in forewing. The heavy black markings, however, are very distinct, and the only trace of the *elegans*-type of colouration is in the touch of mauve near the tornus. The species is also related to *Ps. coelivagus* Walk., which it resembles in its heavy blackish markings, but can be at once distinguished from it by the less rounded wings, and by the fact that *Ps. coelivagus* has a pure white venation, with the heavy blackish pattern of a much more metallic appearance and specialised form, while the arrangement of the gradate series is different also.

PSYCHOPSIS MARGARITA, n.sp.

(Plate III., fig. 2; Text-fig. 1*b*.).

♂. *Total length* 11, *abdomen* 7, *forewing* 18, *hindwing* 14, *expanse* 37 mm.

Head:—*Epicranium* pale testaceous, with hairs of same colour, and with a conspicuous dark pattern as shown in Text-fig. 1*b*; the dark area almost completely encloses two somewhat oval patches of the pale ground-colour behind the antennae. *Antennae* with basal segment pale testaceous, seg. 2 the same colour ringed with black apically, the rest medium testaceous shading to pinkish brown. *Eyes* black. *Face* pale testaceous with a median subtriangular brownish mark continuing from epicranium across frons on to clypeus, and widening from above downwards. *Mouth-parts* testaceous.

Thorax:—*Pronotum* pale testaceous with hairs of same colour. *Mesonotum* testaceous, marked with blackish spots laterally and with two large spots posteriorly, these latter separated by a narrow pale median line. *Metanotum* testaceous, heavily marked with blackish. *Sides* and *underside* testaceous. *Legs* pale testaceous.

Abdomen short, subcylindrical, with pale testaceous hairs; colour dull testaceous, the last two segments and appendages dull grey. *Appendages*:—Superiors broad, held nearly in a vertical plane, well rounded at apices, hairy; inferiors narrower, more triangular, apices much more pointed.

Wings only moderately hairy, the venation whtish, with the intervening ridges of the membrane showing mother-of-pearl iridescence, and the whole wing very pearly in appearance. *Forewing* with two rusty yellow markings one-fifth from base, one on the vena triplica and one on the cubitus, these two connected by two parallel blackish lines, as shown in Plate III., fig. 2; beyond the end of the vena triplica is a semi-transparent brownish patch bordered distally with black lines, and carrying a postero-distal projection with a conspicuous black spot; the vena triplica carries, about two-thirds from base, two black cross-veins in line, these being above the internal gradate series, and there is a small black spot between Sc and R_1 a little nearer the base; the internal gradate series has its middle four or five cross-veins bordered distally with black; another semi-transparent brownish blotch lies just beyond the lower part of the discal gradate series; a series of irregular fuscous and brownish markings runs along and above the posterior margin from the base outwards to tornus; three or four irregular black spots are present on basal half of posterior border, and two small spots at tornus; other very slight markings along costal and distal margins are as shown in Plate III., fig. 2. *Hindwing* hyaline, except for a large rounded blackish spot just beyond the end of the vena triplica. In forewing, M_{3+4} approaches Cu_1 a little beyond half-way and is connected with it by a very short cross-vein, but does not fuse with it. *Gradate series*:—Forewing with the costal series incomplete, there being only 6-8 cross-veins basally, the terminal series entirely absent, the discal and internal series complete, the former having 17 and the latter 10 cross-veins in it. Hindwing with costal series very incomplete, consisting of only 3-4 basal cross-veins, the terminal series absent, the discal

series complete, with 12 cross-veins, and the internal series incomplete, with only 4 cross-veins. *Radial sector* with 13-15 branches in forewing, 10-11 in hind.

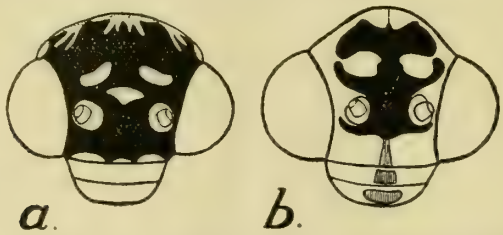
Types:—Holotype and paratype males in Cawthron Institute Collection.

Habitat:—Woodford, Blue Mountains, N.S.W. (A large number were seen inside Mr. Waterhouse's home at Woodford, on Dec. 29th, 1920, and two of these were captured by Miss Margaret Waterhouse).

This interesting species would appear to be very closely allied to *Ps. elegans* Guér., but can be at once distinguished from it by the paler and more pearly wings, with fewer markings, and those without any pink or red colour on them. Venationally, the two species are very distinct, as *Ps. elegans* has complete costal and terminal gradate series, and a fusion of media with cubitus distally in forewing. The hindwing spot is also in a different position in *Ps. elegans*, being placed well below the end of the vena triplica, instead of at the end of it. *Ps. margarita* n.sp. also shows some affinity with *Ps. gracilis* Till., and through that species is connected with *Ps. mimica* Newm. The colour-scheme is also such that it is clear that the more specialised scheme shown in *Megapsychops illidgei* Frogg. could easily be derived from it.

It should be noted that, although *Ps. margarita* n.sp. is clearly far more closely allied to *Ps. elegans* than to any other known species, yet the differences in the gradate series are such that, if Navás's classification were adopted, these two species would be placed in two distinct tribes and genera. This is strong additional evidence of the superficiality of the characters chosen by that author for breaking up Newman's genus *Psychopsis*.

The name of the new species is given as a dedication to its discoverer, Miss Margaret Waterhouse, and also indicates the pearly appearance of the insect, which is more marked than in any other known species.



Text-fig. 1. Colour-pattern of the head in *a. Psychopsis dumigani* n.sp., *b, Ps. margarita* n.sp. (+ 20).

Explanation of Plate III.

Fig. 1. *Psychopsis dumigani* n.sp., holotype ♂. (+ 3.9).

Fig. 2. *Psychopsis margarita* n.sp., holotype ♂. (+ 3.4).

BIBLIOGRAPHY.

NAVAS, P. Longinos, 1916.—"Essayo monographico de la familia de los Sicopsidos (Ins. Neur.)." Assoc. Espanola para el Prog. de las Ciencias: Congreso de Valladolid, Oct. 1915, pp. 181-210.

TILLYARD, R. J., 1919*a*.—Studies in Australian Neuroptera. No. 6. The Family Psychopsidae, with descriptions of new genera and species. Proc. Linn. Soc. N.S.W., 1918 (1919), xliii., pt. 4, pp. 750-786.

————, 1919*b*.—Studies in Australian Neuroptera. No. 7. The Life-History of *Psychopsis elegans* Guerin. Op. cit. pp. 787-818.

NOTES ON AUSTRALIAN BATS, AND THE OCCURRENCE OF *CHALINOLOBUS GOULDII*, GRAY AT NORFOLK ISLAND.

By Ellis Le G. Troughton, Zoologist.

(Contributed from the Australian Museum.)

Very little is yet known of the habits of bats and they are often regarded with superstitious awe and as omens of ill-luck by the general public. Indeed few people realise the high place these mammals occupy, next the order Primates containing man and the creatures nearest allied to him, in the classification of the animal kingdom.

There are a great many species of Chiroptera indigenous to Australia and the neighbouring Islands but their volant habits and mode of life render them difficult both to observe and to collect. Rarely appearing before sunset, they are almost entirely nocturnal and slip stealthily into the dusk from caves, hollow trees or even, in the case of smaller insectivorous ones, from under the curled up bark of dead trees.

The large frugivorous bats or so-called "Flying Foxes," the Megachiroptera, generally associate in large numbers and failing a suitable cave, select trees in some secluded gully for their home; here they hang from the branches, enveloped in their large wing membranes and looking like gigantic cocoons, alternately quarrelling and sleeping when they are not on foraging expeditions. Voracious feeders, they do much economic damage to orchards and their powerful flight enables them to travel far and wide in search of "fruits in season." The "Fruit Bats" are viciously bad tempered and quarrelsome and their strong, sharp teeth and claws are capable of inflicting unpleasant wounds if the animals are handled incautiously.

On the other hand, the smaller insectivorous bats, the Microchiroptera, are comparatively harmless, being at a disadvantage compared with other small mammals as their delicate, membrane covered digits are devoid of strong claws; also though the incisors are sharp, the molars are adapted to the crushing of hard insect bodies, and in any case the gape is seldom wide enough to allow of their use in attacking larger enemies.

I am now preparing a list of Australian Chiroptera and am particularly anxious to secure specimens with complete data and, if possible, photos and notes upon their habits too. The following instances will serve to show that much of interest may be noted by observant naturalists who are interested in other subjects.

Mr. A. F. Basset Hull informs me that while at Ourimbah, N.S. Wales, some years ago he was examining a nest of the White-browed Scrub Wren, *Sericornis frontalis*, when five small bats were observed to fly from the nest; it was an old nest and was placed amongst flood debris near the roadside by Ourimbah Creek.

On another occasion Mr. J. S. P. Ramsay startled four or five bats, apparently adults, which flew out of a nest of the Yellow-throated Scrub Wren, *Sericornis citreogularis*; the incident occurred strangely enough not far from the locality mentioned by Mr. Hull, the nest being pulled down from about eight or ten feet above a little stream flowing into Ourimbah Creek, some years ago in November.

The occupation of old bird's nests by bats has not, so far as I know, been recorded elsewhere and it is a coincidence that the two occurrences quoted above should have been observed in the same area.

Family VESPERTILIONIDAE.

CHALINOLOBUS GOULDII, *Gray*.

As far as I am aware, the only bat listed from Norfolk Island is the "Norfolk Island Bat," *Tadarida norfolkensis*, Gray, which has a wide range in Eastern Australia also, thus rendering the common name somewhat misleading.

Some time ago Mr. J. S. P. Ramsay kindly offered me a bat for the Australian Museum collection which he had secured in December, 1915, while on a visit to Norfolk Island and had stored in his miscellaneous collection. The specimen was gladly accepted and I quite anticipated that it would be an example of *T. norfolkensis*. On examination, however, it proved to be a specimen of Gould's Bat, *Chalinolobus gouldii*, a common mainland species with a very wide range. The specimen does not appear to differ markedly from a large series of mainland examples in the Museum collection and I am able definitely to record the occurrence of the species at Norfolk Island.

Mr. Ramsay informed me that the bat was taken from the hollow spout of a small tree which was about five feet high and several inches in diameter and situated in the scrub. The bats had entered at the opening in the top and were clinging around the edges of the hollow, being so closely packed that their backs were almost touching.

Another member of the genus, the Chocolate Bat, *C. morio*, Gray, was recorded from the neighbouring Lord Howe Island by Etheridge in his Memoir upon that Island in 1889; as I stated in the Records of the Australian Museum (xiii. 3, 1920) the single specimen on which the record was based unfortunately cannot now be found. I also suggested that as *morio* occurred in New Zealand it was reasonable to suppose that it would occur at the intermediate locality of Lord Howe. Mr. Oldfield Thomas however has pointed out that the proper name for the New Zealand Short-eared Bat is *Chalinolobus tuberculatus*, Gray and that it is a different species from the Australian members of the genus. While sorting bats of this genus recently I found so many were incorrectly named that it is remotely possible that the *morio* recorded by Etheridge from Lord Howe may have been the New Zealand *tuberculatus*. This is very doubtful however and the much greater distance between these Islands would suggest that the *Chalinolobus* of Lord Howe was *morio* of the closer Australian mainland or the *gouldii* of Norfolk Island and our mainland.

This year while on an expedition to Lord Howe Island on behalf of the Trustees of the Museum, I endeavoured to secure specimens of *Chalinolobus*, but as far as bats were concerned, was only successful in capturing two more specimens of the Little Bat, *Eptesicus pumilus*, which I recorded from the Island for the first time in 1920. Since the accidental and deplorable introduction of the common introduced rat, *Rattus rattus*, to the Island, residents believe that the bats are less numerous but it is not possible to confirm this. The residents also

informed me that a large Fruit Bat was found clinging to a tree on the Island some time ago. The claws were evidently locked about a branch as, after several shots were fired, it was found to have been dead for a considerable time. Unfortunately not even the skull was preserved and though it was doubtless the large Eastern Australian species, *Pteropus poliocephalus*, it is impossible definitely to say so.

Localities of C. gouldii.—The type locality, according to Thomas, is Launceston, Tasmania; a subspecies has been recorded from as far north as Alexandria in the Northern Territory of South Australia. The species has also been recognised from various localities in Western and South Australia, Victoria, N.S. Wales and Queensland.

NYCTOPHILUS GEOFFROYI, *Leach.*

While on Eyre's Peninsula where I was collecting for the Trustees of the Australian Museum, I was disappointed to find that the bats in some localities did not sally forth until darkness had set in. The impossibility of shooting specimens and the absence of suitable caves in the district made bat collecting a problem which was solved one day quite by accident. On the Peninsula there are a great many "She Oaks," *Casuarina glauca* or *suberosa*, which grow to a considerable size; many of these trees appear to have been killed by some disease and great sheets of their rough bark hang loosely round the trunks.

Tramping over the country side one day I happened to tread upon the fallen limbs of a large She Oak, whereupon a small bat fluttered out from them into the full daylight and flew with surprising accuracy to an upright tree about fifty yards away; on reaching this tree the bat seemed to vanish but upon pulling aside some of the loose dead bark a Long-eared Bat, *N. geoffroyi*, was found under a curled out piece of the bark. The species was for a long time regarded as a synonym of *Nyctophilus timoriensis* but recently Thomas discarded the latter name and reestablished several synonyms and described new species.

After this experience I secured several specimens of *geoffroyi* as well as some of the Little Bat, *Eptesicus pumilus*, by peeling great slabs of loose bark from dead She Oaks and it was remarkable how proficient one became at selecting likely trees. One *geoffroyi* was secured about twelve feet from the ground; it was under a concavity in a large piece of bark which provided adequate room, without exposing the little creature to the weather or its enemies. I saw no signs in any of these resting places to suggest that the bats regularly inhabited them and they were probably chosen at random.

The method of collecting though tedious, yielded some interesting entomological material including spiders, as well as lizards of the Gecko family which often obligingly fell down one's open shirt front accompanied by an avalanche of twigs and bark. In this way I blazed a trail amongst the She Oak stems as tribute to a collecting zeal which was not entirely misplaced.

ORNITHOLOGICAL SECTION.

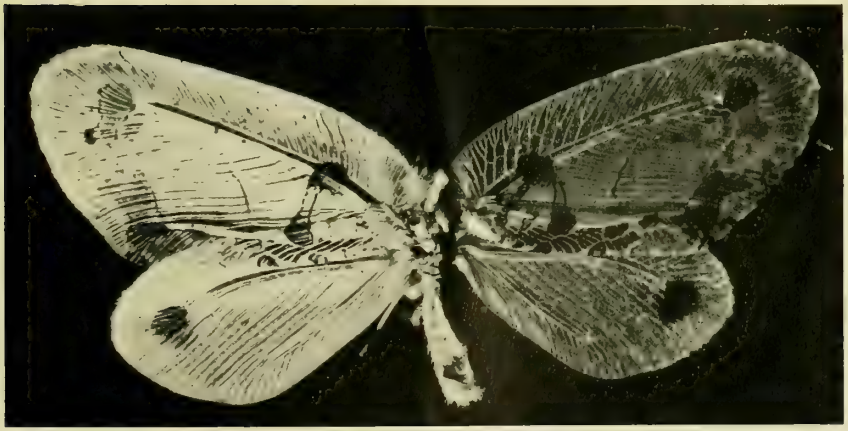
A special meeting of this section was held on the 8th instant. Mr. J. S. P. Ramsay exhibited a series of lantern slides, showing the destruction going on in the National Park owing to the timber-cutting operations there. He also showed a number of bird pictures, illustrating life histories of the White Tern, Morepork and other species, and, in conjunction with Mr. Neville W. Cayley, presented the lantern and slides to the Society for use at Sectional and other meetings. Dr. D'Ombrain moved a vote of thanks to the generous donors; Dr. Ferguson seconded the motion, which was carried by acclamation.

Mr. Ramsay suggested that if members would donate slides or lend their negatives for the production of slides, a representative collection would soon be available for illustrating lectures, and exchange with kindred Societies.

Nests of the House-building Rat *(Conilurus conditor)*.

Conilurus conditor, with young.

1. *Psychopsis dumigani.*



2. *Psychopsis margarita.*

Royal Zoological Society of New South Wales.

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CONTENTS OF VOL. 3, PART 1.

THE AUSTRALIAN ZOOLOGIST

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Edited by
LAUNCELOT HARRISON, B.Sc., B.A.,
Professor of Zoology at the University of Sydney.
And A. F. BASSET HULL, C.F.A.O.U.

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Royal Zoological Society of New South Wales.

AMENDED RULES.

Rules 1, 2, and 3, published in the "Australian Zoologist," Vol. I., Part 5, p. 100, have been repealed, and amended Rules made in lieu thereof. A new Rule, No. 5, has been made, and the following are the Rules now in force:—

1. *Capital Fund.*—In order to carry out the objects of the Society, a Capital Fund is established, and the following moneys shall be paid into such Fund:—

(a) All unconditional cash donations and benefactions.
(b) The subscriptions of all Life Members.
(c) Such sums as the Council may from time to time appropriate from the balance standing to the credit of the Annual Income Account.

2. *Annual Income.*—The Annual Income shall consist of:—

(a) All annual subscriptions paid by members.
(b) Interest and dividends derived from investment of the Capital Fund.
(c) Sales of "The Australian Zoologist."
(d) Such other income as the Council may from time to time determine.

3. *Handbook Publication Fund.*—A Handbook Publication Fund is established for the purpose of providing for the preparation, printing, and publication of Handbooks to Australian Zoology. This Fund shall consist of:—

(a) Such sums as are expressly donated to the Fund.
(b) Any amounts received by the Society by way of Government grant.
(c) The net proceeds of sales of Handbooks.
(d) Interest and dividends derived from any investments of the Fund.
(e) Such sums as the Council may from time to time appropriate from the balance standing to the credit of the Annual Income Account.

4. *Sections.*—

(a) Sections shall consist of not less than three members, one of whom shall act as Chairman and one as Honorary Secretary.
(b) Meetings of Sections may be held in the Society's office on such dates as may be fixed by the Chairman and Secretary, in consultation with the Executive Officers of the Society.
(c) Notices and reports of proceedings of Sections may be published in the "Australian Zoologist" subject to the approval of the Publication Committee. All such notices and reports must be handed to the Honorary Secretary of the Society.

(d) Postage on Sectional notices required to be sent by post will be defrayed by the Society, and the necessary stationery will be provided, but any other expenses incidental to the work of the Sections must be met by the members of such Sections.

(e) During the month of June, Sections shall report to the Council on their operations for the current year.

5. *Sale of "The Australian Zoologist."*—The following is the scale of prices at which "The Australian Zoologist" may be sold:—

Vol. 1, Part 1, 3/, Part 2, 2/, Part 3, 2/, Part 4, 3/, Part 5, 4/, Part 6, 4/, Part 7, 4/6, Part 8, 4/, less 20% to members. The complete volume, unbound, £1 net.

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The price per Part for future Parts shall be fixed by the Publication Committee, and members shall be entitled to purchase any of such Parts at a discount of 20% off published prices.

Section of Economic Zoology.

The inaugural meeting of this section was held at the Society's office on 15th November, 1922. Mr. Charles Hedley was elected chairman, and Mr. J. Mann, honorary secretary.

In outlining the objects of the section, Mr. Basset Hull defined "Economic Zoology" as the study of animal life, with a view to commercial advantage. He quoted from an address, delivered at Baltimore, U.S.A., in 1918, by Mr. E. W. Nelson, Chief of the United States Biological Survey, who said "In its relation to public welfare economic zoology is of the most vital and far-reaching importance. Animal life, from its lowliest organisms, among which lurk some of our deadliest foes, as well as beneficent friends, to the highest vertebrates, touches and affects our lives and welfare in innumerable ways. It must be studied in all its phases to guard against previously unsuspected or little known diseases of man and domestic animals, as well as to develop the wealth and ever-increasing variety of products from which we obtain food, medicines, clothing, dyes, ornaments, and an endless number of other useful articles. No man can now be considered well informed who has not a considerable knowledge of economic zoology in its more direct relationships to human life, while to the scientific investigator the subject has the charm of endless variety and service to mankind."

Mr. Hull continued:—

"While it may be at once admitted that many of the subjects taught in our secondary schools and universities have a direct bearing upon economic zoology, they are more or less disconnected, divided between the professorial chairs of Biology, Zoology and Agriculture, and consequently lacking in correlation. It therefore requires a separate and concrete study for schools, and a special chair at the universities to provide the necessary course of instruction in Economic Zoology.

"In the study of insects, beneficial or injurious to food and other primary products of Australia, much has been done, but infinitely more remains to be done. In the working out of the life histories of our native animals with a view to their utilisation in the production of food and materials for manufacture very little has been attempted, and nothing done on lines similar to those adopted

in America and other progressive countries. The past history of Australia in relation to its native fauna has been like the history in relation to its timber—a record of ruthless destruction. Of late years some half-hearted measures of protection have been placed on the Statute Books, but no attempt has been made by the Government to cultivate the fur and skin animals or the birds, or to foster and assist private enterprise in such cultivation, for commercial purposes. Some attention has certainly been given to the cultivation of fish and oysters, but these operations have been at best of a spasmodic nature and at all times insufficiently equipped. I am not, of course, referring to the mere exploitation of sources of food supply, such as the State Trawler enterprise, but the experiments in oyster culture, fish hatching and distribution carried on by the Fisheries Department.

"The objects of this section may be stated as:—

"1. The study of Australian fauna, both noxious and useful, having in view the suppression of the noxious and the cultivation of the useful, to the advantage of mankind.

"2. The publication and dissemination of knowledge gained by such study.

"3. To advocate the establishment of a Chair of Economic Zoology at the University of Sydney and other Australian universities."

Mr. Hedley exhibited shells (*Trochus niloticus*) used for manufacture of buttons, etc., and advocated the fostering of the industry of cultivating these shells on the Queensland coast. At present their collection was slipping into the hands of the Japanese, and the fisheries might be seriously depleted unless some measure of protection was afforded.

Mr. Hull exhibited a number of trinkets in which beautifully coloured chitons had been utilised. [Plate iv.]. These were made by a Sydney jeweller, Mr. Reginald Hawkins, who is also an enthusiastic collector of the shells.

A bangle, cut from a solid block of clam shell (*Tridacna sp.*) and polished by Solomon Island natives was also exhibited by Mr. Hull, and the process of manufacture described.

The next meeting of the Section will be held at the Society's office on Wednesday, 16th May, 1923, at 7.30 p.m.

New Members.

The following members have been elected since the publication of the last list (17 May, 1922):—

Ordinary Members:—P. G. Braithwaite, Mrs. E. M. Calvert, R. R. Green, A. C. W. Hill, G. H. Hardie and C. A. Lloyd.

Associate Members:—A. J. Campbell, C.M.B.O.U., Dr. F. G. Hardwick, A. A. Perry, A. W. B. Powell and J. M. Smith.

Honorary Member:—E. E. Coates (Honorary Auditor).

Personal Notes.

Two of our young members have recently received appointments to the staff of the Commonwealth Prickly Pear Board. Mr. A. N. Burns goes to the Sherwood Laboratory, Brisbane, and Mr. John Mann to the subsidiary Laboratory at Moree, N.S.W. Both of these members in succession filled the office of Honorary Librarian of this Society, and are enthusiastic entomologists.

Mr. A. R. McCulloch has just returned from an expedition to Western Papua, led by Captain Frank Hurley. The principal object of the trip was to secure cinema pictures illustrating the manners and customs of the natives of this little known region, but a valuable collection of ethnological and natural history specimens was secured, which is to be presented to the Australian Museum. Two planes were utilised in aerial survey work, although the tropical conditions proved to be very unfavourable for flying. The party proceeded up the Fly and Strickland River to Lake Murray, where natives of a remarkable type were encountered.

Mr. Hedley has recently visited Alaska.

Dates of Meetings.

Through an unfortunate error, the dates given in the Syllabus issued with the last Part of the "Australian Zoologist" are incorrect as far as the current half year is concerned. The following are the correct dates of fixtures:—

1923—	p.m.
14 February, Wednesday—	
Entomological Section	7.30
16 February, Friday—	
Ornithological Section	7.30
14 March, Wednesday—	
General Meeting	7.30
11 April, Wednesday—	
Entomological Section	7.30
20 April, Friday—	
Ornithological Section	7.30
9 May, Wednesday—	
General Meeting	7.30
16 May, Wednesday—	
Economic Zoology Section	7.30
13 June, Wednesday—	
Entomological Section	7.30
15 June, Friday—	
Ornithological Section	7.30
11 July, Wednesday—	
General Meeting	7.30

At the General Meeting to be held on Wednesday, 14th March, Mr. E. F. Pollock will give a lecturette on "Animal Photography," illustrated by a number of lantern slides of his own photographic studies, taken principally in Taronga Park.

AUSTRALIAN BLEPHAROCERIDAE.

PART II.—LARVAE AND PUPAE.

By A. Tonnoir, Research Student in Diptera, Cawthron Institute, Nelson, N.Z.
(*Communicated by Dr. R. J. Tillyard.*)

This paper must be considered as the second part of Dr. Tillyard's study on Australian Blepharoceridae (this journal, vol. II., part iv., 1922). Owing to the pressure of other work he has not been able to deal with the larvae and pupae of the species collected and described by him, and he very kindly gave me his material to study as it might interest other workers to know, without any further delay, the early stages of such primitive forms as *Edwardsina.* I have, therefore, to thank him very heartily for the opportunity he thus gave me to get better acquainted with these very interesting larval forms of *Blepharoceridae,* none of which have yet been described from Australia. I am also very much indebted to Mr. A. Philpott, who kindly read through the text of this paper.

Before starting the description of the larvae, I think it necessary to say a few words on their segmentation, which has always been misunderstood up to now, even in the papers published quite recently by Dr. J. Komarek (1) and by Dr. W. Bischoff (2).

When describing Blepharocerid larvae the different parts into which the body is divided ought not to be called "segments," in order to avoid confusion with the actual segments of the larva, which do not correspond to them, at least as far as their numerical order is concerned. I propose, therefore, to call them (1) cephalic division, (2) median divisions, and (3) anal division, each of the divisions being characterised by the presence of a sucker on the ventral face of the body.

When studying the formation of the pupa within the larval body one sees (fig. 1A) that the cephalic division contains the thorax and the *two first abdominal segments,* each of the four following divisions contains one abdominal segment and the anal division the three last abdominal segments, thus the nine abdominal segments are represented.

The last division, composed virtually of three segments, may present a more or less well marked constriction between them; sometimes there is a deep incision between the tenth and the eleventh (seventh and eighth abdominal) and a very distinct demarcation between the eleventh and twelfth (*Edwardsina*); however, this latter may be missing (*Blepharocera, Hapalothrix*), also the constriction between the tenth and eleventh may be only faintly indicated (*Apistomyia*). Consequently, when one speaks of the last segment of the body, it must lead to confusion, and for that reason I consider it convenient to make a distinction between divisions and segments.

---

(1) The Larvae of the European Blepharoceridae. *Ann. biol. lacustre,* 1922.

(2) Zur Kenntnis der Blepharoceriden. *Zool. Jahrb.* v., 46, 1922, pp. 61—120. Abt. system.

Edwardsina australiensis Till.

In the above mentioned paper (p. 166) Dr. Tillyard gives an account of the locality and circumstances in which these larvae were secured. The material collected on Mount Kosciusko contains several larval stages, but not all of them are present, the first, and perhaps the third, are missing. I think it preferable, therefore, to give first a detailed description of the full-grown larva, pointing out afterwards the differences between the earlier stages.

The identification of the early stages of *E. australiensis* has been obtained by picking out first a pupa containing a sufficiently advanced imago to be certain of the identity of the species by the study of the wing-venation and genitalia, and then by looking for a full-grown larva in which a pupa was in process of formation (fig. 1A) and presented the characteristic details of structure of the pupa already established as that of *E. australiensis.* Such a chain of evidence has been secured, and although a pupa in formation with completely developed breathing lamellae has not been found I think that there can remain little doubt, if any, that the stages hereafter described belong to the same species. Besides, it results from the observations and researches made by Dr. Tillyard on the spot, that any other species could hardly have occurred at the same time with such an abundance of mature larvae and pupae without being discovered; also, Dr. Tillyard saw several adults emerging.

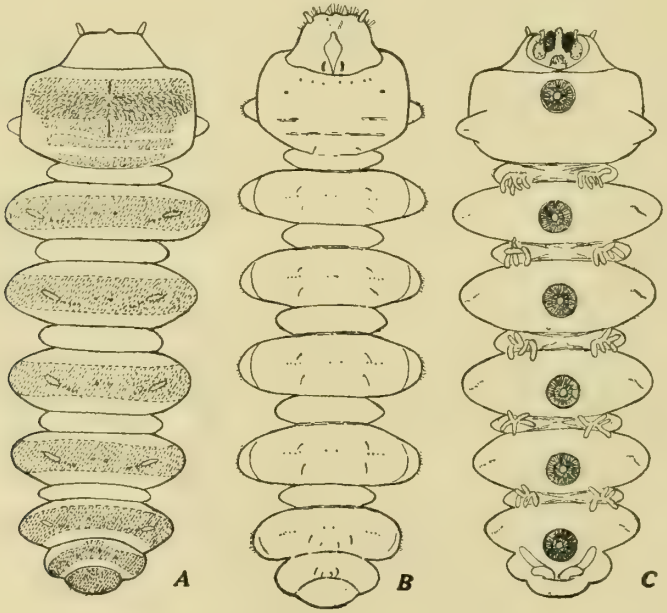

Fig. 1.—A, larva of *Edwardsina australiensis* Till. showing the pupa in formation, (diagrammatic); B, the same larva from above; C, from below.

The larva of *Edwardsina* is characterised by three features of great interest:—

(1) The head forms a complete capsule, well delimited from the rest of the cephalic division.

(2) Each of the second to sixth divisions of the body presents in front a strong constriction leading to the formation of a small secondary segment.

(3) This larva is not provided with any lateral appendages; even the lateral processes of the cephalic division are not true appendages but simple lobes.

When full grown the larva measures 9 mm.; it is therefore among the largest Blepharocerid larvae known. Its colour is dull brown, somewhat tinged with greenish, and it does not present any pattern whatever; even when mature the pupal horns do not show through the skin in the form of a dark spot, as is the case in *Liponeura* or *Blepharocera*. The integuments are smooth and bare, with the exception of the usual microscopic sensillae, a few weak setae on the dorsum, and a minute and scarce pubescence on the lateral end of the body divisions. The head is completely dark brown, trapezoidal as seen from above, and, as already mentioned, well delimited from the rest of the body, both ventrally and dorsally; it carries in front a certain number of small setae pointing forward.

The clypeo-labrum is distinctly protuberant and the praefrons, in the form of a lozenge with short and blunt anterior angle, is completely separated from the clypeus.

The short, one-segmented antennae, with swollen base, may be termed pyriform; they carry at their ends four little sensorial cones.

No eyes are visible, but a little behind the antennae and somewhat on the side two more or less transparent areas of the head capsule may indicate the place where the subcutaneous ocular organs are placed.

On the posterior border of the head capsule, and very near the proximal end of the praefrons, two little processes are to be found; they are somewhat flattened, moderately sharp at the tip, and curved forward; their function may be in relation to the ecdysis.

The mouth-parts are of the same type as is to be found throughout the family; the indentations of the strong mandibles are rather indistinct and their lower or internal part is swollen into a large lobe (fig. 3D); the maxillae are composed of the three usual parts: the upper process with a brush of hairs, the very reduced one-segmented palpi, and below, the large cushion or filter covered with the regularly disposed short curved setae.

The mentum is present in form of a small chitinous subrectangular plate, provided on each side with one sensory papilla, and carrying at its distal border a rather long flat brush of blunt straight setae; this brush overlaps the praementum which is also provided with similar but shorter setae, forming also a flat brush covering it completely.

Not far from the distal end of the hypopharynx are placed on each side the small openings of the salivary ducts, surrounded by a few papillae. The hypopharynx runs into the mouth-floor, which is composed of a subquadrate, rather hard chitinous plate, followed by a curiously shaped armature ending proximally in two spirals, and surrounding the oesophagus. This armature seems to be formed by the two trabeculae internae, which are here of a rather complicated shape not to be found in other larvae, such as *Neocurupira*, for instance, where they are only simple rods.

On the sides of the epipharynx there is no sign of lateral appendages; only two small chitinous rods imbedded in the integument are visible.

Without going into the detailed anatomy of the head capsule, I must mention that it is provided internally with two long strongly chitinous projections or apodemes; they are inserted on the ventral edge of the capsule on each side of the mentum. I doubt if they can be homologised with a part of the tentorium; they seem rather to be the apodemes of the mandibular muscles; other larvae of *Blepharoceridae* also present these rods but they are much less developed.

The first division of the body, which is about twice as broad as long, is provided in front on the dorsal side with a row of 6-8 very small spinules, not always regularly disposed; a little further back are the two usual spiracular scars. On the posterior half of this division two transverse linear depressions are to be observed; the first interrupted in the middle, demarcates the thorax from the abdomen, and the second, running through from one side to the other, marks the limits between the first and second abdominal segments, as may be seen during the formation of the pupa inside the body of the larva (1). The ventral face of the first division is provided on each side with a fleshy lobe, which, no doubt, is to be considered as the homologue of the lateral appendage as seen at this place in other larvae of the family, but it does not possess its hard chitinous structure; it is of the same tegumental nature as the body wall and, indeed, projects from it as a lobe with but a small constriction at its base on the antero-dorsal side only; its extremity is rather blunt and carries but a few inconspicuous short hairs.

The median divisions of the body, 2 to 5, are composed of two parts, a small narrow well-delimited section in front and a large broad section posteriorly. It is curious to note that the small section of each division (2) is much more deeply divided from the larger posterior section that follows it than from the one that preceded it; however, no doubt can exist that it is a part of the following large section as will be seen from the position of the gills under the body. These small anterior sections, on account of the strong constrictions that delimit them anteriorly and posteriorly, and also of their elliptically curved sides, present the appearance of true segments and are therefore rather different from the homologous parts to be found in larvae of *Blepharocera* and *Liponeura*. The large posterior sections of each median division are about four times as broad as long; their shape varies a little, the anterior ones not being quite as long as the posterior ones. Their sides, which project further than those of the cephalic division, are elliptical-shaped and present, not far from the tip and only on the dorsum, a somewhat curved longitudinal depression, an attempt at segmentation of the tip of the section from the central part. This depression is rather deep in the first division and gradually less in the following ones, so that it is only slightly marked on the main section of the anal division.

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(1) Also, in the larva of the genus *Blepharocera* dissected by me the two first pupal abdominal segments are included in the first division of the body, and are there to be seen as Dr. Bischoff figures them (*l.c.* T2, fig. 8) for *Liponeura cinerascens*, though he mistakes the first pupal abdominal segment for a part of the thorax.

(2). Halzstiuck of Dr. Bischoff.

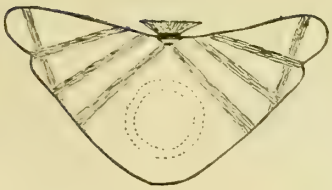


Fig. 2.—*Edwardsina australiensis,* section through the middle of the third body division (diagrammatic).

A cross section through the middle of the body shows that in this larva there are no real lateral appendages, but one may say that they are in the making, as the lateral tips of the large sections take, functionally, the place of these appendages; the ventral faces of these tips are provided with a small and weak oblique depression. The sensory lateral appendages are also completely missing.

Each of the main sections of the median divisions is marked by a few small punctiform depressions; they are disposed in two groups, one pair in the middle, and a series of four or five on each side; above and below the latter a very weak seta is to be found.

The anal division of the body is here composed of four sections:—(1) the anterior small section of the seventh abdominal segment, (2) the main section of this segment, which is narrower and with blunter sides than those of the median divisions; it carries also the same punctiform depressions on the dorsum and four little setae on its posterior part, (3) the eighth abdominal segment, not very deeply separated from the preceding one except on the sides where the notch is fairly deep, (4) the last (ninth) segment, oval in shape and forming with the preceding one a rather well shaped ellipse so that the tip of the body is quite rounded.

On the ventral face of the body, which is of the usual whitish colour, each division carries a sucker not differing in any way from those of other species; their size is relatively small.

The gill-tufts are composed of five filaments, or tubes, placed on the small anterior segments of the divisions 2 to 6; they are arranged close to one another in a rather regular transverse series. The four anal gills are composed of a median small pair, and of the lateral ones, which are not very much developed; they reach about the level of the middle of the last sucker.

The other larval stages I know are:—(1) The second (fig. 3A), which measures about 3 mm.; it differs only from the full grown larva by the shape of the head which is relatively much larger compared with the size of the body; the praefrons is fused with the clypeus and the posterior half of the lateralia is finely corrugated. The posterior border of the head carries a rather irregular transverse row of about ten small spinules; the mouth parts are the same with the exception of the mandibles; the punctiform depressions are not visible on the body. The ventral gills have only one filament; the anal ones are normal. (2). The next stage found in the material studied, although there is a rather large difference in the size of the head capsule compared with the preceding one, may be the third; its average length is 5½ mm. It also differs from the full-grown larva only in the head (fig. 3B); the praefrons is still fused with the clypeus; the posterior part of the lateralia is corrugated, but to a less extent; six spinules are to be found on the posterior edge of these plates, three on each side, not very far from the middle. The ventral gills are composed of three filaments.

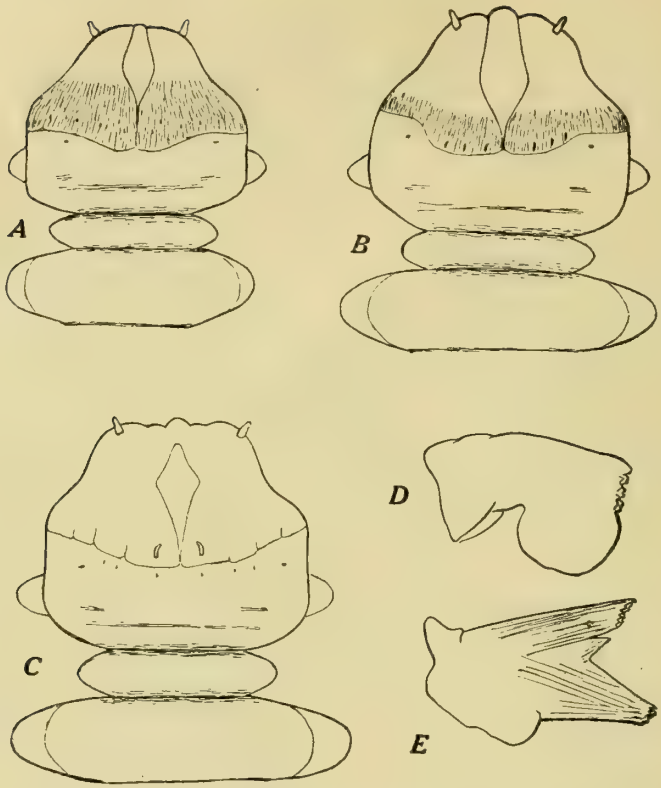


Fig. 3.—*Edwardsina australiensis.* A, head of second larval stage; B, head of third larval stage; C, head of the stage before the last; E, mandible of the full-grown larva; D, mandible of the preceding stage.

(3). Between this and the full-grown larva a series of specimens (fig. 3C) are found whose average size is 7 mm. (6 to 8), and which differ only from the full-grown one in the shape of the mandibles, which present two diverging points with a small tooth between them (fig. 3E), and by the posterior border of the lateralia which has one to three fold-like depressions; the size of the head capsule is, however, exactly the same as in the full-grown larva, and the number of gill filaments also five.

This leads us to suppose that in this species there are at least five instars, probably not the normal number in Blepharocerid larvae, some of certain New Zealand species studied by me presenting only four.

The eggs have also been examined; they were obtained by Dr. Tillyard from a female placed alive in a moist tube, on the wall of which she deposited them singly, the degree of adhesion being only slight. These eggs were fixed in spirit when of an average age of 19 hours; they present a beginning of segmentation. Their shape is that of a long oval, one end being slightly more pointed. They

are a little flattened and their upper (?) surface is densely granulous, the lower (?) being smooth. No micropyle has been observed. Their dimensions are:—length, 525 μ; greatest width, 210 μ; smallest, 178 μ.

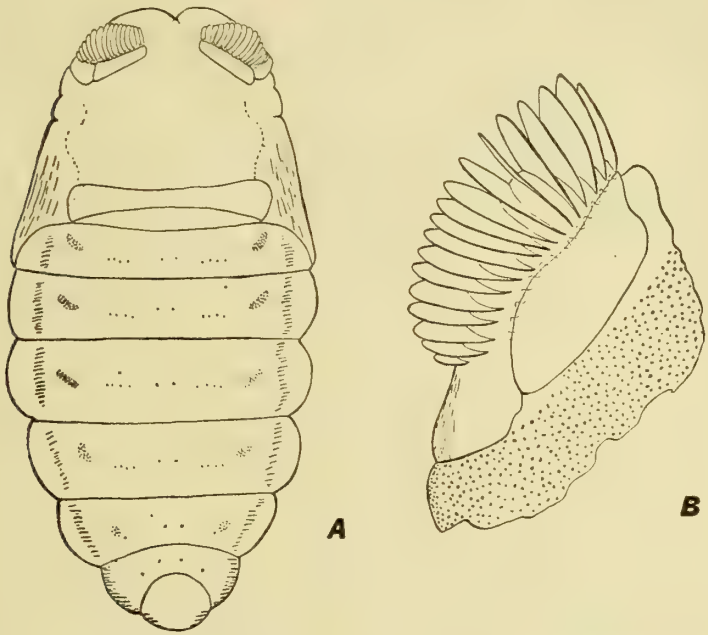


Fig. 4.—*Edwardsina australiensis.* A, pupa; B, pupal respiratory organ, seen from the side.

The average size of the oval-shaped pupa is 7 mm. long and 4 mm. broad; it is at once distinguished by the peculiar breathing organs, without analogy within the family, but otherwise it differs in no important feature or in colouration. The brownish red integuments are densely covered with granulations and on the third to seventh abdominal segments there are two groups of markings, (1) some punctiform depressions in the same arrangement as those of the larva and, (2), on each side a rather deep, oblong, obliquely placed foveole. These markings are to be observed already in the pupa in formation within the larval body (fig. 1A).

The respiratory organs are composed of three elements, (1) basally and posteriorly an elongated subrectangular chitinous plate, (2) before the latter, but extending more towards the sides, another elongate plate, roundish in section, (3) disposed on this, and transversely and perpendicularly to it, a series of about 18 closely approximated lamellae, which gradually increase in size from the exterior to two-thirds of the series, and then decrease slightly. These lamellae are thus placed in planes approximately parallel to the sagittal plane of the pupal body, and the respiratory process with such an organ is rather difficult to understand. If a cross section is made between two lamellae (fig. 5A) it is seen that the wall of the tracheal extension makes a loop between the suture of

the two basal plates of the breathing organ, and is thus destined to collect the air filtering through that suture. This suture, however, seems to be perfectly tight, and a traction made on the two plates to pull them apart does not cause their separation along it; they usually break at some other spot. The super-

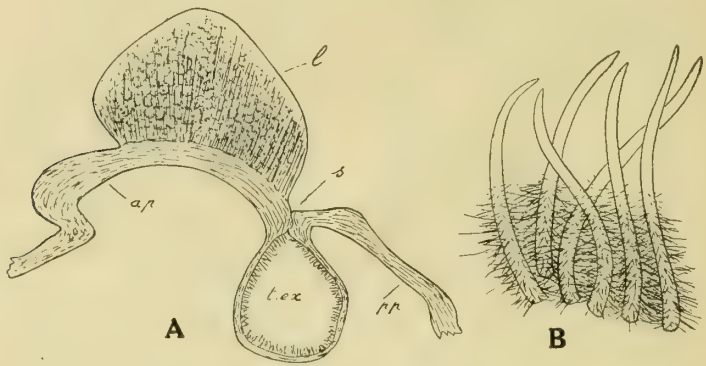


Fig. 5.—*Edwardsina australiensis.* A, section through pupal respiratory organ, *t.ex.*, tracheal extension, *a.p.*, anterior plate, *p.p.*, posterior plate, *s.*, suture, l., lamellae,; B, hairs of the pupal breathing organ in course of formation.

ficial aspect of this suture is a straight line, but when observed by transmitted light it is seen that inside the body's wall it is strongly undulated, its undulations corresponding approximately with the base of the lamellae (fig. 4B). The lamellae are composed of two thin chitinous walls, between which a cellular texture and a fine striation is visible. Their process of formation is exceedingly curious. When the developing pupa is observed within the larval body (fig. 1A), one sees that the cephalo-thoracic part is composed of three sections:—(1) an anterior segment which will develop into the anterior part of the pupa and containing the head, (2) a bristly or hairy section composed of two similar parts touching each other in the middle of the body and, (3) the segment which will develop into the body of the pupa. These two median hairy parts are the future breathing organs; they contain hundreds of little tubes, tapering and sealed at their free ends, and regularly inserted on a membrane. When observed in a more advanced stage these hollow bristles are seen to be densely pubescent, this pubescence starting to develop from their bases, and forming between them a dense felty mass. The division of this mass into lamellae has not been actually observed, but logically it is what must occur, and the fusion of hairs or bristles to form a chitinous plate is not without precedent in the insect world.

Apistomyia tonnoiri Till.

The larvae and pupae of this species have been collected by Dr. Tillyard and myself during an excursion in the Blue Mountains in November, 1921. They were to be found in fair numbers at the "Weeping Rock," a little distance only below the point where the falling sheet of water struck the rock, and just where the water rushed down with the utmost violence. The adults were flying in the vicinity.

The same larvae and pupae were also found a little later in Digger's Creek, Mt. Kosciusko (4,500 ft.) but the fly was not captured on that occasion; the larvae of *A. tonnoiri* were there collected with other larvae belonging apparently to some other species, perhaps to *Neocurupira nicholsoni* Till., from which they differ very little in the young larval stages. As no young larval stages have been found at Wentworth Falls it is difficult to ascertain which are the very early stages of *A. tonnoiri* in the material, so I think it better to abstain from describing them, and to give only the description of the full-grown larva in which the pupa in formation has been found. This larva which measures 6½ mm. is characterised by:—(1) the small incomplete head capsule, the lateralia being deeply notched, (2) the presence of lateral appendages, two pairs of which are present on the anal division, although the last pair is much reduced, (3) the rounding behind of the last division, the fusion of the three last abdominal segments being almost complete, (4) the dorsal surface of the divisions being strongly sculptured and spinulous on the sides.

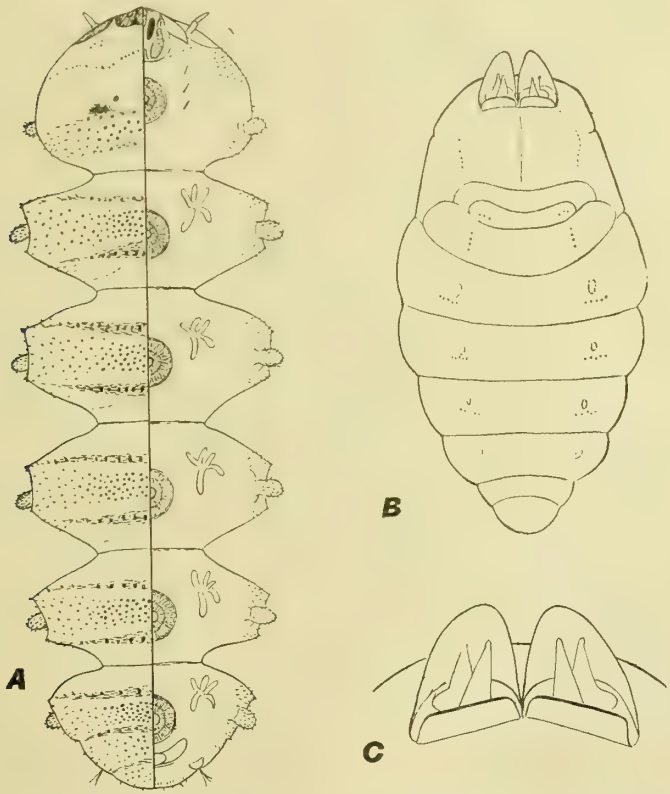


Fig. 6.—*Apistomyia tonnoiri* Till. A, larva, left, dorsum, right, ventral face; B, pupa; C, pupal respiratory organs.

The coloration of the larva is brown with darker transverse bands formed by granulations; the edges of these bands, especially on the middle of the body, being still darker. The head, compared with the rest of the cephalic division, is very small; it has the peculiar conformation that is to be found in all Blepharocerid larvae except *Edwardsina,* that is to say, with the lateralia deeply notched behind the antennae, and not extending very far ventrally, so that the oral opening is not limited on its posterior half by any hard chitinous structure; this disposition is the same in other larvae which I have examined, such as *Blepharocera, Neocurupira, Peritheates,* etc. The short antennae are two-segmented; the basal segment is subcylindrical, the apical one is a little shorter and conical; it ends with four little sensory cones. The mouth-parts are the same as in *Edwardsina* but the mentum is absent; the praementum is membranous and carries only a few short hairs. The mandibles are rather blunt, their teeth not being much developed; they are hinged on two long rods issuing from the anterior edge of the lateralia, a structure that is to be found also in *Edwardsina,* though much less developed.

The anterior division of the body is well rounded in front and on the sides; it is ornamented on its dorsal anterior half with a few lines of granulations, and on its posterior parts by a transverse band delimited by two transverse ridges carrying a row of coarse granulations; between these are disposed smaller granulations, which turn into spinules on the sides of the body.

The simple median divisions of the body are very much alike, a little wider than the cephalic one and with angulated sides, the wall of the body being there a little concave between the two angles, these being rather strongly spinose, especially the anterior one.

Each division presents dorsally two dark transverse ridges, strongly marked in the middle of the body but gradually obsolete towards the sides which each of them reaches at one of the lateral angles; these ridges are formed by a regular series of granules (undeveloped spines) which, as well as those of the body surface placed between them, turn into more or less strong spines towards the sides of the body; these spines extend a little on to the ventral surface. The last division of the body has its posterior edge nearly semi-circular, the notch between the seventh and eighth abdominal segments being rather indistinct, and the one between the eighth and ninth being still less so. The seventh segment presents the two transverse granulose ridges, the posterior one, however, being weak and placed just against the limit of the seventh and eighth segments.

The lateral appendages are not bi-segmented but are composed of two parts, a short basal one and a terminal olive-shaped one divided from the first by a slight constriction; this last part is also more strongly chitinous and carries numerous little spinulose hairs. The appendages of the eighth abdominal segment are much reduced and are different in shape; they are subsemicircular and bear at the apex a tuft of 3-4 rather long hairs.

The ventral gill-tufts, placed at the anterior part of the divisions 2 to 6, are composed of five filaments, three of them pointing forward and the two others, of which the internal is the longer, pointing backwards. The four anal gill filaments are of the usual pattern and rather short.

The oval-shaped pupa (fig. 6B) measures 5 mm. in length and is about half as broad; its posterior extremity is rather pointed and the abdominal segments rather well rounded on the sides. The respiratory organs (fig. 6C) are quite peculiar by their position against one another, and by pointing straight forward; they are composed of four lamellae as usual, but the outer posterior

one is short, truncate, and inserted nearly perpendicularly on the body, whereas the outer anterior one, also rather short and blunt, points forward, so that the breathing organ is wide open and leaves the two internal lamellae well dis-
larva of *N. nicholsoni*, but as I have no other evidence, and as I did not find the pupa in course of formation in any of these specimens, I think it better to
played. These lamellae are small; the first one is acutely triangular and the second of similar shape but with a well developed basal lobe on the external side. Between the bases of these lamellae is the slit opening of the tracheal system which is thus in direct communication with the external medium.

The abdominal segments offer some small markings; the second has on each extremity a transverse series of about three punctiform depressions; below these the third segment carries a longitudinal series of about four, and on the sides of the fourth to sixth segments there is a rather well marked oval foveole, underneath which is placed a transverse series of about six points; the seventh segment has only a more or less circular foveole; the markings of the last segment are indistinct.

Neocurupira nicholsoni Till.

The adult of this species has been found by Dr. Tillyard on Mt. Kosciusko at the same spot where the larvae of the preceding species had been collected,

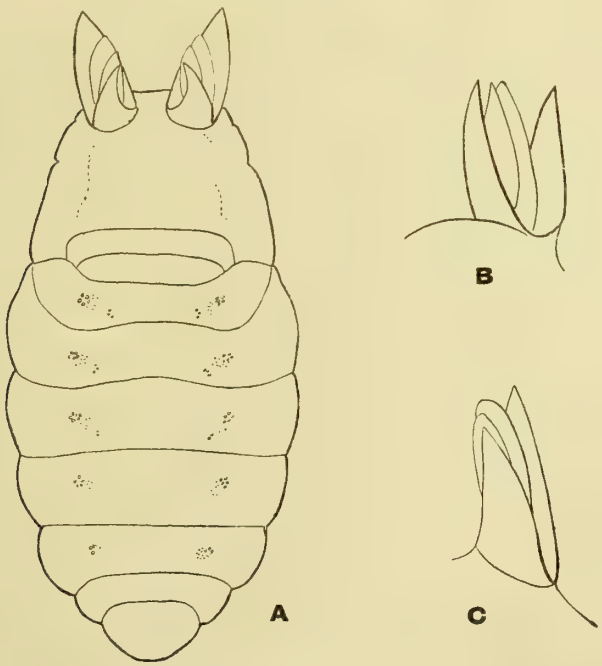


Fig. 7.—*Neocurupira nicholsoni* Till. A, pupa; B, C, breathing organs seen from different view points.

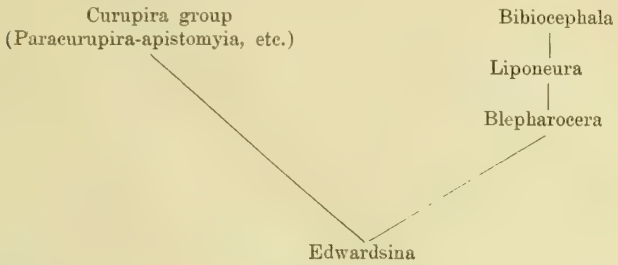
among which were eight specimens not quite full-grown, differing from *A. tonnoiri* among other things, by the relatively long and rather strong bristles on the sides of the body and on the lateral appendages; also there are no traces of lateral appendages on the eighth abdominal segment. This form may be the abstain from describing them until some more material has been procured. On the other hand there were a certain number of pupae which, after the dissection of the well-formed imago, proved to be unmistakably those of *N. nicholsoni*.

The form and colouration is as usual, the length being 5½ mm. and the width 3 mm.; the tip of the abdomen is rather rounded. The respiratory organs, which take the form of a four-bladed horn, are well separated at their bases and point obliquely upward; the two other outer lamellae are wide apart, the posterior one being nearly perpendicular to the body; they both taper to a rather sharp point. The much thinner internal lamellae are equally long, one being a little more pointed than the other; the spiracle opens freely between their bases.

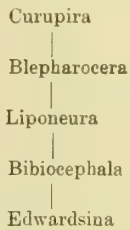
The side markings of the abdominal segments 2 to 5 are composed of a foveole containing about five coarse punctiform depressions and some smaller ones on the internal side. A little further inwards is a little group of 2-3 punctiform depressions; this group is not present on segments 6 to 7, where the foveoles only are to be found.

If we compare these larvae and pupae, especially *Edwardsina*, with those of other genera of the rest of the world, we see that they exhibit certain very interesting characters for the phylogenetical study of the first stages of the family, an attempt at which has been made recently by Dr. Bischoff (*l.c.* p. 93) who came to the conclusion that the phylogeny of the larvae covered perfectly well the phylogeny of the adults. Unhappily he was wrong from the very start because he took as primitive some characters which are evidently specialisations, such as the presence of lateral appendages and feelers (sensorial appendages) on the side of the body division. Of all the morphological features displayed by insects the mouth-parts are indeed those we can with most security rely upon when making phylogenetical study, and if we consider again the mouth of *Edwardsina* larva, with its well developed mentum, we must admit that it is unmistakably the most primitive larval form, just as the imago has proved to be. However, this larva does not carry any kind of lateral appendages; in their place we find a constriction of the lateral ends of the body divisions which is caused by the insertion at this spot of the muscular bundle destined to bend the sides of the body in order to release the suckers. These constrictions are well marked in the first divisions and are obsolete in the last ones, which illustrates how the lateral appendages have been subsequently formed in the other genera. We would then have to assume that a further specialisation has been the appearance of the lateral sensory appendages, or feelers, either by the splitting of the ordinary appendages, as the genus *Hapalothrix* seems to indicate by a beginning of branching in these appendages, or by the anterior angle of the body division being produced, as seems to be the tendency in other genera such as *Peritheates, Paracurupira,* etc. The larvae of the genus *Blepharocera* possess, or do not possess, according to the species, these feelers, and when present they are always little developed, but in *Liponeura* and *Bibiocephala* they are always present. On the other hand, these two genera have already lost the ordinary lateral appendage of the eighth abdominal segment; it is therefore not likely that the larvae of the group *Curupira-Apistomyia* proceed from them as they always carry these appendages, however reduced.

So far as an attempt can be made at phylogeny in our still very imperfect knowledge of the early stages of the *Blepharoceridae*, the genealogical tree for the larvae would be



instead of the following, which is the one that results from the study of the adults alone.



This would show that the evolution of the larvae has not followed the same path as the adult, which proves once more that classification based on larval characters is on very insecure ground indeed.

If, as must be assumed, the other Blepharocerid larvae proceed from that of *Edwardsina*, or a similar form, it is curious to note that in the group *Curupira* they have returned again to a more primitive kind of segmentation of the body, the secondary division of the abdominal segments 3 to 7 of *Edwardsina* being a character which, of course, cannot be considered as primitive in a dipterous larva. The genus *Apistomyia*, in the adult stage, is rather a specialised one by the venation with simple Rs, the eyes holoptic and divided, the elongated labellum, etc.; it proceeds, no doubt, from a form of the *Curupira* group. So far as I know, no larva of this genus has yet been described; this larva of a *A. tonnoiri*, however, would upset this conclusion, because, in some respects, it seems to be more primitive than that of *Curupira*, having preserved the 5 gill filaments in a tuft of *Edwardsina*; the 7 filaments in a longitudinal row is a rather recent acquisition, as the study by J. W. Campbell (1) of the different larval stages of *Paracurupira chiltoni* has proved, because they appear only in the last larval instar, and are not developed in another species of the same genus which I have recently discovered in New Zealand. In a paper which I hope to publish shortly on the larval forms of New Zealand Blepharoceridae, the matter will be more fully considered.

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(1) *Trans. N.Z. Inst.*, liii. (1921), pp. 258-288.

THE PRINCIPAL FAUNA FOUND IN DISTRICT OF MARRANGAROO.

COUNTY OF COOK. N.S.W.

E. C. Chisholm, M.B., Ch.M., R.A.O.U.

1920—1922.

MARRANGAROO is situated in the County of Cook, New South Wales, 100 miles by western rail from Sydney, and about 75 miles by air line to nearest point on the coast.

Elevation.—3,076 feet above sea level.

Temperature.—I have not known it above 90° in summer, but have recorded several times 16° in midwinter.

Rainfall.—Between 40 and 50 inches per annum. Marrangaroo itself lies in a depression surrounded on all sides by mountains from 600 to 700 feet high. It is drained by Middle River, which has its source about 7 miles away amongst the mountains, in north easterly direction. The next watershed to the west is drained by the Cox River, about 4 miles away, and this is the last eastern water. After the main dividing range the country opens out and approaches in character the middle western country.

The fauna mentioned is found roughly within a radius of 4 miles from Marrangaroo railway platform, the western circuit being Cox River, and the north eastern boundary, the head of Middle River. All the fauna mentioned except one bird, *Aegialitis melanops,* were seen in this area. The exception was seen about 10 miles away, on the Cox River.

In the years 1884-5 I was at school at Bowenfels, only 5 miles away, so that I am in a favourable position for comparing what the fauna was then with what I find it now. The native bear was quite common then, but quite extinct there now. Wallabies of several species were quite numerous then, whereas now, in spite of long walks over a period of 22 months, I have only seen six at the most. Opossums (*Trichosurus vulpeculus*) too, are very rare here now where they used to be common. *Echidna* I know of being found here twice since I came recently. *Ornithorhynchus* I saw once in the years 1884-5 on Farmer's Creek, but not seen since. Four birds I used to know here in previous years mentioned, which I have not seen since, viz.: *Cinclorhamphus cruralis, Oreocincla lunulata, Petroeca goodenovii, Climacteris erythrops.*

INVERTEBRATA INSECTA.

COLEOPTERA (Incomplete.)

Anaplognathus porosus „ *viridaeneus* *Lamprima latreillei*	Feeding on Eucalypts.
Leptops tribulus *Chrysolophus spectabilis*	Feeding on Acacias.
Paropsis nucea „ *reticulata* „ *aurea* „ *obovata* „ *liturati* „ *immaculata* „ *nigerrima* „ *intacta* „ *pictipes*	Feeding on Eucalypts mostly *E. viminalis.*
Leis conformis	Insectivorous.

HEMIPTERA.

HOMOPTERA.

CICADIDAE.

Cyclochila australasiae. Green or yellow cicada. Rare.

Melampsalta (incepta?). Little black cicada. Not very common.

LEPIDOPTERA.

HETEROCERA.

Phalaenoides glycinae. The vine moth. Uncommon. Larvae evidently feeding on some other plant than the grape vine, which doesn't do here. This is a day flying moth.

Phalaenoides tristifica. A very common species. The larvae feeding on *Epilobium glabellum.*

Eutrichopidia latina. Common, and very hard to approach. A day flyer, as are all this family.

Apina callisto. Common in grass lands in the late autumn, flying in the day time.

Nyctemera amica. A day flying species and common. The larvae feeding on *Erechites arguta* and *E. quadridentata* plants of the family Compositae.

Syntomis annulata. The ringed moth. Not common. Also a day flying species.

Chaerocampa celerio. A grape vine hawk moth, though the larvae feed on other plants. Fairly common in the dusk about garden flowers, especially the bell shaped ones.

Chaerocampa erotus. A fairly common hawk moth, feeding mostly in the evening, though I have several times seen it flying and feeding in the sunlight in the middle of the day. The larvae feed on the grape vine among other plants.

Chaerocampa scrofa. A hawk moth, which is fairly common, the larva of which feeds on *Epilobium glabellum.*

Pielus hyalinatus. A wood moth, only occasionally seen in April and May, when it emerges from tunnels in the ground at the roots of trees, mostly acacias.

Trictena labyrinthica. A large grey wood moth, very common in April and May, especially after rain. The larvae feed on roots of eucalypts of several species; the moths emerging from burrows in the ground.

Hepialus lignivorus. Not seen often. A very pretty species marked with green and pink. Also a wood moth.

Chelepteryx collesi. Rare. I have only come across odd pupal cases on *Eucalyptus viminalis.*

Anthela sp?. Species unidentified. Pupal cases seen occasionally on *E. viminalis.*

Entometa ignobilis. A case moth. Fairly common. A characteristic of the larva of this species is that in the construction of its case it always leaves one stick longer than the others so as to prevent the case from rolling when the larva is crawling about.

Thyridopteryx herrichii. The larva of this case moth does not use sticks for its case, but strong silk. It is very neatly constructed with 5 equal sides. The common case moth larva, curiously enough, I haven't found here (*Metura elongata*). All these case moth larvae remain in their cases for two or three years before changing into pupae.

Doratiphora lewini. A cup moth. Fairly common. The larvae feed on many species of eucalypts, viz.: among others *E. maculosa, E. coriacea,* and *E. stuartiana.*

Limacodes longerans. Another cup moth, but much rarer than the former. The larva feeding on eucalypts of many species.

Antheraea helena. A silkworm moth allied to the Gum Emperor Moth (*A. eucalypti*) which I have not found here. Fairly plentiful, feeding on several species of eucalypts, e.g., *E. coriacea, E. stuartiana* and *E. viminalis.* The larva is very subject to the attacks of a parasitic fly; the eggs of the fly sometimes covering the whole body. The larvae emerge from the eggs just as the caterpillar is about to pupate, when they work their way into its body and destroy it, then eat their way through the cocoon as flies and escape.

Dasypoda selenophora. A Noctuid moth, seen sometimes in the house, but by no means common.

Sericea spectans. Another of the family NOCTUIDAE. Larger than the last, but not common here. It also is seen in the house.

Agrotis infusa. The Bugong moth, though I have seen this disputed. Very numerous at times, always liking dark places to hide in during the day and frequently found in the house.

RHOPALOCERA.

Danaida menippe. Not very common. I have not seen any cotton plant (*Asclepias curassavica*) anywhere in the district. Seen in March, April and December.

Danaida petilia is fairly common. Seen from September to April inclusive.

Euploea corinna. Rare. Only seen twice, and in the month of December.

Pyrameis kershawi. Very common in spring and early summer of 1920; on the move, all flying in S. westerly direction. Seen from September to May inclusive.

Pyrameis itea. Not so numerous as the preceding, but, like it, flying in S.W. to westerly direction. Seen from September to April inclusive.

Junonia villida. Not a very common species here. Seen from September to June inclusive. One of the first to appear in Spring.

Tisiphone abeona. This seems to be its extreme westerly limit here,, I have to go 3 miles in N.E. direction before I come across it, and then it is only found in 2 gullies within the 4 mile radius, its food plant *Gahnia psittacorum* being fairly plentiful in those places. Appearing from November to March inclusive.

Heteronympha merope. Plentiful; the males appearing in mid-November and the females the latter end of November. The males disappearing the first week of February, the females the first week of April.

Heteronympha philerope. Plentiful in open forest country. Appearing in first week of February and disappearing the first week of April.

Xenica acantha. Only found in certain situations, especially along watercourses, but nowhere plentiful. Seen from last week of November to last week of January.

Xenica kluggi. Very numerous in open forest country. Appearing first in second week of November to 3rd week of April.

Hypocysta euphemia. Not common. I have only seen it for certain on Cox River, especially preferring situations where walls of granite abound. Only seen in the 3rd week of December.

Zizina labradus. Not very plentiful. One of the few to remain into the first cold months of winter. Seen from September to June inclusive.

Neolucia serpentata. Rare. Only seen 1st week of January.

Neolucia agricola. Only seen once on December 3rd.

Polyommatus boeticus (*Lampides damoetes*). Plentiful in spring, ana among the first to make its appearance in the spring. Larvae feeding on Broom (*Cytisus scoparia*) pods. Seen from September to February and April inclusive.

Paralucia aurifer. I have only come across this species at Cox River; it seems to like the rugged granite country. Seen in December and January, though it has a longer life than this.

Candalides heathi. Decidedly rare. Seen only in December.

Candalides hyacinthina. Only seen once, and that in February, 2nd week.

Belenois java. Rather numerous in spring and early summer of 1920 and 1921, all flying in N. westerly direction. Seen from second week of October to end of January.

Appias ega. More numerous in 1920 than 1921, when I only saw it once or twice. Seen from fourth week of December to 1st week in February.

Catopsilia pyranthe. Not numerous. Seen in third week of December and middle of March and May, first week.

Delias aganippe. The common *Delias* here, though not so plentiful as one would expect, seeing that so much *Loranthus* grows about. Seen from September to April inclusive.

Delias harpalyce. Only seen once, on November 29th.

Delias nigrina. Also rare. Only seen a few times. Seen from December 17th to January 21st.

Terias smilax. Not common, and appearing from mid October to end of December, and again in April.

Papilio anactus. Only seen once, and that in middle of April.

Papilio sthenelus. The commonest papilio here. Seen from 3rd week of October to 3rd week of December.

Papilio aegeus. Decidedly rare. Only seen two or three times, In December and January.

Papilio (*lycaon*?). This, only seen once, was flying high along the course of a creek and having a typical papilio flight, and of a light blue tint, I decided it was either *P. sarpedon* (*Choredon*) or *P. lycaon,* but consider it the latter as I had never seen *P. choredon* more than a few miles from the coast. Seen February 21st.

Signeta flammeata. This is a doubtful species, as I only saw it for a few seconds once in the middle of February.

Trapezites symmomus. Fairly common, especially about Cox River. Seen in December, February and March.

Trapezites phigalia. Not common. Seen in October and November.

Trapezites petalia. Only seen once and that in October.

Trapezites eliena. Only seen once at Cox River, viz.: in 3rd week of December.

Taractrocera papyria. Uncommon. Seen in beginning of December.

VERTEBRATA.

PISCES.

Anguilla reinhardtii. Brown Eel. Common in Middle River in the summer months, and growing to a fair size.

Galaxias coxii. Mountain Minnow. A small fish only 2 or 3 inches long, but fairly plentiful. These are the only native fish.

Introduced.

Salmo irideus. Rainbow Trout. Introduced here many years ago. Fairly numerous, but not seen of any size.

Carassius auratus. Only the brown variety seen, and only once. This fish eats the trout ova, and therefore is not very desirable.

REPTILIA.

CHELONIA.

Chelodina (*longicollis* ?). Long-necked Tortoise. Not quite certain of the species. Only seen once dead and distintegrated in the river.

LACERTILIA.

Amphibolurus muricatus. Common Dragon. Very common in the bush; often on dead timber; much the color of itself; relying on mimicry for protection.

Physignathus lesueurii. Eastern Water Dragon. Common about the river into which it dives from a log when disturbed.

Tiliqua nigrolutea. Occasionally seen in the bush. Very sluggish in its habits. Beautifully marked in yellow and black. This is one of the Blue Tongued Lizard.

Lygosoma quoyi. A water lizard, frequenting rocks about water. Fairly common here. A good swimmer.

Ablepharus lineo-ocellatus. Garden lizard, smaller than the last. Common. I have been interested in watching the tactics of these who had taken up their stand at intervals close to where a line of the red meat ant (*Iridomyrmex detectus*) was passing from food to its nest. As soon as the lizards saw one carrying food they would rush out, wrench the food away, and make off to their vantage point to do the same again. If they missed getting the morsel at the first attempt they made off awaiting another chance.

Egernia whitei. Spotted Rock Lizard. A very pretty species marked with a row of small eye spots on both sides, and a double row on back. Fairly plentiful amongst rocks or roots, but very shy.

Rhodona fragilis. Very rare. Only seen once, and this was dug up from the ground. A pretty species with stunted tail and the two pairs of legs far apart with only 3 toes to each foot. There is a total absence of *Varanus varius.* The so-called "Iguana."

OPHIDIA.

Pseudechis porphyriacus. Black Snake. Not often seen here, but mostly about Middle or Cox River. One of the largest specimens ever recorded was killed on Cox River within the last year or two. I think I am correct in stating that it was said to be 6 ft. 9 inches long. This species is generally reported to be one of our most poisonous, but statistics disprove this for, according to Dr. Frank Tidswell's report on "The Researches of Australian Venoms," published by the Board of Health in 1906, out of 87 cases of reported bite from this species none proved fatal, and he sums up by saying that it seems the black snakes seldom or never killed a human being.

Denisonia superba. The Copper Head. Fairly common in the open amongst fallen dead timber. It is always anxious to get away. There is no doubt this snake is frequently confused with the black snakes, especially those individuals that have a well marked line of red scales along the side. The subcaudal scales would reveal the true species. Unfortunately, Dr. Tidswell's report makes no mention of the mortality from this species, though it is probably not high.

Diemenia textilis. Brown Snake. Only one of this species, and that one

found dead on the bank of Middle River. According to the Board of Health report by Dr. Tidswell, this snake has killed 18.7% of its victims reported to that date.

AVES.*

Uroaetus audax. Wedge-tailed Eagle. Seen occasionally amongst the mountains and about Cox River.

Falco lunulatus. Long winged Falcon. This bird was only seen flying. It had very long wings, and was very swift in flight. Only seen twice.

Astur approximans. Australian Goshawk. Not very common, and mostly seen in thick timber.

Astur cinereus. Grey Goshawk. Only seen once or twice. Very shy and difficult to approach.

Lophoictinia isura? Square-tailed Kite. Seen from long distances sailing in the air and high up. Only seen once or twice.

Cerchneis cenchroides. Nankeen Kestrel. Fairly common at certain times, especially in the autumn.

Accipiter cirrhocephalus. Sparrow Hawk. Seen in valley, mostly amongst the big timber, and frequently with a small bird in its claws.

Ninox boobook. Boobook Owl. Not common. I have never heard it utter its cry here.

Corone australis. The Raven. This bird has white eyes. As far as I know this species is still a disputed point. Whether a raven or crow I think is still undecided. Not as common here as the hazel eyed bird.

Corvus coronoides. The Crow. Numerous, and seems to go about in larger numbers than the bird with the white eye. It is said that the bases of the neck feathers of the crow are snow white. I have examined several to determine this point, and in all of them they were a dark grey. From these observations I should say that if this statement is true the crow is an uncommon bird.

Strepera graculina. The Mountain Magpie. Fairly common, and often associated with the Grey Magpie.

Strepera cuneicaudata. The Grey Magpie. Seen often feeding at the edge of swampy ground after rain, but living mostly amongst the hills and fairly common.

Corcorax melanorhamphus. The Black Magpie. Fairly numerous; in flocks of about a dozen on the mountain sides, though looked upon mostly as a western bird, inhabiting the plains.

Oriolus viridis. Green-backed Oriole. Not at all common, and appears to be a partial migrant. I have watched it eating the larvae of the stem saw fly which attacks eucalyptus saplings.

Grallina cyanoleuca. The Pee-wit or Magpie Lark. Not at all numerous. Seen mostly about stagnant water.

Collyriocincla harmonica. The Grey Thrush. A pair here and there with wide areas between.

Graucalus melanops. The Blue Jay. One of the first birds to arrive in the spring, and one of the last to leave. Fairly common in spring and summer. Arriving generally in mid-September and leaving the last week in April.

Lalage tricolor. The Peewit Lark. About the last migrant to arrive. Getting here the first week in November and leaving again the last week in April. Some years quite numerous, in others much less plentiful.

Microeca fascinans. Jacky Winter. A very rare bird here; only seen three times.

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*The nomenclature followed by Dr. Chisholm is that adopted by Hall, Key to the Birds of Australia, 1906.

Petroeca leggii. The Scarlet-breasted Robin. Fairly common. Mostly in the timbered country while breeding, but coming into the open more in the winter.

Petroeca phoenicea. The Flame Breast. Common in the winter in flocks, feeding in the open land. Not seen much during the nesting season, as it breeds in the timbered mountainous country. It is quite common to see one or two males in full plumage amongst twenty or thirty females, and males in grey plumage in the winter months.

Gerygone albogularis. The Native Canary. A rare bird here, and only seen passing through on migration. It doesn't take up its abode here for nesting.

Malurus cyaneus. The Blue Wren. Common about Middle River amongst blackberry scrub, where it nests. The first family of young appear to remain with the parents right through the nesting season, and as the young males are in immature plumage till the following spring, the opinion in some quarters has been that the one male mates with several females, which is not so.

Rhipidura albiscapa. White Shafted Fantail. A migrant. Arriving the first week of September, and last seen in last week of April. Very numerous in some years.

Rhipidura rufifrons. Red Fantail. Quite uncommon, and only found in well wooded gullies in the breeding season.

Rhipidura tricolor. Willie Wagtail. Not a common bird here.

Myiagra rubecula. Leaden Flycatcher. A migrant. Arriving about mid-October, and last seen the second week of March. Mostly found in secluded gullies.

Sisura inquieta. Restless Flycatcher. Rare. Only seen once. A migrant. Fond of the open country. Feeding mostly on the ground, where it hovers in the air before darting down to catch an insect, at the same time uttering its peculiar "grinding" note.

Origma rubricata. Rock Warbler. Found only in rocky gullies, and not very numerous. Builds a hanging dome-shaped nest with side entrance, suspended from the roof of a cave.

Chthonicola sagittata. Field Wren. A migrant. Only seen two or three times in the spring and summer.

Acanthiza pusilla. Brown Tit. Quite a common bird, keeping mostly to the scrub.

Acanthiza lineata. Striated Tit. A very common bird. Mostly seen in small companies, feeding in the trees.

Acanthiza chrysorrhoa. Yellow Tailed Tit. Not common. Seen mostly in open partly cleared country. Generally in small companies.

Acanthiza reguloides. Bark Tit. Common in the scrub, feeding on the ground in companies in the winter months, and often associated with several others of the genus, and frequently in company of *Rhipidura albiscapa, Petroeca leggii,* and *Climacteris leucophoea.* I have noted these four species together frequently.

Sericornis frontalis. White-fronted Scrub Wren. A shy bird, and only seen in dense scrub.

Cinclosoma punctatum. Spotted Ground Thrush. Fairly common, especially on the tops of ranges in rocky country.

Pycnoptilus floccosus. Pilot Bird. Only seen once, and that in a gully covered with dense bracken. This bird has rather a pretty call.

Hylacola pyrrhopygia. A rare bird, and very shy. Only seen in dense scrub, and often in exposed situations.

Xerophila leucopsis. White-faced Tit. Though generally looked upon as a

western species is quite common here in small flocks, and often seen with other small ground-feeding birds of allied genera.

Gymnorhina tibicen. Black-backed Magpie. Fairly common in the open country, flocking together during the winter months.

Cracticus destructor. Grey Butcher Bird. Not very common. Seen in mountain ranges. Mostly coming into the open country in the autumn months.

Falcunculus frontatus. Yellow-breasted Shrike Tit. Only seen a few times about the ranges, and generally high up in the trees.

Eopsaltria australis. Yellow Robin. Seen mostly in shady gullies, but not very common.

Pachycephala gutturalis. Yellow-breasted Whistler. Fairly numerous. Seen in mountain gullies. Here all the year round.

Pachycephala rufiventris. Rufous-breasted Whistler. A migrant. Arriving about mid-September, and leaving again as late as the second week of April. Some seasons the bush resounds with their notes in spring and summer, though usually very silent when they first arrive and sometime before they depart. A beautiful songster.

Climacteris leucophoea. White-throated Tree Creeper. Fairly common on the mountain sides; generally in the company of other birds.

Zosterops dorsalis. Silver Eye. This is a fairly common bird, especially during the winter months, when it associates in flocks, often with other Meliphagidae. This bird has a fine song, heard only in spring and summer.

Melithreptus brevirostris. Short-billed Honey-eater or "Cobbler." All through the winter months seen in flocks feeding amongst the foliage of the eucalypts; often with other species of the family.

Melithreptus lunulatus. Black Cap. Often immense flocks of these birds are seen passing over on migration, while others seem to remain all the year.

Meliphaga phrygia. Regent Honey-eater. A migrant. Seen in large flocks of upwards of 100, flying mostly north east, on April 3rd, 4th, 12th, and 18th, 1922.

Meliphaga fusca. Brown Honey-eater. Not common. Seen only occasionally, and then perhaps travelling.

Meliphaga chrysops. Yellow-faced Honey-eater. A migrant. Many passing through in flocks; some remaining to breed. Their note is one of the commonest in the bush during spring and summer.

Meliphaga leucotis. White-eared Honey-eater. A stationary bird. Fairly numerous, and found generally amongst stunted scrub.

Meliphaga auricomis. Yellow-tufted Honey-eater. Not a common bird, and only seen singly or in pairs.

Meliphaga penicillata. White-plumed Honey-eater or "Greeny." Is quite a common bird here at the present time, a fact which interests me very much, for I have always looked upon this bird as belonging to the western side of the Great Dividing Range. I have never seen it so far east in N.S.W. before. To add to my surprise I find it on both sides of the foreshores of Port Jackson, having met with it 3 times during June, 1922, at Mrs. Macquarie's Chair, Vaucluse, and Taronga Park. At first I thought it might be just passing through Marrangaroo on migration, but it has been here for months now, and is apparently stationary. This year, 1922, was the first time I had ever seen it away from its western haunt.

Acanthorhynchus tenuirostris. Spine Bill. Common where various plants of the family Proteaceae abound, such as Banksia and Grevillea for which its long bill is especially adapted.

Meliornis novae-hollandiae. Bearded Honey-eater. This species is com-

mon about the Middle River, where *Grevillea acanthifolia* abounds, of the nectar of which it is very fond.

Meliornis sericea. White-cheeked Honey-eater. Found in the same situations as the last bird, though this is the much rarer species here.

Manorhina garrula. Soldier Bird. Found in small colonies in certain localities in open forest land not generally distributed.

Acanthochaera carunculata. Gill Bird. Fairly numerous. Mostly stationary and breeds here. Fond of the nectar from Banksia blossom and eucalypts, and will attack garden fruit on occasion.

Philemon corniculatus. Leatherhead. A migrant, passing through in large flocks in spring and autumn, but doesn't seem to take up its abode here.

Philemon citreogularis. Yellow-throated Friar Bird. Rare and migratory. This bird I have not seen so far east before, but it was travelling in the company of the lastnamed bird during the autumn months in flocks.

Dicaeum hirundinaceum. Mistletoe Bird. Not seen often, but is much in evidence as the Mistletoe in places is very numerous, and it is through this bird's agency that it is mostly distributed. The male bird is a fine songster. This species always seems to me to belong very closely to the MELIPHAGIDAE, as it is certainly partial to sweet substances, and its tongue, though not typically brush-like, is divided at the tip. I have frequently seen it attacking garden fruit, especially grapes and apricots.

Pardalotus ornatus. Striated Diamond Bird. This bird whenever I have seen it close always had the speculum on the wing crimson, and always the same shade, and always builds in spouts of trees. Fairly common. Its note is double, not treble.

Pardalotus punctatus. Spotted Diamond Bird. Very common. Heard everywhere, especially in early spring, when it is busy tunnelling burrows in banks for nest building. The male has two distinct calls, one a double note, thrice repeated, and this is common to the female, too, and a double note, consisting of a very high pitched note, followed by a very low pitched one.

Hirundo neoxena. Welcome Swallow. A migrant here. Arriving very early in spring, occasionally in the 3rd week in August, and once the third week in July for a few days only.

Petrochelidon ariel. Fairy Martin. Rather a rare bird here, and migratory. Only seen a few times, and does not breed here.

Petrochelidon nigricans. Tree Martin. Commoner than the former, though nowhere plentiful. Also a migrant, and breeds here.

Anthus australis. Ground Lark or Pipit. Common on open ground. Has a very pleasing song while ascending in the spring.

Artamus sordidus. Common Wood Swallow. A migrant here. Arriving in last week of August, and remaining till last week in April.

Artamus superciliosus. White-browed Wood Swallow. Seen only in 1922, and then in an immense flock, and only stayed for a few days and passed on. This was in first week in April on their autumn migration.

Artamus personatus. Masked Wood Swallow. A pair only seen associated with the flock of lastmentioned birds.

Staganopleura guttata. Diamond Sparrow. Not common. Only seen a few times in pairs or small companies. I have met with the young of this species about 2 or 3 weeks out of the nest, and having black bills, on June 29th, so that the eggs must have been laid about the last week in April. This is rather surprising, seeing what a cold climate this is at that time.

Aegintha temporalis. Redhead. Fairly plentiful in gullies. Flocking in winter.

Menura superba. Lyre Bird. Not very common. This district seems to be about the extreme western limit for this bird, I have only met with it to the east of Marrangaroo.

Chaetura caudacuta. Spine-tailed Swift. Not often seen, and in both years first noticed in first and second week of March respectively.

Podargus strigoides. More Pork. Seen occasionally. Generally a pair together, and heard on summer evenings. I am convinced in my own mind that this bird does utter a long drawn out double note and resembling the sound "morepork," and that the Boobook Owl does too, but in this case it is much shorter and uttered more rapidly. I asked a friend who had a Podargus in captivity if she ever heard it utter its "morepork" note, and she answered very decidedly in the affirmative. I have had the opportunity of hearing the birds utter their notes close together, and to a close observer they are quite distinct. I know this is not the generally accepted opinion. I have been intimate with this bird for upwards of 40 years. Another thing, the two birds do not as a rule take up their abode in the same kind of locality, the Podargus preferring open forest country in the tall timber of which it relies on its mimicry for protection; the Owl on the other hand likes denser timber where it can hide by day, e.g., it is very fond of roosting in pine trees about a house. The long drawn out "morepork" note is usually only heard in the former localities, whereas the Boobook note is most often heard where dense bush abounds.

Eurystomus australis. The Dollar Bird. Not common. Seen occasionally. It is a migrant. Appearing in October.

Dacelo gigas. Laughing Jackass. One of the commonest birds here.

Halcyon sanctus. Sacred Kingfisher. A migrant. Appearing here in third week of October, and departing late in February. Not very numerous.

Cuculus pallidus. Pallid Cuckoo. A migrant. Appearing from the middle to end of September. Some years their notes heard everywhere, but after settling down it becomes silent.

Cacomantis flabelliformis. Fantailed Cuckoo. A migrant. Appearing in 1921 as early as August 19th, but usually about mid-September. Not common. Generally to be found in gullies.

Chalcococcyx basalis. Narrow-billed Bronze Cuckoo.

Chalcococcyx plagosus. Bronze Cuckoo. These birds are so much alike in the bush that I class them together. Both are migrants, and are not very numerous. They lay their eggs in the nests of the same species, though I have found the egg of *C. basalis* in both the nest of The Red-browed Finch and the Flame-breasted Robin. They both generally prefer the nests of different Acanthizae or the Wren family.

Glossopsitta pusilla. Little Lorikeet. Only saw a flock of these flying past once in the autumn.

Glossopsitta concinna. Musk Lorikeet. More common than last. Only seen flying over in the autumn or late summer.

Callocephalon galeatum. Gang Gang. Occasionally seen in the mountains, a few associated together. They are shy and difficult to approach. I saw a pair of these birds feeding 2 young about 2 weeks out of the nest on April 23rd, 1922, so that the eggs would have been laid about the first week in March or last in February.

Calyptorhynchus funereus. Yellow-tailed Black Cockatoo. A small flock seen occasionally, and often in misty weather. They mostly keep to the mountains.

Psephotus haematonotus. Red-rumped Ground Parrot. A pair together, seen only once. This is a western bird.

Platycercus elegans. Mountain Lory. Fairly common on the sides of the mountains, and in the denser growth. Feeding on the seeds of the thistle in flocks or small numbers.

Platycercus eximius. Rosella. Not very plentiful. Seen more in the open country amongst dead timber in the holes of which it nests.

Melopsittacus undulatus. Budgeriegar. The appearance of this was evidently accidental. Only one bird by itself; seen several times often in the company of a flock of sparrows and feeding with them.

Geopelia tranquilla. Peaceful Dove. Seen several times, but by no means common.

Leucosarcia picata. Wonga Pigeon. I have not seen this bird, though I have heard it almost certainly several times, and I am told it has been seen here.

Turnix varia. Scrub Quail. A migrant seen from first week in September to last in April. Some seasons numerous.

Gallinula tenebrosa. Black Water Hen. Seen only once, and that by itself on the Middle River.

Lobivanellus lobatus. Spur Winged Plover. Heard only flying over at night.

Aegialitis melanops. Black Fronted Dottrel. Seen about 10 miles away on Cox River lower down.

Carphibis spinicollis. Straw-necked Ibis. Only seen once in a flock of about a dozen feeding in grass lands by the river.

Notophoyx novae-hollandiae. White Fronted Heron. Occasionally seen about holes in the river.

Notophoyx pacifica. White-necked Heron. Only seen once or twice about the river. Mostly towards evening.

Nycticorax caledonicus. Nankeen Night Heron. Only seen two or three times in trees bordering the river.

Phalacrocorax (hypoleucus?). A white-breasted Cormorant. Seen once or twice about the river.

Podiceps novae-hollandiae. Black-throated Grebe or Diver. This bird seen several times and breeds here.

Anas superciliosus. Black Duck. Seen in small flocks several times on Cox River.

Introduced.

Passer domesticus. English House Sparrow. Numerous, building about houses and in spouts of trees. A fact about this bird not generally known is that after the breeding season is over the old birds leave the district and only the young remain. I witnessed in this same district once a huge flock of sparrows high up in the air evidently travelling from one district to another.

Carduelis elegans. English Goldfinch. Small flocks seen occasionally feeding on the thistle and also on garden plants such as the cosmos, of the seeds of which they seem fond.

Sturnus vulgaris. European Starling. This bird here feeds out in the open grass lands all day, flying in large flocks towards their roosting place in the timber in evening. Not complained of as a fruit eater here.

MAMMALIA.

MONOTREMATA.

Tachyglossus aculeatus. Porcupine. Rare. I know of 2 instances where it has been seen since I have been here, though I have not come across one myself.

Ornithorhynchus anatinus. Platypus. Not seen on Middle River. In

Farmer's Creek at Bowenfels in 1884 or 1885 I saw one.

MARSUPIALIA.

Phascologale minutissima. Smallest Pouched Mouse. Only one seen dead in the bush.

Dasyurus viverrinus. Common Native Cat. Rare. I have heard lately of an occasional one being caught in rabbit traps.

Phascolomys mitchelli. Wombat. Very common here judging by their burrows and by their excreta. From my experience I should say that they rarely come out by day, waiting until long after dark. They live amongst the caves and rocks of the mountain sides.

Trichosurus vulpeculus. Grey Opossum. Not common here now, and only occasionally seen, though quite numerous in the years 1884-5.

Macropus ruficollis. Red-necked Wallaby. Rare. Only seen once or twice amongst the hills.

Macropus ualabatus. Black-tailed Wallaby. I have seen this species once or twice at Cox River on the sides of the hills.

CHEIROPTERA.

Bats. Not identified; probably several species.

RODENTIA.

Lepus cuniculus. Rabbit. Fairly numerous, though kept in check with traps.

Lepus timidus. Hare. Quite uncommon. Only occasionally have I seen an odd one.

Mus musculus. Mouse. Fairly plentiful.

Epimys norvegicus. Grey Rat. I have only seen one.

CARNIVORA.

Vulpes vulgaris. Fox. I have seen this several times among the mountains, and it is usually shy.

BIRD STUDIES AT TARONGA PARK.

Mr. E. V. Pollock has made numerous photographic studies of the animals and birds exhibited at Taronga Zoological Park. He showed an interesting series of lantern slides of the bird pictures at a recent meeting of the Society. A selection of these bird studies appears in plates v., vi., and vii., and it is intended at some future date to publish some of the same member's animal studies.

NOTE ON THE AUSTRALIAN GENUS *TAPEIGASTER* MACQ. (DIPTERA) WITH DESCRIPTIONS OF NEW SPECIES.

By Prof. M. Bezzi, Turin, Italy.

(*Communicated by Dr. E. W. Ferguson.*)

The Acalyptrate genus *Tapeigaster* was described in 1847 by Macquart (*Mem. Soc. Sci. Lille,* 1846, p. 102) as belonging to the *Sciomyzidae,* notwithstanding the presence of a pair of strong vibrissae, well recorded in the original diagnosis. Only one species, *Tap. annulipes,* from New Holland (without precise locality) was described and figured on pl. VI., fig. 1; the type is to be found in Bigot's, now Verrall's, collection. The genus was not recorded subsequently, until in 1917 Prof. Hendel (*Deutsch. entom. Zeitschr.,* 1917, p. 46) described a new genus *Sciomyzoptera, incertae sedis,* with a new species *Sciom. annulata* from Australia.

Having received recently from Dr. E. W. Ferguson, of the Health Department, Sydney, rather numerous specimens of flies of the present genus, and comparing them with the descriptions of Macquart and of Hendel, I have come to the conclusion that both genera are synonymous, even their types being, in my opinion, the same species.

Regarding the systematic position of the genus *Tapeigaster* (the better spelling of which is perhaps *Tapigaster*), I think that it may always be placed in the *Scatophagidae,* as a special subfamily between the *Scatophaginae* and the *Norelliinae.** But the reduced orbital and dorsocentral bristles, the convergent postvertical bristles, the entire costa** and the spinose femora are very peculiar. The shape of proboscis seems to be very like that of *Scatophaga,* the genus belonging thus to the Thecostomata.†

The genus may be characterised as follows:—

Tapeigaster Macquart, 1847. (*Sciomyzoptera Hendel,* 1917.)

Shining reddish or yellowish species of middle or great size, with unspotted wings, with thickened and spinose femora and with greatly developed male genitalia.

Head rounded, as broad as the thorax, rather convex behind, with the occiput swollen below. Frons flattened, or even a little concave, not prominent in profile, with parallel sides. Vertical plates short. Ocelli at vertex, on a rather prominent tubercle. Face short and concave; mouth border more or less prominent, with a strong vibrissa on each side. Para-facialia linear; peristomialia rather broad, as broad as the third antennal joint, or a little more. Eyes bare, rounded. Lunula not or less visible from above, appearing as a prominent tubercle between the base of antennae, which are therefore distinctly separated at root. Antennae inclined, inserted near the middle of eyes, short, extending or not to the mouth border, with the third joint rounded at end or quite circular; arista long, bare or shortly pubescent. Mouth opening broad; praelabrum concealed, but well developed. Palpi not dilated, never flattened, destitute of terminal bristle; proboscis rather elongated, chitinous, with short terminal flaps.

Cephalic chaetotaxy well developed; postvertical as a rule convergent or even decussate; 2 vertical of about the same length; a few occipital; 1 ocellar; 2 short superior orbital; no inferior orbital, but the frontal stripe above the antennae with some bristles, directed inwardly.

**Hendel,* Deutsch. entom. Zeitschr., 1917, p. 35-36.

***Hendel,* Entom. Mitteil., v., 1916, p. 296-299.

†*Frey,* R. Acta. Soc. Fauna and Fl. Fenn., 48, 1921, p. 209.

Mesonotum elongate, with the suture broadly interrupted in the middle; hypopleura prominent; mesopleura bare.

Thorax chaetotaxy as follows:—1 humeral; 1 praesutural; 2 notopleural; 1 anterior and 2 posterior supra alar; 1 prescutellar; 2 dorsocentral; 0 pteropleural; 0 mesopleural; 1 sternopleural placed in the middle of the upper border of sternopleura.

Scutellum bluntly triangular, convex, rather bare on the disc, with four marginal bristles.

Abdomen short, not longer and not broader than the thorax, with five visible segments; no distinct bristles. Male genitalia very greatly developed, sometimes tuberculate below; female ovipositor retractile, with two terminal lamellae.

Legs strong and hairy; femora thickened, with strong but short spines below, placed in two rows on terminal half; tibiae not spinose, with distinct praeapical bristle.

Wings elongate, with bare and shining membrane. Costa bare, with no costal bristle and without basal interruption. Subcostal vein well developed and complete; first longitudinal vein bare; last portions of third and fourth vein parallel or slightly converging; hind cross vein straight and near the hind border; second basal cell normal; anal cell shorter than the second basal cell, obtuse or a little acute below but never produced; sixth vein not extended to the hind border or with a spurious prolongation only; axillary lobe broad; axillary vein broad, but spurious; alula rounded and large.

Type: *Tapeigaster annulipes Macq.*, 1847.

Nothing is known about the habits of the adults, or about the first stages; it is probable that some species, like *annulipes*, breed on fungi, as is to be seen from labels on the specimens. The most robust species looks very like the European species of *Neurotena*, and seems to be likewise confined to mountainous districts.

It is possible that some species described by old writers from Australia under the generic name *Dryomyza* may belong here. Thus *appula* Walker (List p. 984), of which, however, is said that the sides of face are without bristles; *bicolor* Walker (Ins. Saund. iv., p. 370) from N.S.W., which has a very different coloration; and certainly *cingulipes* Walker 1857, also from N.S.W.

The four species before me may be distinguished as follows:—

1 (6). Upper mouth border not much prominent and not bi-tuberculate in the middle; head without silvery spots near the eyes; abdomen entirely reddish; tibiae yellowish with black rings, hind cross vein less oblique.

2 (5). Antennae and proboscis black; wings greyish hyaline or very faintly yellowish.

3 (4). Frons with whitish stripes at sides near the eyes; postvertical crossed at end; back of mesonotum opaque greyish with distinct dark and whitish stripes; abdomen with distinct whitish hind border to the segments; legs grey dusted with no distinct black rings or with less developed ones; femora with strong bristles above, those of the hind pair more thickened than those of the middle; male genitalia not tuberculate below; wings quite hyaline. *marginifrons*, n.sp.

4 (3). Frons destitute of whitish lateral stripes, with only a very narrow white line in front near the eyes; postvertical parallel; back of mesonotum shining reddish with a single whitish longitudinal stripe in the

middle; abdomen entirely shining reddish, without whitish bands; legs shining yellowish, with black rings on femora and tibiae; femora without strong bristles above, those of the middle pair more thickened than the hind ones; male genitalia with two very prominent tubercles below at end; wings distinctly a little yellowish. *annulipes,* Macq.

5 (2). Antennae and proboscis reddish yellow; frons without white borders; abdomen entirely shining reddish; legs shining reddish, with less marked black rings; all the femora destitute of rows of strong bristles above, those of the middle pair more thickened than the hind ones; male genitalia bilobate at end, but without strong tubercles; wings intensively yellowish. *luteipennis,* n.sp.

6 (1). Upper mouth border very prominent and with two strong tubercles in the middle; head with silvery spots near the eyes and on the occiput; abdomen shining black in the middle; hind femora more thickened than the middle ones; tibiae black with a yellow ring in the middle; male genitalia spheroidal, with no prominent tubercles below; wings yellowish, with the hind cross vein inwardly oblique. *argyrospila,* n.sp.

1. *Tapeigaster marginifrons,* n.sp.

Closely allied to the following species, but at once distinguishable by the broad whitish orbits. Type ♂ in the collection of the Health Department, Sydney, with several other specimens of the same sex from the Blue Mountains, March-April, 1922. Type ♀, id. id., from Sydney, 2nd June, 1922. Two ♂ from Kosciusko, New South Wales, 5,000 ft., June and December, 1920-21; one ♂ from Hallet's Cove, South Australia, 9th October, 1920. ♂♀. Length of body and of wing, 6, 5,-7 mm. Occiput reddish above, whitish below, above in the middle with two white shining stripes extended from the neck to the sides of vertex, and there in contact with the white sides of the frons; moreover, the upper eye-border is whitish to the beginning of the occipital bristles. Frons reddish in the basal half and yellowish in the terminal one, with an elongate whitish ocellar triangle, and with complete whitish stripes at sides near the border of the eyes. Lunula shining whitish. Face pale yellowish, like the peristomialia which are broader than the third antennal joint; parafacialia linear, white shining, in continuation of the frontal orbits. Mouth border rather prominent, but simple; palpi pale yellowish; proboscis black. Antennae entirely black, a little shorter than the face; they are rather separated at base, but are approached towards the middle; the third joint is rounded at end, and about as long as the second; arista long, bare. All the cephalic bristles are black; postvertical crossed at end; occipital black, lower part of head with whitish hairs; frontal stripe with short black hairs at sides in front.

Thorax entirely reddish; on the back it is rather opaque, and has a broad, greyish longitudinal middle stripe, extended equally from the neck to the scutellum; in its praesutural portion this stripe is divided by a narrow middle longitudinal line of the ground colour; on the sides there is a broad greyish band extending from the humeri to the root of the wings, just above the notopleural line. Pleurae wholly clothed with a thin light grey dust; they are bare, but the sternopleura are clothed with long whitish hairs, which are more dense on the breast. Scutellum reddish, with faint grey dust and short black pubescence. All the bristles black; the short pubescence of the back of mesonotum is black. Calypters reddish, with a whitish and white fringed border. Halteres whitish, with reddish stalk. Mesophragma reddish, with a faint whitish dust.

Abdomen entirely reddish, rather shining; segments from second to fifth with a greyish hind border, which is dilated in the middle and prolonged forwards; pubescence short and dark on back, long and whitish on sides. Venter reddish, whitish dusted, with scattered white hairs. Male genitalia shining reddish, not at all dusted, with scattered white hairs on terminal portion; the apical segment is a little bilobate, but without prominent tubercles. In the female there are some blackish bristly hairs at hind border of the last segments; ovipositor reddish, white pilose.

Coxae reddish, whitish dusted and with long white hairs; femora reddish, with faint greyish dust, those of the front pair dark grey on the outer side; front femora with a row of black bristles above, and with dense and long white hairs below; middle femora thinner than all the others, with 3-4 long black bristles near the end above and with long white hairs below; hind femora with 3-4 erect black bristles above before the middle and with white hairs below; the spines are black, but they are well developed on the hind pair only. Tibiae yellowish, the anterior ones with black end only, the hind ones with black base and black end; they have long and dense hairs at the inner side. Praeapical bristle, and spur of middle tibiae black. Tarsi with yellowish basal joint, with reddish middle joints (second and third) and with blackish terminal joints; claws stout, black; pulvilli whitish.

Wings quite hyaline, not at all yellowish, with reddish veins. First posterior cell distinctly narrowed at end by a sudden curving below of the end of the third longitudinal vein; second longitudinal vein perfectly straight; small cross vein a little beyond the middle of the discoidal cell; hind cross vein nearly perpendicular.

II. *Tapeigaster annulipes* Macquart.

Tapeigaster annulipes Macquart, *Mem. Soc. Sci. Lille* (1846), 1847, p. 103, pl. vi., fig. 1.
Dryomyza cingulipes Walker, *Trans. Ent. Soc. London* (2), iv., 1857, p. 220.
Sciomyzoptera annulata Hendel, *Deutsche entom. Zeitschr.*, 1917, p. 47.

A characteristic fly, recognisably described and figured by Macquart, chiefly on account of the greatly developed male genitalia. Macquart's figure shows the broad white orbits peculiar to the preceding species; but this seems to be an erroneous exaggeration of the fine white line of the anterior part, the genitalia (fig. 1c and 1d) referring without any doubt to the present species.

Some specimens of both sexes from the Blue Mountains, 13th April, 1922; other specimens from Mosman, 26th May, 1917, "settled on *Psalliota campestris*," also from Milson I. (Hawkesbury River), May, 1915, "on fungus"; and from Sydney, without data.

♂♀. Lengths of the body and of the wing 7-8 mm. Occiput reddish, with a faint grey dust, shining only in the postvertical region, clothed with scattered erect black hairs, without silvery spots. Frons rectangular, longer than broad, of a deep purplish-red colour, more intensive on sides, chiefly in the male; ocellar spot triangular, blackish, margined with grey; orbital white lines very narrow, and visible only near the antennae; it is clothed with dark hairs and has some black bristles in front above the antennae. Face yellowish; parafacialia linear; peristomialia as broad as the third antennal joint, whitish, unspotted; mouth border less prominent and simple. Lunula triangular, whitish, visible between the roots of the antennae, which are entirely black like the arista, and are extended to the mouth border. Palpi pale yellowish or whitish; proboscis black. All the cephalic bristles black; postvertical parallel or convergent; occiput below with whitish hairs.

Thorax entirely reddish; on the back it is darker and rather shining with a broad, equal, complete middle grey stripe, extended from the neck to the scutellum; another broad but less determined stripe on the sides, just above the notopleural line, extended from the humeri to the postalar calli. Pubescence black, rather long, erect, scattered. Pleura with light grey dust, entirely opaque and bare, except on the sternopleura, which are clothed with dense and long pale hairs. Mesophragma likewise dusted, but shining. Scutellum like back of mesonotum, shining, dusted at base only. All the bristles black. Calypters vitreous, with yellowish border, fringed with white hairs. Halteres whitish.

Abdomen shining reddish, almost without dust, with dark pubescence and longer dark hairs at sides; middle segments with the hind border narrowly black, but not always distinctly. Ventral membrane soft and dirty whitish; tergites reddish yellow, those of the male with long whitish hairs. Male genitalia greatly developed and very prominent; the apical segment with two long tubercles, directed below, one on each side; they are shining reddish yellow, clothed with long dark hairs. Ovipositor shining reddish, with the extreme end and the terminal lamellae black.

Legs shining reddish yellow, with black spots on femora and with two black rings on the tibiae; the four posterior femora have, moreover, a short black ring at end; front and middle femora thickened, more strongly in the male; tarsi blackened at end. The hairs of femora are black above and pale below; all the femora are armed with strong black spines below on the terminal half.

Wings as described for the preceding species, but distinctly yellowish at stigma and in the fore half; first posterior cell proportionally broader and not distinctly narrowed towards the end.

III. *Tapeigaster luteipennis*, n.sp.

Nearly allied to the preceding species, but of greater size and more robust, with quite yellowish antennae and proboscis, and with differently shaped male genitalia.

Type ♂, a single specimen in the Health Department collection, Sydney, from Eccleston, New South Wales, 1st March, 1922.

♂. Length of body and wing about 10 mm. Head, its appendages and chaetotaxy as described for the preceding species; postvertical parallel.

Antennae distinctly shorter, ending at a considerable distance before the mouth border; they are entirely yellowish, the rounded hind joint being even more pale; arista with distinctly longer pubescence. Proboscis entirely pale yellowish.

Thorax broad and strong, dark reddish, entirely opaque; humeri and notopleural line paler; on middle of the back there is a praesutural whitish stripe, which is divided by a broad middle line of the ground colour. Pubescence blackish, shorter but denser than in the preceding species. Pleurae with some darker and some paler portions, bare, the sternopleura only being clothed with long pale hairs. Scutellum lighter reddish than the back, shining, with short black pubescence; mesophragma of the same colour; shining, not dusted. All the bristles black. Calypters and halteres as in the preceding.

Abdomen entirely shining reddish, without black hind borders of the segments; its pubescence is short and black, but the longer hairs of the sides are reddish; sternites with long whitish hairs. Male genitalia greatly developed, shining reddish, with long hairs of the same colour; in general shape they are as in the preceding species, but the terminal segment with only two short, obtuse, rounded tubercles; moreover, the last abdominal tergite has a strong prominence on each side, before the genitalia.

Legs shining reddish, with less developed black markings; all the femora with a more or less complete middle dark spot, and the four posterior ones with a small black, not ring-shaped, spot at end; the tibiae with only the apical ring-like spot, the basal one being not distinguishable. Tarsi pale yellowish, with only the last joint black. The four anterior femora are greatly thickened, those of the hind pair much less thickened; the hairs are dark above and reddish below, and there are no distinct rows of differentiated bristly hairs above; the strong spines are black, developed on all the pairs, but longer on the four anterior ones.

Wings very intensively yellowish, only a narrow posterior border being greyish hyaline; stigma more reddish. All the veins reddish, directed as in the preceding species; first posterior cell but little and gradually narrowed at end.

IV. *Tapeigaster argyrospila*, n.sp.

The most robust of all the species here differentiated, and very distinct from all the others on account of the silvery spots of head and of the peculiar shape of the mouth border.

Type ♂, a single specimen in the Health Department collection, Sydney, from the Blue Mountains, 11th March, 1922. ♂. Length of the body 10 mm.; of the wing 9 mm.

Occiput reddish, rather shining above, with an elongate argenteous spot in the middle, extended from the neck to the postvertical; at the eye-border there are five argenteous spots on each side, two lower ones of greater size, and three superior smaller, the internal of which is placed on the frons at the upper corner of the eyes; it is clothed with scattered blackish hairs on upper half, and with denser yellowish ones below. Frons quadrate, as long as broad, distinctly concave, the ocellar tubercle being thus rather prominent; it is of a deep purplish colour, with a triangular argenteous spot at vertex, in which is the blackish ocellar area, and with an elongate argenteous spot on each side in the middle near the eyes; the white shining lunula is visible from above between the roots of antennae. Face concave, with a not sharp but distinct middle keel, and with the upper mouth border very prominent and strongly bituberculate in the middle. Parafacialia linear; peristomialia broad, deep purplish, bare, about as broad as the length of the third antennal joint; along the eyes there is a narrow argenteous line. Antennae considerably shorter than the face; third joint only a little longer than the second, of circular shape; they are entirely reddish, the third joint being, moreover, whitish dusted; arista broken off in case of type specimen. Palpi yellowish, with some long blackish hairs at end; proboscis reddish. All the cephalic bristles black; postvertical decussate.

Thorax entirely reddish; on the back it is clothed with a rather dense dark yellowish dust, becoming opaque; on the sides and pleura it is without dust, being, therefore, rather shining; longitudinal stripes not distinct, although the yellowish dust seems to form a broad middle band; above the humeri, along the notopleural line and above the root of wings there are some not well determined white shining spots; the short pubescence of the back is black, like all the bristles. The pleura are bare, except the long whitish hairs of sternopleura, longer, denser and yellowish on the breast; propleura and front part of mesopleura with broad white shining spots. Scutellum shining reddish-yellow, with short black pubescence and some whitish dust at extreme base. Mesophragma shining reddish. Calypters yellowish, with yellow fringe. Halteres pale yellowish.

Abdomen shining black, with reddish base and pale yellowish terminal segment; the pubescence is black, but the longer hairs of the sides are reddish. The

greatly developed genitalia are pale yellowish, shining; they are clothed with long yellowish hairs on the sides and below; the basal segment is as long as the terminal abdominal segment; the apical segment is rounded, without any prominent tubercle.

Legs stout and short, with greatly thickened front and hind femora, those of the middle pair being the least thickened of all. Coxae reddish. Femora shining reddish, those of front pair with a broad black patch from the middle outwards; they have long whitish or yellowish hairs below, and blackish hairs and bristles above; on the terminal part there is below a short black denticulation, but as it seems there are a few spines on the hind pair only. All the tibiae black, with a more or less broad yellowish ring just beyond the middle; they are clothed with long and dense dark hairs inwards, chiefly those of the middle pair. All the tarsi whitish, shorter than the tibiae.

Wings shorter than the body, intensively yellowish on the anterior half; veins reddish, brighter towards the base. Third and fourth longitudinal veins distinctly and equally convergent at end, the first posterior cell being thus gradually narrowed at end. Hind cross vein straight, placed inwardly oblique, the upper outer angle of the discoidal cell therefore acute. Lower angle of the anal cell distinctly acute, even if not produced.

Note: The types of the new species described in the above paper have been presented to the Australian Museum, Sydney.—E.W.F.

THE POLYPLACOPHORA OF KING ISLAND, BASS STRAIT, WITH DESCRIPTION OF A NEW SUBSPECIES.

By Edwin Ashby, F.L.S., M.B.O.U. and A. F. Basset Hull.

Plate viii. Figs. 1-6.

Foreword.—Both W. Lewis May, of Tasmania, and I had for several years contemplated a visit to King Island with a view to the examination of the Chiton fauna, as we believed that no one had collected Chitons there since the visit of Peron and Lesueur in November and December, 1802. On 3rd December, 1922, May wrote informing me that he had been away from home for a fortnight on a preliminary trip of investigation to King Island. With the letter he sent a number of Chitons he had collected during his visit; of this number he thought two were new species, and asked me to describe them. By a curious coincidence Hull was just about the same time on his way to the island, he having informed me under date 25th November, 1922, that he was leaving Sydney on the 28th idem to collect Chitons on King Island. He actually reached the island barely a fortnight after May had left it. Thus, after the lapse of a hundred and twenty years, two workers, quite independently of one another, planned their respective expeditions only a week or two apart. The following paper is a record of the results, so far as concerns the *Polyplacophora,* of these two expeditions. As "L'Ile King" is given as the type locality of several of the Chitons described by Blainville (1824) and others, these results should be of interest to all workers. May collected at Currie Harbour (middle west coast), Surprise Bay (south-west), Fraser or Sea Elephant Bay (middle east coast), and Grassy Creek (south-east coast). Hull, who was accompanied by Gerald Lewers, a keen young collector, worked for several days from Currie Harbour south to Badger Box Creek, spent one day at Yellow Rock River, working towards Whistler Point (north-west coast), and three days at Fraser Bluff. The material and notes of both collectors are amalgamated in this paper. E. Ashby.

Introduction.

King Island lies almost midway between the north-western coast of Tasmania and Cape Otway, Victoria, and from its position one might reasonably expect its Chiton fauna to be a rich one, comprising representatives of the southern Australian and Tasmanian faunas. The island is about 40 miles in length from north to south, and 16 miles in width, having an area of approximately 400 square miles. No examples of the following genera were found:—*Lepidopleurus, Callochiton, Rhyssoplax* or *Lorica.* It might be claimed that the limitations of time and tide under which the collectors laboured account for their failure to secure representatives of the genera mentioned, but the period covered by their operations embraced both full and new moon spring tides, in addition to which some dredging operations were carried out in ten fathoms off Fraser Bluff. It was noted that both species and individuals were most numerous about the limits of the neap low tides, and as the depth of water increased the Chiton fauna rapidly decreased, until in three or four feet at low water, where on the mainland one would expect to find *Rhyssoplax, Lorica,* etc., the stones examined were almost invariably bare, except for an occasional specimen of the ubiquitous *Heterozona subviridis,* or *Cryptoplax striatus.* The entire absence of *Sypharochiton pellis-serpentis,* which is such a common shallow water species on the Tasmanian coast; the presence of *Ischnochiton virgatus,* and the fact that all other recorded species are common to southern Australia and Tasmania, suggest that the Chiton fauna of King Island is more nearly related to that of the South

Australian coast than to that of Tasmania or the East Coast of Australia. The most interesting omission is that of *Stenochiton longicymba* Blainville, 1825 (*Chiton longicymba,* Bl. Dict. Sc. Nat., vol. xxxvi., 1825). One of us took numerous examples of this shell on *Posidonia* both in King George Sound and near Cape Le Grand, east of Esperance Bay, and the other has recorded it from the west coast of Western Australia. Peron and Lesueur collected in King George Sound, in 1802, but Blainville gave "rivages de l'île King" as the type locality of his *Chiton longicymba* (Dict. Sci. Nat. xxxvi., 1825). Not only was there no trace of the seagrass *Posidonia* discovered in the numerous localities visited on King Island, but the most searching inquiries of the older inhabitants, including professional fishermen, failed to elicit any information pointing to the existence of this weed, either at the mouth of the Sea Elephant River, or in any other locality not visited by the collectors. *Cymodocea* was noted in and south of Currie Harbour, and at Whistler Point, in fairly large beds. These beds were closely examined, but no trace of *Stenochiton cymodocealis,* Ashby, was found. One of us examined the type of *S. longicymba* in the Paris Museum (Ashby, Trans. Roy. Soc. of S. Austr. vol. xlvi., 1922), and found it conspecific with *Stenochiton juloides* Ad. & Ang., 1865. Blainville's type is labelled "Ile King Peron et Lesueur." In the paper cited it is pointed out that under the name of *Chiton hirtosus* (Peron M.S.), "Ile King," is a specimen of *Liolophura hirtosus* (Peron M.S.), Blainville in the Paris Museum. This shell undoubtedly came from Western Australia, and not from King Island. There is in the same Museum a specimen of *Acanthopleura gemmata,* Blainville, marked in Peron or Lesueur's handwriting, "Ile King." This shell certainly could not have come from that locality, but was probably collected as far north as Shark Bay, Western Australia. It is therefore quite possible and even probable that *S. longicymba* may also have been collected in Western Australia, where it is common, and afterwards have become mixed with specimens collected on King Island.

SPECIES COLLECTED.

ISCHNOCHITON LINEOLATUS.

Chiton lineolatus, Blainville., Dict. Sci. Nat., t., xxxvi., p. 541, 1825.

Ischnochiton crispus, Reeve., Conch. Icon., t., 19, f. 120, 1847.

Ischnochiton lineolatus, Ashby, Trans. Roy. Soc. of S. Austr., vol. xliv., pp. 272-275, 1920, and vol. xlvi., p. 573, 1922.

This shell was far from common, half a dozen specimens being taken at Fraser Bay, and a few at Grassy Creek. It was not found at all on the western coast. None of those taken showed the brown streaks of the type, but one from Grassy Creek is in other respects very similar to the type. One specimen taken at Fraser Bay is a deep red variety, identical in colour and sculpture with specimens from Portland, Victoria.

The type was collected by Peron and Lesueur at King Island in 1802. One of us examined this type, and confirmed his previous identification with *I. crispus* Reeve. In the latter paper cited, p. 573, the words "The larger shell is smooth and shiny" should have been preceded by the words "The anterior valve of." This correction is necessary to make the meaning quite clear.

ISCHNOCHITON ATKINSONI LINCOLNENSIS.

Ischnochiton atkinsoni, Iredale & May, sub-sp., *lincolnensis.* Ashby, Trans. Roy. Soc. of S. Austr., vol. xliv., p. 275, 1920.

A number of biscuit-coloured shells taken at Surprise Bay appear to be conspecific with the Port Lincoln shells, but most of them are considerably

eroded. One of us possesses three shells from Sulphur Creek, near Penguin, north-west Tasmania, that are similar in character. It therefore seems likely that the deeply sculptured insular form, *I. atkinsoni* Iredale & May, overlaps the subspecies on the north-west coast of Tasmania, but does not extend to King Island.

ISCHNOCHITON IREDALEI KINGENSIS, n. subsp.

Plate viii., Figs. 1-4.

Ischnochiton iredalei, Dupuis, Ex. Bull. Mus. Hist. Nat., 1918, No. 7.
Ischnochiton lineolatus, Blain. of Iredale & May, Proc. Mal. Soc., vol. xii., pts. ii. and iii., Nov. 1916 = *I. contractus,* Reeve, of Pilsbry, Auct.

General appearance.—Dingy white flecked and mottled with olive, in large specimens these olivaceous markings become streaks and dashes. The streaking or flecking is very pronounced in the dorsal area where it is brownish olive. The shape is elliptical, almost evenly rounded at either end. The jugum is a little more raised and less rounded than in *iredalei, sensu stricto.*

Anterior valve.—Apex raised, slope straight, not curved as in the shells from the mainland coast. The sculpture consists of closely packed, well defined, radial ribs; while these are sub-granulose they are not so granulose as shells of *I. iredalei, sensu stricto,* neither are they broken by concentric grooving as in that shell. Interior white, slits 11.

Posterior valve.—The posterior portion is decorated with strongly granulose, radial ribs, in many cases consisting of strings of rounded beads; this portion of valve is separated from the anterior part by a raised, diagonal, broken rib. The mucro is median. The anterior portion of this valve is sculptured with well defined, diagonal ribs, produced forward towards the jugum and slightly pectinated; slits 14.

Median valve.—Lateral areas raised, decorated with five or more radial ribs, somewhat irregular, and formed of rows of raised and rounded granules; the posterior margin coarsely serrate with rounded teeth. The pleural area is deeply and longitudinally grooved and ribbed, the ribs directed forward diagonally towards the dorsal area, practically covering the whole of this area; in this respect differing from the mainland shell. The dorsal area is broadly wedge-shaped, and is covered with ribs diverging each side of the jugum and thereby forming a V, and crossing the ends of the diagonal ribs of the pleural area. This area is coloured brownish olive, interior white, eaves well defined, teeth smooth, slits 1/1.

Girdle.—Is similar in width and character to *I. iredalei, sensu stricto,* banded, and clothed with similarly grooved scales.

Measurement.—Type 24 x 12½ mm., but adult and worn specimens up to 47 mm. in length were collected. Those in which the sculpture is badly worn can hardly be separated from *I. iredalei, sensu stricto.*

Habitat.—May took two specimens at "Grassy" and Hull a fairly long series at Fraser Bay. We have with May's consent discarded his shell and taken a larger shell from Hull's series as type, so that the type locality will be Fraser Bay. The type while now in Ashby's collection is later on to be presented to the South Australian Museum.

In conclusion.—The markings of this shell are in character like those of very juvenile *I. iredalei* from the South Australian coast, but in this sub-species this marking seems to be consistently retained into the fully adult stage. The King Island shell is less rounded in the jugum, showing a dorsal ridge. The whole sculpture in unworn shells is beautifully sharp and clear-cut, and the diagonal longitudinal ribs of the pleural area are continued right up to the dorsal area, in this respect differing from the mainland shells. While there is little difficulty in

separating these King Island shells from those from the mainland coast, there is considerable difficulty in separating them from the forms found at Sulphur Creek, in north west Tasmania. Ashby has a fine series from that locality, which differ greatly in colour and markings, and many of them in sculpture from typical *I. iredalei,* whereas that species varies very little on the Australian coast. We think all the shells from King Island are referable to this sub-species, and that probably some of the north-west Tasmanian ones are as well. It looks as if a well defined geographic race has been developed in the waters of King Island, but in Tasmania proper it overlaps with *I. iredalei, sensu stricto.*

ISCHNOCHITON VIRGATUS.

Ischnochiton virgatus Reeve. Conch. Icon. t. 28, f. 192, 1848.

This shell was rare on the west coast, but numerous specimens were taken at Fraser Bay, including a remarkable pinkish coloured juvenile. Four specimens were taken at Grassy Creek. The adult shells were of the beautifully decorated, blue freckled form occurring commonly on the Victorian coast, and differing in this respect from the common form found in King George Sound, Western Australia. May had not previously taken this species within the Tasmanian region, but the late R. N. Atkinson collected it at Clarke Island, Bass Strait (north east Tasmania).

ISCHNOCHITON (HAPLOPLAX) SMARAGDINUS RESPLENDENS.

Lophyrus smaragdinus Angas, P.Z.S., p. 115, t. 13, f. 28, 1867, dominant form.
Ischnochiton resplendens Bednall & Matthews, Proc. Mal. Soc., vol. vii., pt. 2, 1906.

Not common; eastern coast only. Most specimens were of the dark form, common on the north-west coast of Tasmania, but one taken at Fraser Bay has the irregular broad dorsal pattern with light coloured margin of *I. resplendens,* although it shows none of the delicate tracery of Bednall and Matthews's type.

ISCHNOCHITON (HETEROZONA) SUBVIRIDIS.

Heterozona subviridis Iredale & May, Proc. Mal. Soc., vol. xii., pts. 2 and 3, 1916.

This species was found in extraordinary abundance in each locality visited; as many as fifty individuals being counted on the under side and edges of one stone, 6 x 8 inches. For the most part eroded dorsally they nevertheless exhibited a brilliant colouring, principally in shades of cobalt, pale to dark, with scattered examples in cream, brownish, and dark purple. May expressed surprise, assuming the conditions to have been the same in 1802, that the French naturalists had not taken or recorded this species. As a matter of fact, they appear to have taken specimens of this shell. On examining Blainville's types in the Paris Museum one of us (Trans. Roy. Soc. of S. Austr., vol. xlvi., p. 573, 1922) noted that the type of *I. lineolatus* is undoubtedly a fine well-marked specimen of the Chiton we used to know as *I. crispus* Reeve. On other cards in the same Museum are further specimens under the same name (*lineolatus*) collected at "Ile King" by the same naturalists, some of which are probably half-grown examples of *Heterozona subviridis.* Further, one of the specimens collected by Peron and Lesueur at "Ile King," formerly belonging to M. Paul Dupuis, and presented by him to the senior author, is undoubtedly *subviridis.* It is reasonable, therefore, to conclude that the French naturalists collected both species, but those of the species under review being half-grown, dingy, inconspicuous shells, Blainville selected the larger, better-looking shell for his type of *Chiton lineolatus.*

ISCHNORADSIA AUSTRALIS EVANIDA.

Chiton evanidus Sowerby, Mag. Nat. Hist., vol. iv., p. 291, 1840.
Ischnoradsia novae-hollandiae, Reeve, of Iredale & May, Proc. Mal. Soc., vol. xii., pts. 2 and 3, 1916, p. 112.
Ischnoradsia evanida, Sow. of Ashby, Trans. Roy. Soc. of S. Austr., vol. xlii., 1918.

This species was not common on the west coast, but fairly numerous on the east coast. May's comment is that it showed very little longitudinal striae, but an examination of the material collected in all localities discloses some mature specimens showing the longitudinal striae, while the majority are without this sculpture.

CALLISTOCHITON ANTIQUUS MERIDIONALIS.

Callistochiton antiquus meridionalis Ashby, Trans. Roy. Soc. of S. Austr., vol. xliii., p. 400, 1920, vol. xliv., 1920.

One anterior valve of this species was obtained at Currie Harbour, and three living shells at Fraser Bay.

PLAXIPHORA ALBIDA.

Plate viii., Figs. 5, 6.

Chiton albidus, Bl. Dict. Sc. Nat., pl. 74, vol. xxxvi., p. 547, 1825.
Chiton costatus, Bl. l.c. p. 548—Ashby, Trans. Roy. Soc. of S. Austr., vol. xlvi., 1922.
Chiton glaucus Quoy & Gaimard, Zool. Astrolabe, vol. iii., 1835, p. 376.

May writes: "Both species (the smooth and the wrinkled shells) fairly numerous on exposed rocks at Grassy Creek, also a few at Currie." Hull obtained one specimen only of the smooth shell, and many of the wrinkled shell, at each locality visited.

Blainville's type of *P. albida* was collected by Peron et Lesueur at "Ile King." It is an eroded and bleached shell with evidence of wrinkling on one valve only, the wrinkled shells from King Island correspond with the type. The range of this form extends well round the southern and western coasts of Australia as far north as Dongara. Should workers wish to separate them then by strict rules, Quoy and Gaimard's name is preoccupied by *Chiton glaucus,* of Gray, now *Amaurochiton glaucus,* Gray, a New Zealand shell, in which case we shall have to adopt the name *Plaxiphora tasmanica,* Thiele = *Chiton glaucus* Q. and G. Whether this is only a smooth variety of *P. albida,* Bl. or a distinct species must be left to future investigation.

Note by Edwin Ashby.—The writer has collected *Plaxiphora* of the wrinkled variety from New South Wales, round southern Australia and Tasmania to as far north as Dongara in Western Australia. He has also collected in most of these localities the smooth form called *Chiton glaucus* by Quoy and Gaimard, and has specimens of this smooth form from as far north as Burleigh Head, Queensland. He considers the smooth shell from King Island conspecific with the latter.

The series in his collection appears to cover every stage from the strongly sculptured specimen with two granulose, diagonal ribs, called *conspersa,* by Adams and Angas, to the smooth form with nongranulose diagonal rib or no rib at all, named *glaucus* by Quoy and Gaimard. In conversation with Mr. Tom Iredale recently in London, he (Mr. Iredale) concurred with the writer in the conclusion that the question as to whether this series represents one very variable species, or more than one, is still undetermined.

ACANTHOCHITON SUEURI.

Chiton sueurii Blainville, Dict. Sci. Nat., vol. xxxvi., p. 553.

This was one of the very common species, found on both west and east coasts. Some finely preserved specimens of large size were collected, but the majority observed were much eroded.

ACANTHOCHITON GRANOSTRIATUS.

Acanthochites granostriatus Pilsbry, Nautilus, vol. vii., p. 119, 1894.

Two typical specimens were taken at Fraser Bay. The species was not seen elsewhere, and may be recorded as "rare."

ACANTHOCHITON VARIABILIS.

Hanleya variabilis Adams & Angas, P.Z.S., 1864, p. 194.

At Grassy Creek May collected a remarkable variety of this species. It is 8½ mm. in length, ground colour darkish, decorated with opalescent granules which completely coalesce across the pleural areas, forming ribs which are bright blue in colour. The wide interspaces between the ribs being dark coloured show up the blue ribbing and opalescent granules to great advantage. The whole of the sculpture of valve iii. is bright blue.

ACANTHOCHITON KIMBERI.

Acanthochites kimberi Torr., Trans. Roy. Soc. of S. Austr., vol. xxxvi., p. 167, 1912.

Two specimens of this by no means common shell were taken at Fraser Bay. They are in good condition and typical examples, the larger measuring 8½ x 4½ mm.

ACANTHOCHITON COSTATUS.

Acanthochites costatus Adams & Angas, P.Z.S., 1864, p. 194.

One specimen only, 19 mm. in length, was taken at Fraser Bay. The species was not met with elsewhere on the island.

CRYPTOPLAX STRIATUS.

Chitonellus striatus Lamarck, Anim. Sans. Vert., t. vi., p. 317, 1819.

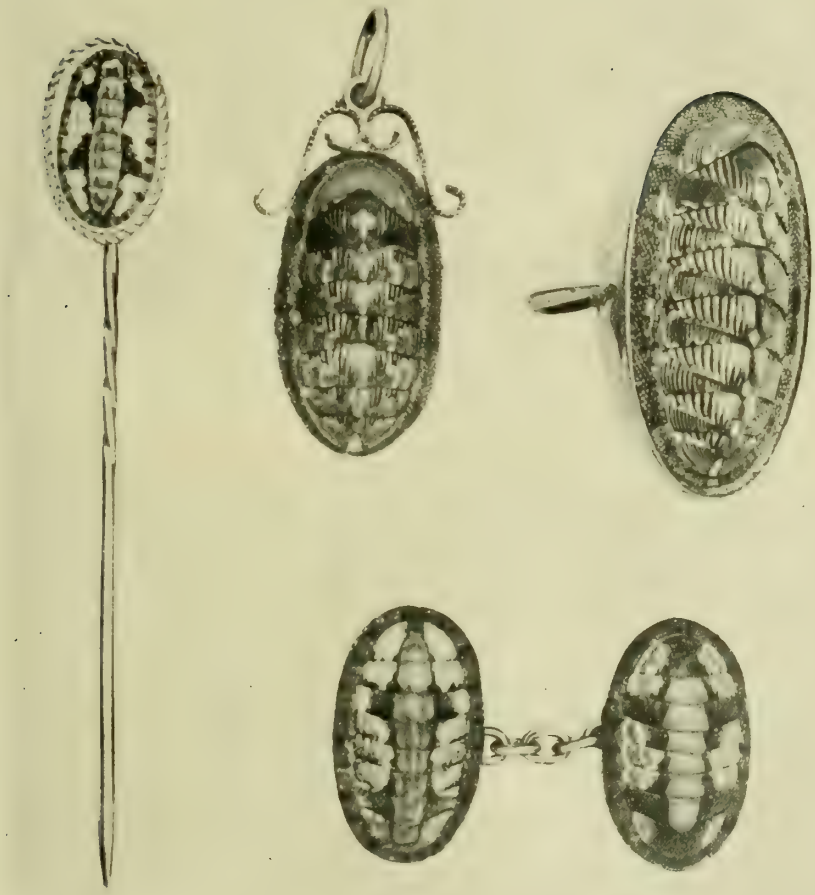
Cryptoplax striatus Ashby, Trans. Roy. Soc. of S. Austr., vol. xlvi., p. 577, 1922.

This was a very common shell indeed on the west coast, but not so common on the east coast. A large series was obtained, and it may be noted that the King Island shells differ from typical South Australian shells in that the spicules on the girdle are shorter and more widely spaced, although about the same thickness and similarly curved towards the point. The granulose character of the sculpture of the juvenile shells is apparently changed at a little earlier stage of growth into the adult coarse, irregular, longitudinal ribbing, characteristic of this species. It is noted that a great many of the spicules are broken off, thereby increasing the appearance of wide spacing. We do not consider these slight differences sufficient to warrant our giving even subspecific rank to the King Island specimens. It is worthy of notice that the largest shell collected shows evidence of spacing between valves 5, 6 and 7; this feature is characteristic in adult specimens of *C. striatus*. Mawle has collected specimens of *Cryptoplax* at Port Arthur, Tasmania, that vary considerably, and some of them correspond with those from King Island.

EXPLANATION OF PLATE viii.

Fig. 1. *Ischnochiton iredalei kingensis.* Entire shell, from photograph by E. Ashby.
„ 2. do do. Anterior valve.
„ 3. do do, Posterior valve.
„ 4. do do. one-half median valve.
„ 5. *Plaxiphora albida,* one half median valve (wrinkled shell).
„ 6. do do. one half median valve (smooth shell).

Drawn by Joyce K. Allan.



Chitons Utilised in Making Jewellery (enlarged).

BIRD STUDIES AT TARONGA PARK.

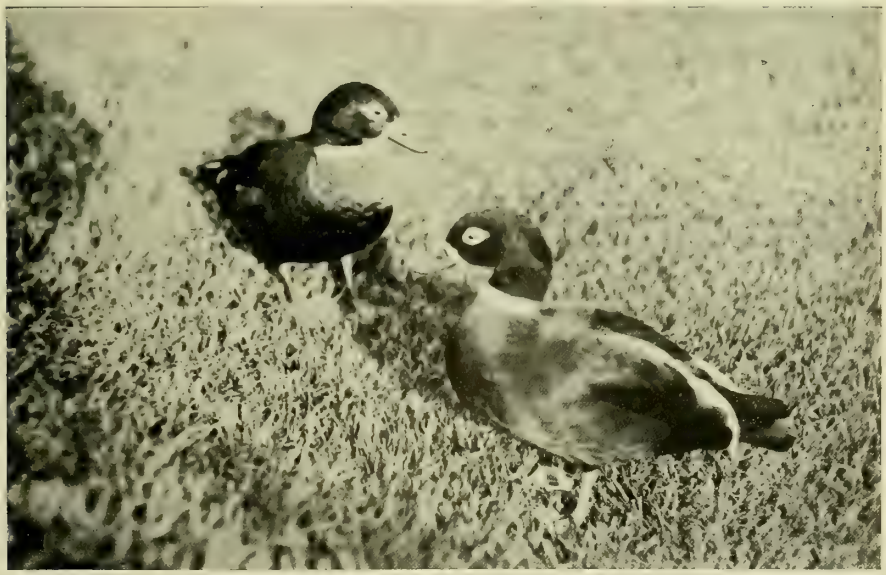
"Sunshine and Shadow."
(Flamingoes).

"The Dunces."
(Indian Adjutant Stork).

Photographs by E. F. Pollock.

BIRD STUDIES AT TARONGA PARK.

"Peace, Perfect Peace."
(White Swans).



"Mates."
(Ruddy Sheldrake).

Photographs by E. F. Pollock.

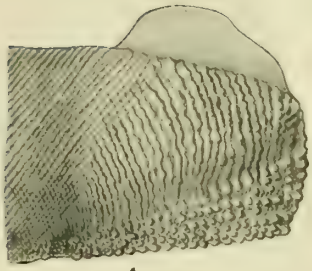
BIRD STUDIES AT TARONGA PARK.

"On Guard."
(The Jabiru).

"Three Fishers went Sailing."
(Australian Pelicans).

Photographs by E. F. Pollock.

1



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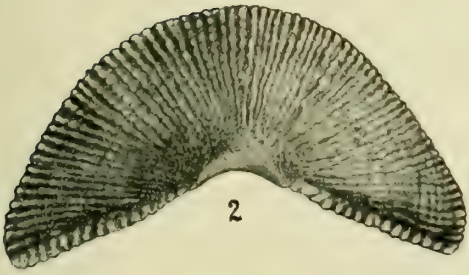

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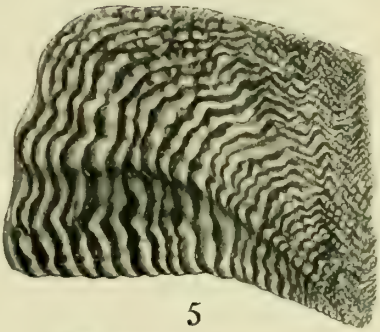

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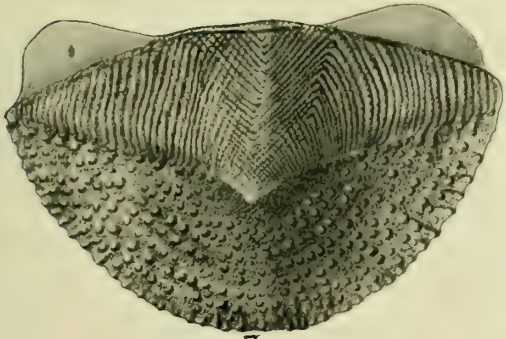

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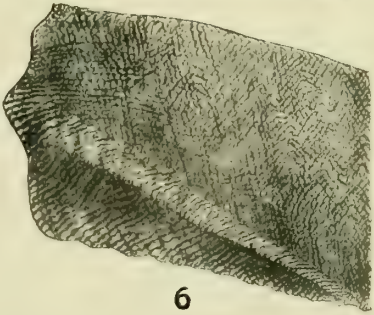

6

King Island *Polyplacophora*

Royal Zoological Society of New South Wales.

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CONTENTS OF VOL. 3, PART 1.

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Edited by
LAUNCELOT HARRISON, B.Sc., B.A.,
Professor of Zoology at the University of Sydney.
And A. F. BASSET HULL, C.F.A.O.U.

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Royal Zoological Society of New South Wales.

NEW MEMBERS.

The following members have been elected since the publication of the last list (9th March, 1923):—

Ordinary members:—O. H. Baas, T. G. Campbell, T. E. Hall, C. H. Weaver, and Miss E. H. M. Weaver.

Associate members:—J. C. B. Allen, Miss M. J. Bancroft, A. G. Campbell, A. J. Campbell, A. H. Chisholm, W. B. Gurney, L. Gallard, H. A. Longman, J. M. Mackerras, A. E. J. Thackway, and Dr. Casey A. Wood.

S. W. Jackson has converted his Ordinary membership into Life Associate membership.

SUBSCRIPTIONS.

Ordinary members are reminded that the financial year ends on 30th June, and, in order to avoid any possible delay in obtaining passes to Taronga Park for the ensuing financial year, it is desirable that subscriptions be sent in before the end of June.

ORNITHOLOGICAL SECTION.

On the occasion of the usual meeting of the Ornithological Section on 20th April, the members met at the Australian Museum, the lecture hall of that institution having been kindly placed at their disposal by the Trustees. As an experiment, the public were invited, and the result was such as to justify the change of meeting place. There was a good attendance of members and their friends, as well as of the public, the hall being nearly filled. Formal business was dispensed with, and the proceedings took the form of a series of lecturettes, illustrated by numerous lantern slides. Mr. Neville W. Cayley, honorary secretary of the Section, talked about Bower Birds and Lyre Birds, a series of remarkable slides from photographs by Messrs. Ramsay, Morse, and others, showing the birds with nests, young, and playgrounds being used. Mr. A. H. Chisholm discoursed on Birds and Children, and advocated the training of youngsters in the knowledge and care of bird-life. Mr. P. Gilbert showed a wonderful collection of Honey-eaters in their most characteristic attitudes, and with their nests. Mr. Basset Hull told of his experiences amongst the sea-birds of the New South Wales coast and islands, illustrating his remarks by pictures of the birds and their breeding places. Mr. Roy J. Kinghorn discussed Birds in Museums, illustrated by a series of views, showing the life-like groups of birds reproduced with natural surroundings in the Museum; and Mr. E. F. Pollock exhibited some of his fine views of Birds in Cap-

tivity, mostly taken at Taronga Park, accompanied by an interesting chat on the subject and the illustrations.

The meetings of this Section have become so popular that arrangements have been made to hold them monthly instead of bi-monthly. The next meeting will take place on Friday, 15th June, and thereafter they will be held on the third Friday in each month. All members of the Society will be welcomed at these meetings.

Dr. Casey A. Wood, a noted American ornithologist, and a member of the American Ornithologists' Union recently visited Sydney. He brought fraternal greetings from his Union to the brother bird men in Australia. Members of the Section did their best to make his all too brief stay in Sydney a pleasant one. He expressed a desire to see a Bower Bird and its Bower and a Lyre Bird and its Lyre. Messrs. Hull, Le Souef and Nubling took him to National Park, where his desire met with abundant fulfilment. A freshly-constructed Bower of the Satin Bower Bird was located, the bird's preference for blue ornaments being displayed in the selection of pieces of blue glass, matchbox labels, used blue-bags (collected from the Rest House laundry) and other similarly coloured objects. After inspecting the bower, the party retired to a little distance, focussed their binoculars on the playground, and were soon delighted to see a young male Bower Bird in his rich green plumage visit the spot. He was shortly after joined by a magnificent male in the glossy black plumage, and the two went through some interesting evolutions in and out of the bower. A female Lyre Bird also appeared on the scene for a few minutes. A move was then made a mile or two up the river, where the Azure Kingfishers, Pied Crow Shrikes, Black Moor Hens, Grebes, Black Swans, and other birds were seen and admired by the visitor. An unmistakable imitation of chopping and sawing wood sounded from near the bank, and the boat was quietly pushed into the reeds. Not twenty yards away a female Lyre Bird was vigorously scratching beside a fallen tree, and along the prone trunk a magnificent male was going through his marvellous repertoire of "Songs and Sounds of the Bush." The cheerful cry of the Pied Crow Shrike or Corrowong, the cawing of the Raven, the rich flute-like notes of the Harmonious Thrush, the barking of two dogs, and many other sounds were emitted by the bird as it strutted along the tree trunk, waving its tail and dropping its wings, reminding the observers of a Highland piper or a drum major at the head of a band. Close behind him came a young male in almost full plumage, the whole group forming a sight that even the experienced eyes of the Australians had rarely looked upon. The birds were quite fearless, and Dr. Wood landed to have a closer view. He and Mr. Nubling followed the procession through the subtropical scrub, amongst hanging vines and drooping ferns, as the birds wandered along the sandstone ridges, scratching, singing, and displaying their beautiful tails, for nearly half an hour. The day's outing was enjoyed by the local bird men quite as much as by the visitor.

On Monday, 30th April, the Ornithological Section held a special meeting to welcome Dr. Casey Wood at the Society's rooms. A selection of bird pictures from the Society's collection of lantern slides, supplemented by additions lent by Mr. Ramsay and other members, was shown by Mr. Cayley, who undertook to make up a representative set for presentation to Dr. Wood for use in the United States at some lectures on the Birds of Australia he proposes to deliver on his return home.

On Tuesday, 1st May, Mr. Harry Burrell entertained Dr. and Mrs. Wood to a private view of his wonderful collection of eggs, nests and embryos of the Platypus, the connecting link between birds and mammals.

Dr. Casey Wood's specialty in ornithology is a study of the eyes of birds and their relation to those of the Lacertilia or Lizards. He has a monumental work in hand, on which he has been engaged for some fifteen years, and hopes to complete shortly, on the structure of the eye and the vision of birds. He may revisit Australia to see more of its remarkable avifauna, and may feel assured of a warm welcome on his return.

BIRD NOTES.

The Jabiru.—While at the mouth of the Mooloolah River, Queensland, in September, 1922, I observed a Jabiru on two occasions, feeding on the sand flats. He was a magnificent bird, with his blue-green neck and head, black tipped wings, and bright vermilion legs. It was most fascinating to watch him walking up and down in the shallow water, lifting his legs very carefully; then suddenly he would appear to be in a hurry but unwilling to lose his dignity. At times he would so far forget himself as to do a real good run, flapping his wings to help him go faster. I saw him catch two good sized fish, which he treated in the same manner as a Laughing Jackass treats his prey, only he kept on washing the fish, and after a final wash, gulped it down. Those poor birds in the Zoological Gardens look like apologies, after seeing this keenly alive bird. In April of this year the Jabiru appeared with a mate, which was even more brilliant in leg colouring than he was. Every morning they arrived together and solemnly patrolled the sandbanks and shallow waters together. One morning they fished on a little sandbank just opposite our cottage, and we had a splendid view of them with our binoculars. In watching them fishing I have come to the conclusion that they flap their wings and half fly, half run through the water in order to frighten the whiting and cause it to bury itself in the sand. Then they go casually to the place and pull the whiting out. Twice, when watching the Jabirus, I noticed that after one of their flying manoeuvres they just walked up a few paces, put in a bill, and pulled up a fair sized fish. Once I saw one of the birds go through the same performance, but with no result. There were also quite a number of White-headed Sea Eagles before Easter. One day I counted eight of them all together. Another morning one flew past, close to the surface of the water, with a large mullet flapping helplessly in its talons. We saw one of these Eagles bathing. He was out on a sandbank in front of the cottage, in what appeared to be about three inches of water, adopting the same methods as a swallow does when bathing on top of our tanks. He stayed there quite a long time, and seemed to enjoy his dip. It is the first time I have seen one of these birds sitting or standing in the water in that manner.

VERA V. FOOTE. Buderim.

ERRATUM.

An error occurred in M. Tonnoir's paper on Australian Blepharoceridae, appearing in the previous part of this volume. Lines 4 and 5, page 57, should be transferred to page 58, to follow line 4.

PROTECTION OF OUR NATIVE FAUNA.

By A. F. Basset Hull.

Several interesting papers, published in this Part, voice the need for more effectual legislation to regulate the taking and export of our native animals and birds, their furs, skins and feathers, before the fate of extinction overtakes some of Australia's remarkable fauna. The subject has lately had considerable attention bestowed upon it by the press and the public, and the time seems to have arrived when some united effort should be put forth by this and other Societies to urge governmental action.

The question is not without the difficulties inseparable from any matter which affects a number of conflicting interests, and it might be of advantage to glance at some of the problems to be faced, and to suggest possible solutions.

No doubt from the government point of view the question of meeting the cost of administration is one that would be immediately raised. The administration of both the Fisheries and Birds and Animals' Protection Acts is at present in the hands of the Chief Secretary of this State, a separate staff being maintained to deal with each branch. Amalgamation of the two staffs at once suggests itself, with possibly a slight reduction in number. There are some 36 Inspectors of Fisheries, who are *ex officio* Honorary Rangers under the Birds and Animals' Protection Act, so that the principle of amalgamation is at least partially applied already. Such a staff of Inspectors is, however, quite inadequate to carry out the duties required by both Acts throughout the whole State. The Police, also under the Chief Secretary's administration and Honorary Rangers are supposed to supply the deficiency. Anyone knowing the numerous extraneous duties the police are called upon to perform will recognise the impossibility of their carrying out to the required extent the duties of rangers or inspectors under the Acts mentioned. While in no way suggesting that their powers in this direction be curtailed, we consider that their hands might be strengthened by increasing the number of officers authorised to act as rangers. The foresters and forest guards under the Forestry Commission, and the Conditional Purchase Inspectors of the Lands Department, have already been gazetted as rangers, and also the Inspectors of Stock, Tick and other Agricultural Department Inspectors, but officers of the Pastures Protection Boards, and others might be added to the list of rangers. The one weak spot in this system of adding the ranger's to the other duties of these officers is that they receive no additional remuneration for the added work, and thus there is no incentive, other than that of "duty" for the performance of what must be at all times an unpleasant part of their official work. To allot a fixed allowance to each ranger would entail a fairly heavy expenditure, as there are considerably over 200 official rangers already appointed, but some method of payment by results might be adopted, such as a reward for each conviction, or a moiety of the fines inflicted, together with a refund of all expenses incurred and payment for lost time. To meet the cost of administration the regulations relative to game licenses might be amended and the fees increased. Provision should also be made for the issue of licenses to sportsmen, who at present may shoot up to twenty game birds every day during an open season without paying one penny to the Crown—the lawful owner of the birds—for the privilege. Even the miner, who follows a useful occupation, cannot lawfully search for Crown minerals until he has paid a license fee of five shillings per annum, the cost of his miner's

right. Why then should the sportsman, who shoots for his own amusement or for the replenishment of his larder, be allowed to gather in the Crown game free of charge? The Gun License is another source of revenue which should be applied towards the cost of administering the Protection Act. Lastly, a small export duty on furs, skins and plumage would yield a revenue large enough to defray the whole cost of administering a greatly improved Act and an increased and reasonably remunerated staff.

The second question that requires consideration is the effect of protection, and the consequent increase of possibly noxious animals, on the man on the land. Wholesale and indiscriminate protection cannot be reasonably demanded, even by the most sentimental protectionist. There must always be provision for regulated thinning out where the increase threatens settled industries. The existing Act makes provision in this direction, and nothing but careful administration in the issue of permits to destroy animals said to be noxious is necessary. For this purpose, however, it is absolutely necessary that the officer entrusted with the issue of permits should be an experienced field naturalist or zoologist, having a good knowledge of the local names of birds and animals, which in actual fact vary to an extraordinary degree. Further, the district rangers should be furnished with concise handbooks, containing information which would at once enable them to identify any bird or animal as wholly or partially protected, or as wholly noxious. The measures of protection must be carried out so as to cause as little interference as possible with agricultural and pastoral interests. Hence a suggestion made by one writer that the country along the lines of railway be proclaimed nature reserves is impracticable, as settlement naturally follows the railways. The very fact that such settlement results in the clearing away of the forests, swamps, and other natural cover for both birds and animals should be enough to cause the rejection of the suggestion. The best sanctuaries are the greater Forest Reserves, Water Reserves, Parks, and other national areas upon which settlement is forbidden. The official rangers, adequately remunerated for the work, would be the best judges as to whether the natural increase of any given species were likely to cause damage to adjoining settlers, and to make recommendations accordingly. The periodical reports of these officers would also be of the greatest value to the central administration as enabling the compilation of a census of rare species, those threatened with extinction, and those which could be judiciously thinned out.

The views expressed by Sir Douglas Mawson (South Australia) are so practical from an economical standpoint that we offer no apology to our readers for reprinting his paper from another scientific publication which is probably inaccessible to most of them. On the contrary, our thanks are due both to the writer and the Royal Society of Tasmania for the permission to reprint such a valuable contribution to Economic Zoology.

Reference to this branch of study leads us to again urge upon the Minister for Education and the Councils of the State Universities the need for greater facilities for the pursuit of knowledge in the direction of the study of native animals with a view to commercial advantage. The establishment of experiment stations where animals and birds, fishes, mollusks, and all other native fauna may be bred, observed, studied and cultivated is also advocated as a necessary adjunct to the provision of educational facilities.

In relation to the conservation of Marine Mammals and Fish it is significant to note the following resolutions which were unanimously adopted by the California Academy of Sciences on January 3, 1923, after a full and free discussion:—

Whereas, It is known that many valuable species of marine mammals such as fur seals, sea otters, elephant seals and whales, and many species of important food fishes such as salmon and halibut, formerly occurred in the Pacific in such vast numbers as to constitute the objects of fisheries whose annual products were worth more than one hundred million dollars, and

Whereas, Nearly all of those great natural resources have been seriously depleted, many of them even to commercial extinction, through greed, short-sightedness and ill-considered fishery methods, and

Whereas, It is known that small remnants of fur-seal and sea-otter herds and small numbers of whales and other commercially valuable species still remain in certain places, and

Whereas, The rapid recovery of the Alaska fur-seal herd in the short space of ten years from complete commercial ruin to an annual production of more than $1,500,000, as a result of the international fur-seal treaty of 1911, demonstrates conclusively the wonderful recuperative power of such depleted natural resources of the sea under international co-operation, and justifies the belief that other depleted fisheries can be rehabilitated through similar co-operation among the nations concerned, and

Whereas, It is conservatively estimated that these resources when rehabilitated will yield to the world a regular annual product of more than one half-billion dollars * in value, therefore be it

Resolved, That the California Academy of Sciences strongly recommends that the various countries bordering on, or interested in, the Pacific, take such steps as may be necessary to bring about an International Treaty for the restoration of the vanishing resources of the Pacific to their former abundance, that they may be maintained for all time as the objects of great commercial fisheries of which they are easily capable, and be it further

Resolved, That the California Academy of Sciences recommends that the governments of the countries bordering on the Pacific enter into correspondence for the purpose of establishing an International Commission for the scientific study of the biology, physics, and chemistry of the Pacific in the interest of the restoration, proper utilisation, and conservation of its vanishing natural resources.

Similar resolutions were unanimously adopted at the Pan-Pacific Commercial Conference.

In this journal (p. 11 ante) Dr. G. Dallas Hanna has ably dealt with the question of protecting the fur-seal herds of the Southern Hemisphere, and Professor F. Wood Jones has recently made some pointed comments upon the "protection" afforded to the unfortunate remnants of the once plentiful seal herds of South Australia. He says: (1) "There is no doubt the seals that inhabit the islands of South Australia are being mercilessly exterminated. A partial, but unfortunately a purely nominal, protection is extended to them; but the protection goes no further than the words printed in the Act. Upon the islands where they are 'protected' they are slaughtered as freely and as barbarously as they are

* $500,000,000 at $4.60 equals £108,695,600. The American million is one thousand million.

1. Trans. Roy. Soc. S. Aust., vol. xlvi., 1922, p. 192.

upon the islands where the killing is sanctioned by the law. As a matter of fact, the seals anywhere upon the islands are at the mercy of any scoundrel who cares for the revolting brutality of their slaughter, and deems the gain of a few shillings sufficient reward for the labour involved in flaying the carcass and preparing the pelt."

The species referred to by Professor Wood Jones as inhabiting the islands of the Nuyt's Archipelago is the large "hair seal" (*Arctocephalus forsteri* Lesson). He describes it as a wholly inoffensive animal, deserving of all the protection that can be afforded it. My experience in the Archipelago of the Recherche (1921) is that the fishermen regard the hair seals as mischievous destroyers of edible fish, and they do not hesitate to shoot them as being "noxious animals."

RETENTION OF TYPES IN AUSTRALIA.

One of the resolutions adopted by the Congress of the Royal Australasian Ornithologists Union in October, 1921, related to the desirability of retaining the types of any new species of birds collected in Australia.

The extension of the principle to all classes of the Australian Fauna has since been advocated, both in the press, and by learned Societies. It is therefore gratifying to know that the Prime Minister of the Commonwealth has intimated that in future scientific collectors will be required to deposit the types of new species collected in an Australian Museum, and that specimens of any rare species collected (already named) are likewise to be so deposited. An expedition of British scientists is now operating under these conditions.

MACQUARIE ISLAND AND ITS FUTURE.

By Sir Douglas Mawson, Kt.B., D.Sc., B.E., O.B.E.

Plates ix.-xiv.

[*Reprinted, by kind permission of the Author and the Council of the Royal Society of Tasmania, from that Society's Proceedings, (1922), pp. 40-54*].

Macquarie Island has recently assumed an importance in the public mind far beyond that suggested by its modest proportions. This distinction emanates from its wonderful population of quaint Subantarctic (1) life. From the days of its discovery in the year 1810, it has ever been remarked by visitors to its shores as a wonder island of marine bird and seal life.

The hand of man has, alas! cast a shadow over its myriad inhabitants, and wrought irreparable havoc; but this devastation is not yet so complete as that of the more accessible islands to the south of New Zealand, where the destruction of the native fauna is much further advanced.

In the consideration of its animal population, the island is quadruply unique in the Australasian seas. Firstly, for the abundance of the life; secondly, for the variety of species frequenting its shores, some, like the King penguin and the Sea-elephant, breeding nowhere else in Australasian waters; thirdly, for the fact that it is the only speck of land in the vast expanse of ocean to the south of Australasia and New Zealand between latitude 52 degrees south and the Antarctic Circle, and is consequently the only possible breeding place for such life in those seas; finally, for the fortunate circumstance that up to the present man has not completely wrecked nature's handiwork, though certain species of life formerly abundant are now extinct, and others so greatly reduced that they are in danger of complete extermination.

In these days the nations of the world are taking council. Realising the economic and scientific value of perpetuating, as far as practically possible, the varied forms of life which, in association with man, populate mother earth, they are making more and more provisions to ensure the continuance of species.

In illustration may be mentioned National reserves where indigenous life is afforded absolute protection, as, for example, Laysan Island, in the Sandwich Group, which is entirely set aside by the United States Government as a sanctuary and breeding ground for marine birds; also our own reserves in the several States of the Commonwealth, where areas are set aside for the indigenous fauna. At other times protective measures are adopted in relation to the exploitation of certain animals where there is a danger of indiscriminate slaughter leading to the extermination of "the goose that lays the golden egg." As examples of this kind may be mentioned, firstly, the International legislation controlling the fur seal industry of the Pribyloff Islands, where alone there now remain extensive rookeries of fur seals; secondly, the control effected over the whaling and sealing industry of that part of the Antarctic and Subantarctic that falls within the jurisdiction of the Falkland Islands and Dependencies.

In both cases these latter restrictions refer to very lucrative industries,

(1) This spelling, in preference to "sub-Antarctic," is adopted in conformity with the decision of the Philosophical Institute of Canterbury, N.Z., in connection with their Report on the Subantarctic Islands of New Zealand, published in 1909. It is thus made a definite and specific regional name.


MACQUARIE ISLAND
Lord Nelson Pt
Wireless Hill
Buckles Bay
Eagle Pt
Island L.
Nuggets Beach
Bauer Bay
Ballast Bay
Aurora Pt
Stars Gulch
Flynn L.
Davis Pt
Waterfall Bay
C. Touchard
Major L.
LUSITANIA BAY
Mt Fletcher
Waterfall Lake
Caroline Cove
South West Pt
Hurd Pt
TRUE NORTH
1 2 3
SCALE IN MILES

which, but for the passage of wise legislation, would ere this have been a thing of the past. Prior to the inauguration of protective measures, the days of the fur seal of the North Pacific were numbered; each successive year saw the rookeries greatly reduced. But in the long period that has elapsed since indiscriminate slaughter gave place to a rational treatment of nature's bounty, the numbers of the fur seals resorting to the Pribyloff Islands during the breeding season have at least remained undiminished. It would appear that fur seals were relatively as numerous (2) in the Southern seas in past times as their kindred in the Sub-Arctic; but the slaughter was carried on with such vigour and without discrimination in the days before measures for regulating the traffic were thought of, that they have been practically exterminated, and thereby a great and valuable trade lost to the Southern Hemisphere.

So it is with all the larger wild animals of the world; they are rapidly diminishing in numbers, and this is especially so in the case of animals yielding products of commercial value. It is only by the adoption of strict control over the slaughter that such can hope to be preserved. In no instance is this better marked than in the case of the whale.

Referring to whaling, Dr. Harmer says (3): "In every case the history of "the operations has been identical, the period of prosperity with which they "opened having been succeeded by a notable fall in the numbers caught, so that "in most of the localities where whaling was once profitable the industry has be-"come a thing of the past."

In the Arctic Regions where the Right Whale has been hunted for a very long period, its numbers have now reached a vanishing point.

Antarctic whaling began in earnest in the year 1904, when the vast schools of finner whales were attacked by modern methods, with bases at the island of South Georgia and at the South Shetland Islands. Dr. Harmer (4) says: "At "both these localities whaling has been extraordinarily successful, and in a single "year the total catch of both together has exceeded 10,000 whales; a number "which should be contrasted with 1,437 Greenland whales captured in 1814, a year "described by Scoresby as a specially good one."

But already the whales are becoming scarcer in those seas, which diminution would be the more accentuated but for certain restrictions imposed by the administration. The falling off is specially noticeable in the case of the Humpback whale, which constituted 90 per cent. of the catch in the years 1910-12, but had diminished to less than 10 per cent. in the season 1916-17.

In the case of the whales, which animals live their entire lives in the sea, there is far less chance of extermination than in the case of the seals and penguins, which spend a part of the year, the breeding period, ashore; this is especially so with the Antarctic life which has never been hunted by man or predatory land mammals, and is consequently an easy prey.

It would be an easy matter, by the exercise of uncontrolled slaughter over a period of several years, to wipe out the Sea-elephant and penguin life in Macquarie Island. Once gone, it would be practically impossible to regenerate the lost fauna, and the feasible project of perpetual economic exploitation, whilst at the same time maintaining their numbers, would be gone for ever. With the extinction of the seals and penguins goes the economic future of the island.

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(2) There is record that 320,000 fur seals were taken from the South Shetland Islands in the two seasons 1820-21. From Macquarie Island it is likely that not less than 180,000 skins were taken between the years 1810-13.

(3) Scientific Development of the Falkland Islands and Dependencies, by Dr. S. F. Harmer. Jour. Geog., Vol. LVI. (1920), p. 61.

(4) Ibid., p. 62.

It is, therefore, only common sense that postulates that the very least that should be done in the case of Macquarie Island, if killing is to be permitted, is the passage of legislation to secure the maintenance of its animal population by limiting the slaughter. But without Zoological advice and proper oversight on the ground such administration could never expect to be effective.

Considering its small size and its absolutely unique position as the *sine qua non* for certain Subantarctic life in our Australasian Quadrant, I am convinced that the wisest course is to reserve Macquarie Island as a sanctuary and breeding place, interfering as little as possible with the balance of existing life.

How this protection can best be secured necessitates a divergence for the brief consideration of its geographical features (5) and administration.

Macquarie Island is situated about 900 miles S.S.E. of Hobart as a solitary speck in the stormy seas of 55 deg. South Latitude. In actual miles it lies nearer to New Zealand than to Tasmania, but on account of the prevalence of strong westerly weather, it is easier of approach from the latter. For the same reason the direction of New Zealand is the more favourable to navigation for the return voyage. On these grounds, voyages to the island in sailing craft would be best included in an itinerary between Hobart and New Zealand. In the case of power-driven craft, however, the existence of the Auckland Islands, with good harbours, situated in an intermediate position, rather favours communication backwards and forwards to New Zealand.

As it is placed on the map, Macquarie Island does indeed suggest a genetic connection with the New Zealand Archipelago. It has the appearance of being an outlying member of the company represented by the Auckland Islands, Campbell Islands, and Snares Groups. But the latter all stand in comparatively shallow water upon the New Zealand platform, from which the Macquarie Island ridge is separated by a deep submarine trough.

Since its earliest days it has been attached as a dependency of Tasmania, though until recently few Tasmanians were aware of their charge. In the year 1890 an endeavour was made by the New Zealand Government to annex the Island. Upon discovering that it had been attached to Tasmania for some 70 years past, efforts (6) were made to have it transferred to New Zealand, but without success.

As a result of this awakening to the existence of Macquarie Island the Tasmanian Government passed regulations (7) prohibiting the killing of seals of any kind. Henceforth a permit was needed granting permission to kill.

There are rumours that representatives of the New Zealand Government have again recently probed the ground to ascertain whether the Tasmanian Government still holds the same opinion with regard to the transfer.

Macquarie Island is somewhat over 20 miles in length, and not exceeding 3½ miles in width, with the long axis nearly north and south across the direction of the prevalent winds. It represents the backbone of a ridge which can be traced for a long distance beneath the sea, reappearing 8 miles to the north in the Judge and Clerk rock, and again 20 miles south from the southern extremity in the Bishop and Clerk, another isolated spray-swept outpost.

The land rises steeply from the sea except here and there along the coast, where strips of a boggy, raised beach platform intervene. The summit of the

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(5) For fuller particulars refer to "Macquarie Island" by D. Mawson. Proc. Roy. Geog. Soc. Australasia (S. Aust. Branch), Vol. XX., pp. 1-15.

(6) See N.Z. Parl. Papers App. to Journal of House of Reps., Sess. II., 1891 A. -5 in cont. of A. -5 1890.

(7) Under Section 12 of the Fisheries Act, 1899 (53 Vict., No. 11), proclamation issued in 1891 by the Tasmanian Government, and published in the Hobart "Gazette," 21st Apl., 1891.

island is an undulating plateau at almost 1,000 ft. above sea level, dotted at intervals with lakelets at least partly of glacial origin. Evidence is everywhere afforded that the island was overwhelmed with an ice sheet in the recent past, though no permanent ice now remains. The rocks are chiefly volcanic—basic lavas, agglomerates, and cinder beds.

The climate in terms of our own, here in Australia, is rather a miserable one. The mean annual temperature ranges between 38 deg. F. and 40 deg. F., and is kept surprisingly uniform throughout the year by reason of the great body of the surrounding ocean. The almost continuous strong westerly winds, combined with fogs and driving rain, result in a climate almost, but not actually, glacial.

As to the vegetable and animal life (8) sustained by this comparatively inhospitable spot, little can be said of the former beyond that the island supports no tree growth, the only vegetation being rank tussock grass, Kerguelen cabbage, a variety of ferns, moss, and such like. On the other hand the animal life resorting to those shores is of the greatest possible interest, both on account of the wealth of population and the interesting forms represented.

The beaches are still well stocked with that largest of all the seal tribe, the sea-elephant, the bulls of which quite commonly attain a length of twenty feet. Fur seals, formerly so numerous, are now practically extinct. The only other variety of seal haunting those shores is the sea-leopard, which preys on the other seals and the penguins.

Of the bird life there is an amazing population, remarkable for its numbers, its variety, and the lesson that it teaches in adaptation to environment. They are principally marine forms; albatross, petrels, and the like on the one hand and penguins on the other. Of land forms, there is little to say beyond the presence of a species of duck frequenting the boggy flats; the former existence in great numbers of a flightless parakeet now extinct; and the presence of innumerable Maori hens (Wekas), which have multiplied from a few specimens brought down from New Zealand by sealers many years ago.

This is no occasion for detailed reference to the wonderful penguin population, beyond stating that four species regularly resort to the island in the breeding season, namely, the King, the Royal, the Victoria, and the Gentoo. The noble and handsome King penguin is one of the worst sufferers from the scourge of the sealer, and is in imminent peril of complete extermination. The Royal penguins are still found congregating in rookeries of hundreds of thousands in several localities, notwithstanding that their numbers have been heavily drawn upon by the sealers for many years past. The Victorian and the Gentoo penguins are less attractive to the oil seekers, being smaller in size and never herded together in the same numbers.

The story that this bird life teaches of evolutional change along lines fitting it for existence under the special conditions of that great wind-swept belt of the southern seas, is something to be particularly remarked upon.

Records concerning the green parakeets which existed in great numbers in the earlier years of last century indicate that, in all probability, they were descended from a normal parakeet stock transformed to an almost flightless condition by long existence under the wind-swept and treeless environment. Though not wingless, the bird was gradually losing the use of the wings, under conditions where it was doubtless safer to keep to the ground than battle on the wing against the ever-prevalent gales.

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(8) For a detailed account refer to "The Home of the Blizzard," by D. Mawson. Heinemann and Co. 1915.

The case of the specialisation exhibited on the one hand by the penguins, whose wings have degenerated to mere swimming appendages, and on the other by the albatross class of birds, which plane on the wind without flapping their wings, appears to be the direct outcome of an evolutional development to meet the possibilities of an existence in that great wind-swept region encircling the Globe northward of the margin of the ice belt. The region between 40 deg. and 60 deg. south latitude is famous for its ever-blowing westerlies. The existence of these winds in their present strength hinges upon the continuance of the great heat engine of the Antarctic ice-cap. That great ice-cap was greater still in the recent past, pushing out farther to the north, and therefore doubtless more efficient than it is to-day in keeping the southern atmosphere constantly circulating. The roaring forties and the screeching fifties may have then been even more formidable than is the case now.

At least we can be sure that these winds have continued to blow around the earth in these latitudes for a very long time in the past; under which conditions the bird life would find no profit in flight by flapping the wings. The two evolutional alternatives to meet the conditions would be either to abandon flight altogether, and become a penguin, or else to master the art of planing on the wind, thus turning the very power of the storm to account, as do the albatrosses and petrels. It is significant that the natural range of the penguin and the albatross is just this great storm-swept belt around the earth. Macquarie Island is the very soul of the tempestuous south, and the natural home of its specialised life.

Now turning to the history of human occupation, we find that the island has been visited from time to time since the days of its discovery by vessels in search of seal pelts and blubber oil. The rush during the first three or four years after its discovery served to practically exterminate the fur seal. Thereafter visitations were less frequent, though the blubber oil industry appears to have been revived on occasions during last century.

Apart from the damage to fauna directly wrought by these sealers, they are indirectly responsible for irreparable losses arising out of the introduction by them of the domestic cat. The wild descendants of these felines are scattered about the island spreading destruction amongst the smaller forms of bird life. The final extinction of the ground parakeets is ascribed to the depredations of these cats. They are also a factor to be reckoned with in the depletion of the smaller petrels.

Short references to the wonderful bird population have been recorded at intervals during its history by exploring expeditions (9), which, in passing, made brief calls at the island. But no proper chart or detailed survey of Macquarie Island was made known until the work of the Australasian Antarctic Expedition in 1911-14. Up to this latter campaign, the only important contributions to the Natural History (10) came from Professor J. H. Scott and Mr. A. Hamilton, of the Otago University, who made short visits there: the former in 1880 and the latter in 1894. These visits resulted in the publication of a general description of the plant and animal life, and drew attention to that fascinating field for further observations.

This brief record is not complete without some reference to Mr. Joseph Hatch's association (11) with the island. For many years past he has conducted

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(9) Bellinghausen, 1821; Wilkes, 1840; Scott, 1904; Davis (Shackleton Expedition), 1909.

(10) See: Scott, Repts. A.A.A.S. Vol. III. (1891), pp. 226-227. Proc. N.Z. Inst. XV., pp. 484-938. Hamilton: Proc. N.Z. Inst. (1894), pp. 559-578.

(11) He has operated at Macquarie Island at least as early as 1891.

a blubber oil industry, with headquarters at Invercargill. Every year parties of men have been sent down to the island to kill the sea-elephants and penguins and render them down for their oil. This was then brought back in casks to Invercargill to be refined before marketing. The slaughter of about 700 sea-elephants and some 300,000 Royal penguins would, as far as one can ascertain, be considered a fair season's work at Macquarie Island.

This trade was never attended with any proper financial compensation for the toll of life involved. As a result Mr. Hatch has passed through a series of financial crises, and, indeed, the nominal rent of £20 per annum for the lease of the island remained for years unpaid. This is an indefensible position for anyone seeking to justify the great slaughter.

More recently, in 1914, the trade was revived with greater vigour, Mr. Hatch having interested additional capital in the venture, which was then floated off under the title of "The Southern Islands Exploration Company." From this date the business was pressed with still greater energy under a lease renewable annually at the discretion of the Tasmanian Government for the sum of £40 a year. During this period much of the crude oil was returned to Hobart and refined there.

This lease continued between 1915-1918, but, even with the high war prices ruling for the products, the Government experienced difficulty in collecting the rent. In connection with the operations of this company, a further extension of lease for one year was granted in 1918 to enable them to remove their plant, which operation was apparently never effected; doubtless, for the simple reason that value of the said plant did not warrant its removal.

The proposition had not been a payable one, and the company had gone into liquidation (12). Yet there were those who had the temerity to be again contemplating a lease of the island, with a view to further prosecution of the blubber industry. This is surely unjustifiable slaughter, though Mr. Hatch has recently delivered propaganda lectures (13) in Tasmania and New Zealand with a view to substantiating a claim for a further lease. The very interesting life of the island lends itself as a subject for a lantern lecture, and, if skilfully handled, can doubtless be made very good propaganda to draw the sympathies of the audience to the lecturer. In this way must be explained the psychological anomaly of some, at least, of these audiences, which, after admiring the views of the wonderful animal life, have ended by expressing confidence in the very gentleman who, for practically thirty years past, has made it his business to slaughter annually vast numbers of the island population.

The argument which counsels the withholding of a lease of the island for the prosecution of the blubber oil industry is that, unless conducted on a scientific basis and under proper control, the annihilation of certain species will be quickly accomplished. It has been asserted that the killing as conducted by the sealers does not reduce the numbers. This is obviously untrue, though the reduction in

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(12) See the Hobart "Mercury," 26th November, 1920.

(13) I regret that Mr. Hatch, on account of my efforts to maintain the island as a sanctuary for the fauna, has, in the course of these lectures, according to press reports, found it necessary to make disparaging and wholly unfounded statements regarding myself. Contrary to Mr. Hatch's assertions, the establishment of the Australasian Antarctic Expedition station at Macquarie Island was a great boon to his commercial operations. Twice in the period of the two years the Expedition rendered signal assistance to his undertaking at some financial loss to ourselves. On the other hand, Mr. Hatch never went out of his way at any time to assist our operations.

Judging by the records of other expeditions, we were not alone in these unsatisfactory relations with the gentleman.

numbers over a short period may not be apparent where the original number is very great, as is the case with the Royal penguins.

The life frequenting the island at the date of its discovery was unquestionably a balanced population at its full capacity. Any new factor of destruction entering that metropolis must assuredly, by continued exercise against any members of the community, effect a reduction in numbers. Exacting a constant annual toll, the population will decrease in continually increasing proportion. This principle must obtain, though in practice somewhat modified by the operation of several contributing influences.

The effect of past sealing operations at Macquarie Island has been disastrous to its economic and scientific interests, a statement which is quite indisputable.

The sealers first attacked the most valuable of its animals, the fur seal, making a clean sweep of these, so far as they were able, in the first three or four years. Odd survivors of that senseless butchery, being the special mark of all subsequent sealers, were never afforded that respite necessary for the recuperation of their numbers.

The flightless parakeets (14), which are recorded on the island up to the year 1880, were extinct by about the year 1891. The early sealers killed these in great numbers, as they were reported particularly good to eat. The final extinction must have been due to the ravages of the wild domestic cats.

The sea-elephants, fortunately, still maintain themselves in considerable numbers, though greatly reduced, if we judge by early reports. Several fortunate circumstances have contributed to the survival of this monster: In the first place, much of the coastline is not economically accessible to blubber oil operations, and it is on the stormy western coast where the elephants now principally congregate; secondly, it is certain that in these latitudes sea-elephants often travel far, so that accessions from distant Kerguelen and other resorts are to be reckoned with; finally, on account of its immense size—therefore blubber value—in comparison with that of the female, the bull elephant is naturally the particular mark of the sealer, and a considerable toll exacted amongst the numbers of the bulls should have no serious effect in the birth-rate in the case of such polygamous animals.

The next creatures to attract the attention of the oil seekers would be the handsome King penguins at Lusitania Bay, the only rookery of this the largest of the Subantarctic penguins, that now exists (15) in the Australasian seas. The oil yield of this penguin of course exceeds that of the smaller species, hence the persecution these birds have suffered, resulting in the dwindling of the rookery to a mere handful—perhaps a few hundred birds—at the present day. They are indeed in serious peril of extinction in the near future, though the sealers have ceased to trouble them of late years, beyond levying a not inconsiderable toll upon their eggs on account of their palatability.

Compare this state of affairs with the position in the year 1894 as reported by Mr. A. Hamilton (16).

"At Lusitania Bay we went in and dropped anchor within a few hundred "yards of the shore in 15 fathoms of water." . . . . "We had to amuse ourselves by watching the thousands of King penguins sporting around us. . . ."

"The factory at Lusitania at the King penguin rookery is not now used; the "great heap of refuse testifies to the great numbers of the birds destroyed. No

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(14) Other less conspicuous finch-like land birds appear to have suffered extinction also in like manner with the parakeets.

(15) Mr. H. Hamilton, of the Australasian Antarctic Expedition, found abundant bones of the King penguin on the spit at the north end of the island, indicating the site of another rookery apparently wiped out during the reign of the sealers.

(16) Proc. N.Z. Inst., 1904, p. 562, et seq.

"impression, however, seems to have been made on the numbers occupying the "beach, as every available place seemed full of birds."

"The interest and the novelty of the sight of thirty or forty acres of pen-"guins (King) made up for the deafening noise and the fearsome smell. . . ."

"Nearly the whole of Lusitania Beach, over half a mile in length, is occupied "by King penguins."

The lamentable dwindling of these once countless birds has all taken place within a period of twenty years, during the continuance of Mr. Hatch's connection with the island.

The Royal penguins, which for some years past, in normal seasons, have been levied upon to the extent of 300,000 birds per annum, have not given unmistakable evidence of this drain upon their numbers. At least this was so in the year 1913. Fortunately for them, several very large rookeries occur at other parts of the island inaccessible to the sealers, and these must help to maintain the numbers at the Nuggets rookery, where the boiling down works is situated. Viewed in the light of what has happened elsewhere, it may be reasonably predicted that under the continued pressure of a steady drain on the rookeries by the sealers, a very serious decline in their numbers must be expected after the lapse of a few years.

What has been said is sufficient to show the practical inadvisability of leasing the island for the indiscriminate killing of the fauna.

The question presents itself—How can the island be turned to permanent profitable account consistent with maintenance of the animal life?

Inquiry into the possible future of Macquarie Island suggests several alternative courses, which will be considered *seriatim*.

1. *An unrestricted lease,* such as has been granted in the past. There is no need to add more to emphasise the unwisdom of this policy.

2. *A limited lease,* defining conditions of occupation framed in the interests of the general fauna.

   A. With license to slaughter each year a stipulated number of bull sea-elephants and Royal penguins. The numbers considered safe to kill would be a matter for agreement annually by a board of advice, of which one member at least would need to be a zoologist. Such a board would require to be well informed as to the condition of the rookeries each season, a stipulation that would call for an annual inspection.

      In order to cover the expense of such administration, the rent would need to be a figure far above that recently demanded. Under this circumstance it is very questionable whether anyone would be found willing to invest in the venture, in view of past experience where operations working under more favourable conditions have ended in failure.

   B. With absolute protection for the native fauna, but granting rights for fur-farming or grazing rights for sheep, cattle, or reindeer.

      On first consideration much might be expected by developing the island on these lines, but, knowing its limitations, I would be very chary to recommend such undertakings as profitable.

      The artificial rearing of black foxes is now a settled industry on Prince Edward Island. Good skins sometimes fetch many hundreds of pounds sterling, and £1,000 for a single animal as prize stock for breeding purposes is not considered an exorbitant charge.

Sheep (17) have been fattened on the island, and if the Romney Marsh variety recommended by His Excellency Sir William Allardyce (18) were introduced, they should thrive satisfactorily. Success might also attend the introduction of Highland cattle, or even reindeer. The latter recently introduced into the Island of South Georgia are reported to be doing well, and increasing in numbers.

But in estimating the grazing value of the island, the map area is no indication of the available pasture land. The whole summit of the island is either bare of vegetation or at the most supports only mosses and lichens. The steep hillsides, leading from the sea, carry a very considerable clothing of tussock grass and other vegetation, and present possibilities for grazing. The best fodder, including abundance of Kerguelen cabbage, is that on the flat strips of raised beach along the coast, but much of this is so boggy as to be more suited for ducks than for cattle.

The occupation of the island for any such grazing purposes would undoubtedly have some effect upon the native fauna and flora; for example, the burrows of the prions would be trampled in by the presence of anything like herds of these animals.

3. The permanent withdrawal of the lease and the proclamation of the island as a *National Faunal Reserve*. To my mind, this is the best course to pursue, in view of its advisability from a scientific standpoint, and in the face of the great difficulty of economically exploiting an island hampered by such natural deficiencies as absence of harbours, remote situation, absence of fuel, semi-glacial climate, etc.

To make such a sanctuary efficient, some form of supervision is called for, if for no other reason than to prevent poaching (19).

Such supervision, unfortunately, necessitates expenditure. If the island were placed under Commonwealth control (20) it would be an easy matter for a gun-boat or lighthouse vessel to make an annual visitation, at no great additional expense to the community.

Considering the desirability of making any scheme as self-supporting as possible, the practical solution of this problem may lie in the maintenance on the island of a small Government party, whose chief work might be to maintain the "wireless" meteorological station, to kill limited numbers of bull sea-elephants for skins and oil, possibly develop a penguin egg industry for dried egg substance, attempt to re-establish the fur-seal, and to run a few sheep and reindeer sufficient at least for their own requirements.

Should these operations be carried out under adequate control, the result ought to be satisfactory, as far as the question of the fauna is concerned, and the financial return perhaps sufficient to pay expenses.

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(17) See: "Report on Macquarie Island," by A. C. Tullock: Parl. Papers No.7; Hobart, 1916. Also in "The Home of the Blizzard." Heinemann and Co. 1915.

(18) Furnished with a long experience of the Falkland Ids., His Excellency the Governor of Tasmania could not be better equipped to advise on the future of Macquarie Island, where many of the natural conditions are identical.

(19) Mr. Hatch has reported that sealing vessels from Newfoundland have in recent years been known to make raids upon the island. With the two boiling down plants left on the island, the inducement to poachers will be enhanced.

(20) In 1918 conversations took place between the Tasmanian and Commonwealth Governments on this matter, resulting in an offer of the island to the Commonwealth Government for a faunal reserve on the basis of 5s. an acre, amounting in all to a sum of £14,000. But as the value of the island, judging by the rent (which rent of £40 per annum included the right to wipe out practically the only asset the island possesses) asked, had been previously valued at less than £1,000, nothing further eventuated.

EXPLANATION OF PLATES.

Plate IX.

Luxuriant herbage in a gully on the south-west side of the island. The waters of the highland lakes descend by rapid and deeply-entrenched courses to the sea.

(Photo. by F. J. Henderson.)

Plate X.

The Nuggets Beach at Finger and Thumb Point. The shore is thronged with Royal Penguins (*Catarrhactes schlegeli*), which come and go between the sea and their rookery inland, high on the hill slopes.

(Photo. by F. J. Henderson.)

Plate XI.

Bull Sea-elephants in combat, a not unusual sight during the months of spring. Such frays continue until one or other is vanquished, sometimes lasting the whole day long.

(Photo. by F. Hurley.)

Plate XII.

Macquarie Island Skua Gulls (*Megalestris antarctica*) feeding on the carcase of a seal left by the sealers.

(Photo. by R. L. Blake.)

Plate XIII.

Victoria Penguins (*Catarrhactes pachyrynchus*), a variety made specially handsome by the adornment of a crown and golden eyebrows.

(Photo. by H. Hamilton.)

Plate XIV.

A Bull Sea-elephant, just emerged from the ocean water, challenges the Island population.

(Photo. by F. J. Henderson.)

IS THE KANGAROO DOOMED?

By Heber A. Longman, F.L.S., Director, Queensland Museum.

The kangaroo is so closely associated with the history of Australia, and is of such special interest in the world of natural science, that the possibility of its extermination in years to come, unless definite preventive steps are taken, is sufficient excuse for this inquiry. In the southern coastal districts of Queensland the large kangaroos are practically a thing of the past. They are doomed in all areas of fairly close settlement. The average Queenslander will go through life without seeing a kangaroo unless he visits the Zoological Gardens. However, there are 670,500 square miles in this State, comprising a variety of environmental zones. Accumulation of evidence as to the paucity or profusion of the Macropods in all Queensland would be a very difficult matter. In some districts residents may condemn as pests animals which are practically extirpated two hundred miles away. The evidence to be submitted is sufficiently definite, however, to show that safeguards should be taken in the near future to secure the national animal of Australia from threatened extinction.

It is pleasant to state that the Queensland Government has been most sympathetic to the appeals of nature lovers. The legislation embodied in the Animals and Birds Act of 1921 stands as a record of an advanced attitude. When the remarkable "native bear" appeared to be in danger of extinction, this quaint animal was placed under total protection by the Minister for Agriculture and Stock (the Hon. W. N. Gillies), and the open season for "opossums" was also restricted to two months. Kangaroos and wallabies, however, are totally without protection. In some districts the smaller wallabies are so numerous as to be a great pest, and cultivation has to be strongly fenced, whilst on station properties, especially in times of partial or severe drought, kangaroos are serious competitors with sheep, and the large indigenous animals, if numerous, may even menace the existence of flocks. Apart from this view, it must also be recognised that the marsupial skin industry is an important one, giving employment to large numbers of "scalpers." No definite figures are available as to the number of pelts coming annually to the Brisbane market, but in answer to my inquiry, Messrs. Mactaggart Bros., Ltd., have kindly made an approximation of between 300,000 and 400,000 skins; this number, however, includes in addition to kangaroos and wallaroos, all descriptions of wallabies.

The large Grey Kangaroo, *Macropus giganteus*, and the giant Red Kangaroo, *Macropus rufus*, are the two species to which the term kangaroo is commonly applied. Both are animals of the plains, and at least two varieties of each species may be recognised. Wallaroos vary greatly in colour, and they are also widely distributed in rocky, hilly country over Australia. Therefore it is not surprising that oversea scientists, afflicted with that common complaint, *Cacoethes nomenandi* (from which most biologists occasionally suffer), have given no less than ten names, in addition to the typical *Macropus robustus*, to varieties of these marsupials.

In response to a letter sent out by the writer, replies have been received from places so far apart as Dalveen and Talwood in the south, Coongoola and Claverton in the south-west, and other western places ranging from Adavale and Alice Downs to Torrens Creek, and Stanley in the north. The essential part of my letter was worded thus:—"It is considered by many people that our kangaroos

and wallaroos are in danger of ultimate extinction. Although these large and characteristic marsupials may be a nuisance in places, their complete extermination would be a disgrace to Australia, and it is suggested that certain areas in appropriate districts should be proclaimed as reserves. I should be extremely obliged if you would give me your views on this matter."

A selection from typical replies is of varied interest and includes valuable information on the habits of certain marsupials. It is pleasant to record that, without exception, all correspondents agreed that the extermination of kangaroos and wallaroos would be a disgrace. The Secretary to the United Graziers' Association of Queensland replies, *inter alia,* "the prevention of the extinction of these native animals is a most laudable object to keep in view." Most correspondents, however, state that there is no immediate probability of their extinction. Mr. A. Leeds, junior, of Claverton, does not think that "there is much chance of them being exterminated in this district, at any rate for years to come."

Mr. W. B. Wilson, of Victo, Coongoola, says that there are about 500 kangaroos on 40,000 acres and "they appear to breed freely, and this applies to other places in the district that I have been over." He considers that 6 per cent. more sheep could be carried if there were no kangaroos, and suggests that any reserves, if necessary, should be established away from the sheep walks. Mr. John Horsington, of Bulgroo Station, Adavale, states: "I can see no chance whatever of the extinction of the kangaroo or wallaroo. I suppose that you are aware that the kangaroo only becomes numerous in very dry times, and that when the rainy season comes a disease thins them out again. . . . When I came into the bush, 40 years ago, the bilbi was in thousands; then they disappeared; now they are about and increasing. In dry times the thick tailed mouse seems to disappear totally, and then when the good season comes he can be found everywhere."

Mr. J. R. Chisholm, of Stanley, Great Northern Railway, who is a keen naturalist, writes that he does not see danger of extinction of kangaroos at present, adding, "but I do think that this is the time for the reservation of lands that will in the future become preserves for our native animals." He suggests as a good reserve an area of rough country on Torrens Creek, bounded by the Flinders River on the west and north-west, by Lolworth and Goldsboro holdings on the north and north-east, by the Cape Goldfield on the east and the railway on the south."

Mr. D. W. Gaukrodger, of Alice Downs, an enthusiastic ornithologist, says: "In this part these animals have been so numerous that their destruction in pastoral interests has been imperative, but at the present time I think in a great many localities a halt should be called, as they are no longer a menace. For instance, in this property there are no more than it is good to see hopping about, whilst on other places near to the ranges they appear still to need some check on their numbers."

Mr. Gaukrodger notes that the individual owner does not always have power to deal with "shooters" to keep them within bounds, not carrying destruction beyond a reasonable point.

Mr. Benjamin Hore, of Forest Hills, Torrens Creek, North Queensland, gives some interesting information on the habits of kangaroos and wallaroos. Regarding the danger of extinction, he writes:—"It would depend a great deal on the locality and class of country. On the bare open downs west of here, kangaroos might become scarce in time to come, as they have very little cover there. But in this district they have scrubs, forests and mountain ranges which afford them protection. The wallaroos, inhabiting, as they do, rough and in many cases inaccessible country, would be the last to need any protection. Speaking as a bush-

man and resident of this district for over thirty years, I may say that kangaroos and wallaroos are as numerous as ever they were. Of course, they fluctuate a bit from year to year, according to the seasons, droughts, heavy rains, bush flies, and sand flies, all having an influence on their numbers. If there is ever any danger of extermination in the distant future, the Grey Kangaroo (*Macropus giganteus*) will go before the Red Kangaroo (*Macropus rufus*), or wallaroo (*Macropus robustus*).

"During the big drought that terminated in 1902, I saw numbers of grey kangaroos lying dead under the bauhinia trees or other shady trees along the dry sandy creeks on the edge of a dense gidyea scrub and the open plains. They came on to the creek, which had scrubs on one side, and open plains on the other, and dug in the sand for water. When the water gave out, or the sand was too deep for them to reach the water, they simply laid down and died there, rather than face seventeen miles of bare open country to the next water. Not so the red kangaroo; he is a battler! I have seen long strings of them hopping along across the open plains to water, and they had plenty of life in them, and were in fair condition all through the long drought, unless they were old ones with worn or broken teeth. There was hardly a vestige of grass anywhere on stocked country at that time, and I have often seen red kangaroos in a small cloud of dust digging up the roots of the vanished grass. When shot, their fore claws were worn down short almost to the tips of their fingers. Their mouths were full of the white roots of grass and their lips and nostrils caked with pellets of hard, black soil, which had become wet when they were snuffing in the dust for the roots of grass. But they kept themselves alive and in fair condition to the end. After the drought broke up, and the rains came, the kangaroos spread and very few were seen. But in three years' time they were all back and as numerous as ever. Neither shooting or droughts seem to make any diminution in their numbers in the long run. But some years after a real good season and heavy rains, sand flies kill them in numbers over miles of country. Flies crawl up the nostrils and so worry them that they die in a very short time.

"The wallaroos are far more cautious and crafty than either the red or grey kangaroos. I have often seen them sit crouched down; as you walk or ride past them, they will not move or show themselves unless you stop or go towards them, and when a wallaroo shifts he very rarely stops until he is out of sight over a hill or down a cliff, or else in a thick scrub. The kangaroos, unlike the wallaroo, will always jump up if they smell, see or hear you, and after going a few yards, stop and have a look at you. Then there is often a chance of a shot at them. Sometimes, like the wallaroos, they will hop right away without a stop, but not often, unless they have been lately disturbed or hunted. The wallaroos in their natural haunts in the rough and broken scrubby country have so much cover and ways of escape in the gorges, gullies and caves, that it is impossible to exterminate them. They always have water in rock holes, native wells and springs, so a dry time does not affect their water supply in any way, except that the grass is dry and withered.

"According to my observations kangaroos and wallaroos have young all the year round. A female kangaroo nearly always when shot or caught has a young one in the pouch, and very often she has a young one following her in addition to the small one in the pouch. They seem to be great breeders. In this district, if we have any bush fires it will always draw kangaroos in numbers to feed and eat down the fresh new grass. Long before cattle and horses are able to graze on it, the marsupials will be feeding on the tender new grass after a fire. It is to be understood that these remarks apply to this district, where there are no

towns of any great size, and neighbours, although their properties adjoin each other, mostly have their homes miles apart."

Mr. Donald Gunn, Boolarwell, Talwood, writes:—"Re extinction of larger marsupials: there is no danger of that in districts where the holdings are large, but when they are cut up into small areas the marsupials will have to go. I don't suppose there are many left on the Darling Downs proper, while about where I live there are a good many. It is no use waiting until they are extinct before something is done; they should be preserved in all our National Parks. About Inglewood and Miles our larger marsupials used to abound in large numbers and were a great pest, and there are quite a number yet left. In these districts there are large timber reserves for railway sleepers and I think it would be a good idea to turn these reserves into a sanctuary for marsupials and birds such as the Scrub Turkey and Wonga Pigeon, etc. These birds were in large numbers near where I live when I settled here first, and now there are none; the same with the native bear, opossum, platypus, etc. All these could be protected on our timber reserves. On my own place I will see that they are not wiped out, but my lease will soon run out, and when the run is subdivided that is the end of the marsupials. If marsupials are preserved on our timber reserves, the adjoining land owners may complain, in which case the cure would be to put marsupial netting round the reserves. It would be a disgrace to our English race if we allowed our wonderful marsupials to become extinct."

Mr. W. G. Bunning, Braeside, Dalveen, agrees with the opinions expressed in my letter, but points out several difficulties. He says: "If reserves in specified districts are established, the adjoining land owners may object, and also, at certain seasons, raids will be made for the skins of the animals unless protected in a way which may prove expensive." Mr. Bunning kindly promises to give further consideration to the matter of reserves. The Secretary of the United Graziers' Association stresses the point also raised by Mr. Bunning, and states that adjoining land owners would object to reserves as "breeding centres" menacing their lands.

Mr. Arnold Wienholt writes:—"I must heartily agree with your idea that if we let our kangaroos and wallaroos become in time extinct it would be a terrible disgrace to us and prove us nothing but the most thoughtless savages. I do not think, however, that it is, at any rate, as far as the immediate future is concerned, a matter of anxiety." Mr. Wienholt refers to the number of kangaroos recently seen by him on the Paroo, including "splendid specimens of old men," and believes that the kangaroo and wallaroo are pretty safe in the outback country. He adds that should their extinction be at any time threatened, "our Governments should absolutely protect them till they get up into fair numbers." Mr. Wienholt also makes an important and attractive suggestion for a reserve. As a traveller in Africa he saw the world-famous reserve running for miles by the Uganda Railway where game literally in thousands can be seen. "One of the greatest attractions to a tourist that East Africa can show." Why not a similar reserve in Queensland? Mr. Wienholt says: "I have often thought what an attraction and interest it would be to visitors to Queensland if from our mail trains when passing through country like our Darling Downs they could see kangaroos and emus and other essentially Australian and therefore unique animals at wild." Some such reserve as Mr. Wienholt suggests, perhaps including rough country not required for agriculture, would be most attractive by the main line, and, if adequately fenced (netted), it would not be a menace to surrounding properties, even if our large marsupials were very numerous therein. That this and other reserves may be established is the fervent hope of the writer, and herein undoubtedly lies the solution of the problem.

At present (March, 1923) Queensland has no less than 108 sanctuaries, including such large areas as Hinchinbrook Island (97,280 acres), Bellenden-Ker Reserve (79,000 acres), Stradbroke Island (78,720 acres), and the Lamington National Park (47,000 acres). With few exceptions, however, these 108 sanctuaries are situated on the coast, and there is definite need for additional reservations in inland districts.

Before the advent of the white man the marsupials had only to fear the aborigines, a few natural enemies, and the ravages of drought. By means of modern methods of shooting, often aided by motor car transit, "scalpers" can take a tremendous toll of the marsupials in any particular district. It is necessary to see that legitimate limits are not exceeded, and that the large marsupials are given fair play.

When considered as a natural group, apart from certain rare species, our marsupials are not lacking in virility, and they often breed freely in captivity. The "opossums" introduced into New Zealand have multiplied a thousand-fold. It is quite incorrect to class marsupials as a decadent race. If not unduly harrassed the kangaroo should remain as secure in many of its native haunts as its image is indelible on the arms of Australia.

THE AUSTRALIAN NATIVE ANIMALS.

How they stand to-day, and the cause of the scarcity of certain species.

By A. S. Le Souef, C.M.Z.S., Taronga Park.

Plate xv.

The fact that some of our native animals are getting increasingly scarce is well known to those familiar with them in their native haunts. Mr. W. W. Froggatt drew attention to this matter [Proc. Linn. Soc. N.S.W., 1913], but little else of an authoritative nature has been published. Much uncertainty and misapprehension has been caused by many people writing and speaking about the matter without having any basic knowledge of the subject.

Actual facts are rather difficult to secure, as comparatively few people take sufficient interest to make observations, or can recognise any but the common species when seen. In the absence of any comprehensive survey this resumé is only approximate.

The cause of the disappearance of some of our animals can be stated to be—(in order of importance):—

(a) Introduction of the fox, the cat, and the rabbit.
(b) Shooting and trapping for the fur market.
(c) Opening up of the country by settlement.
(d) Disease.

(*a*). The Marsupials are representatives of animals that appeared very early in the history of evolution; they were in process of time completely superseded by the more advanced animals that we know to-day. The isolation of Australia at a time when the Marsupials were predominant, allowed them to remain unmolested, except for the later introduction of the dingo. With no competition except among themselves, they have stayed in their primitive state—remarkably harmless and with a low instinct of self-preservation.

When animals of this class suddenly find themselves placed in competition with such advanced forms as the fox, the cat and the rabbit—types that are far ahead of them in the evolutionary scale—it is just as inevitable that they should go down before the invader, as that the aboriginal should give place to the white man.

The fox is by far the greatest menace that our wild animals are faced with. It is widespread, uncontrollable, and reaches places where man has not penetrated. Its progress towards northern and central Australia will be watched with interest; if it can establish itself in the dry and also in the tropical areas, then a great many of our animals—some hardly known to science—will disappear. So far there is no evidence that it can live away from permanent water or in the tropics. It is significant that most of our animals live in the driest areas, getting their moisture from roots, bark and insects. The rabbit, the cat and the European mouse have already spread over the Continent; the rabbit thriving in waterless areas in good seasons and being swept off again in dry times—but I do not think that they have any marked effect on the native animals.

Fortunately there is a well marked safety zone in the eastern coastal areas extending from Victoria to North Queensland. This area is the habitat of the poison tick, *Ixodes holocyclus*, which is fatal to canines and somewhat less harmful to cats. Tasmania and the islands off the coast are free from the fox.

This scourge has been responsible for clearing off practically all the small ground animals outside the coastal districts in eastern and southern Australia.

The fox has spread along the south and reached as far north as Geraldton in Western Australia. In New South Wales the only species that are holding their own, as far as I can judge, are the larger kangaroos, the Wombat and the Platypus. The Red and the Grey Kangaroos, owing to their gregarious habits and their size, are fairly safe. The Wombat is too doughty an animal for the fox to tackle, while the Platypus is protected by its environment. A large animal that seems to be affected is the Wallaroo; this species lives singly or in pairs or at most three or four together, and the female is often alone. It has been stated by observers in the Monaro District, that when a fox finds a female with young in the pouch, he chases her until the "Joey" is thrown out; this is then secured and killed.

That the arboreal animals are sometimes taken when on the ground, is shown by reports from the Kosciusko District. The Opossums (*Trichosurus*) have been killed by this animal, and that a fox was found carrying a white Flying Phalanger (*Petauroides*), near Gosford.

(*b*). The insatiable demands of the fur trade form the second heavy drain on our native animals. This trade should absorb only the natural increase, but the machinery for control is lacking, and the laws make very little difference in the number of skins taken and exported.

(*c*). The opening up of the country by settlement has had its effect on the native game. The first stage, after upsetting the balance of life, was an enormous increase in the Marsupials, but systematic killing and the advent of the rabbit and the poison cart soon stopped this.

(*d*). Under normal conditions there is a very correct balance of life among the wild animals. Occasionally, in the absence of natural enemies, a species will increase to such an extent as to overtake the food supply; then in their weakened condition, disease is apt to break out in a virulent form and sweep them off in thousands. Well known instances of this occurred in 1898-9 and in 1901-2-3. Koalas, Native Cats (*Dasyurus viverrinus*), Rabbit Bandicoots (*Peragale*) and certain Phascogales were almost exterminated from Central Queensland to Victoria. Native Cats in the vicinity of Sydney being isolated were not affected, but in other parts of the country they have never recovered lost ground. Koalas are very slowly coming back to New South Wales and are now getting numerous again in Southern Queensland. They are very thick in the Victorian National Park on Wilson's Promontory, where they have to be reduced owing to their killing out the food tree.

To recapitulate.—Practically all the ground animals (outside the coastal areas) with the exception of those mentioned of eastern and southern Australia, are threatened with extermination. The fur trade is taking a heavy and unchecked toll of the arboreal animals and certain of the coastal Wallabies.

On the other hand most of the coastal areas, the great Central, Western and Northern parts of the Continent are teeming with wild animals; Tasmania and most of the islands off the coast are well stocked with their respective species; Red Kangaroos are very numerous on the plains of Western New South Wales and Queensland. The Grey Kangaroo and the Wombat are much in evidence in the Mountains (both the Red and the Grey Kangaroos with their wide range over the country extending throughout Central and Western Australia, must yet exist in countless numbers). The rivers of Eastern Australia and Tasmania are well stocked with Platypus which will, in my opinion, outlast any other species in its range.

This survey does not take into account many small marsupials and rodents such as *Phascogales, Sminthopsis, Dromicia, Acrobates, Petaurus,* etc., and many native rats and mice that are still in most places in their normal numbers,

lessened only by the clearing of the forests and the occupation of the land with domestic animals in their respective areas.

Remedies.—There are probably only three species of animals that are entirely confined to the fox area of Eastern Australia. These require our immediate attention if the remnants are to be saved. They are the Bridle Nail-tailed Kangaroo (*Onychogale frenata*), the Brush-tailed Rock-Wallaby (*Petrogale penicillata*), and Gaimard's Rat-Kangaroo (*Bettongia gaimardi*).

The only Bridle Nail-tailed Kangaroos that exist as far as I know, are a few on Mr. Charles Baldwin's farm, near Manilla, and some in Taronga Park. Attempts to get this species to live in a wild state in Taronga Park have failed, as they apparently cannot live in the tick area, their proper home being the foot hills of the Dividing Range of Eastern Australia. A few Brush-tailed Rock-wallabies are found round Jenolan Caves, and at the head of the Murray River. I cannot locate any Gaimard's Rat-Kangaroos; they used to live on the Mountains and western plains of New South Wales.

A haven where these species can immediately be placed in Pulbah Island in Lake Macquarie—a sanctuary set apart by the Government at the instance of the Australasian Society—for the preservation of our rare native fauna.

The basis of any work for the preservation of our fauna should be a Zoological Survey. This will, however, take time and money, and there does not seem to be any prospect of carrying it out. The Chief Secretary of New South Wales bases his actions regarding the close seasons or the exemption of any species from protection if it gets too numerous in any given district, on reports from the local official sources. This system gives good results, but does not take into account any species that are getting scarce.

The species that are in the eastern coastal areas are for the time being safe enough, but it is necessary to have more exact information concerning them. This might be done by appointing local residents Rangers under the Birds and Animals' Protection Act, and asking them to report; by seeking the co-operation of the Forestry Department, and by investigations by naturalists.

We have in this area the Brush-wallaby (*Macropus ruficollis*), Black Wallaby (*M. ualabatus*), Black-striped Wallaby (*M. dorsalis*), Parma Wallaby (*M. parma*), Rat-Kangaroos (*Bettongia tridactylus* and probably *Aepyprymnus rufescens*), Opossums (*Trichosurus vulpecula, T. caninus nigrans*), Ring-tailed Phalanger (*Pseudochirus*), Native Cats (*Dasyurus viverrinus*), Flying Phalangers (*Petauroides volans, Petaurus australis, P. sciureus, P. breviceps*) besides many smaller pouched mice, opossum mice, etc. There are also a few Koalas, but these never get a chance, as the temptation to shoot or catch the defenceless little animals as they sit exposed on a bough, is more than the so-called sportsmen of the community can resist, and even in our National Parks they are destroyed.

To deal with this matter effectively, we require the whole-hearted co-operation of every naturalist and person interested in preserving native animals in the Commonwealth. Official observers should be appointed throughout Australia and their reports sent to a central body. On the basis of these reports, together with the information obtained by the Government Departments, permits could be issued.

Exports could then fairly well be restricted to the surplus or ordinary increase of each species. Animals that were getting unduly scarce could be noted and special arrangements made to safeguard them. The surplus of certain species is at times considerable, and must be kept in check if the man on the land is to get the full results of his labour, and the domestic stock fed. At the present time it is likely that numbers of Red Kangaroos will have to be killed off in the Riverina, owing to the shortage of grass. There are, throughout the Con-

tinent, vast areas of unoccupied land where numbers of wild animals feed, and there is no reason why, under proper restriction, these should not be turned to good account.

The asset of the fur trade has given Australia millions sterling in the past and will, if preserved, do so in the future; but unless control is based on accurate knowledge, it may be frittered away. At present it is nobody's business to ascertain what species of animals' skins are leaving the country, but if a small export tax were imposed, they would have to be examined. The funds so collected could reasonably be used to preserve the asset.

Of Marine animals we have two species—the Fur Seal and the Hair Seal; there is also the peculiar Sea Cow or Dugong.

The Seals extend from Seal Rocks, off Port Stephens, N.S.W., to the Abrolhos Islands in Western Australia; they are also found round Tasmania and as far south as Macquarie Island.

Unfortunately we know very little indeed about the habits or distribution of the Seals. There is no map indicating the islands inhabited, or estimate of the numbers; they are at the mercy of poachers. A number was taken by a foreign raider from islands south of New Zealand, and also from Western Australia in 1921; this was probably not the first raid, nor will it be the last.

Our Fur Seals should be a very important asset. The American Fur Seal Herd is increasing at the rate of 8% per annum and at the same time giving skins to the value of a quarter of a million sterling to the Federal Government. The American Government was induced to step in and take over the Seals, which were being rapidly exterminated, through the action of the Camp Fire Club.

The Dugong inhabits the shallow seas of Northern Australia. It was once numerous, but is now getting scarce as, according to Mr. Banfield, it forms the principal food of the Japanese Trepang Fishers operating off our coasts. This animal should be worth preserving; its flesh is equal to the finest pork; it feeds on Sea Grass, which grows abundantly in the warm seas, a crop that is never affected by weather conditions and is of no other economic use.

THE LIFE OF A NATIVE BEAR (KOALA) IN CAPTIVITY.

By A. S. Faulkner, Albany, Western Australia.

(Communicated by A. F. Basset Hull.)

Plate xvi.

Being on a cattle station on the Proserpine River, North Queensland, in August, 1914, I determined to procure for my wife a Koala cub as a pet, although everyone told me it was impossible to keep them alive in captivity.

However, when out mustering one day I managed to secure a female cub about three months old.

With much difficulty I succeeded in tying it up in a marsupial skin, and rode straight back to the homestead where the beautiful little creature in its coat of soft French-grey fur was hailed with delight by all.

Although made as comfortable as possible and given a cushion to sleep on in the writer's room, she cried piteously for the first few nights, and required continual petting until the skin, after being roughly cured, was fastened round a small cushion, upon which she thereafter rested contentedly whenever left alone.

Morning and evening she was given about a quarter of a pint of fresh cow's milk to drink, which she lapped up very slowly in the same manner as a kitten, from a basin, held while she rested upon one's knee, and afterwards she was given sprigs of fresh young blue gum to eat.

When she was but four months old I took her in easy stages from Proserpine to Geraldton, Western Australia, a distance of 3,867 miles, always keeping her in my cabin in a large wicker dress basket properly fitted out for the purpose. By this means she received constant and every attention, including much petting, which seemed necessary to her existence, and sometimes she nestled in the arms of a large toy Teddy bear and slept.

While travelling, bags of suitable blue gum leaves were obtained at the capital cities, where there was no difficulty, excepting at Adelaide, where only one tree existed in the Botanical Gardens, but the Curator was kind enough to grant sufficient supplies rather than allow the little orphan to suffer.

I was much surprised upon visiting the Zoological Gardens at each Australian capital to find no specimen of the Koala in captivity, but at the Taronga Park Zoo, at Sydney, one of the keepers informed me they often had a few, but they generally cleared out into the bush again, not being caged in, and there were none at the time of my visit.

Upon arriving at Geraldton a large wire netting cage 12 ft. x 12 ft. x 10 ft. high was erected upon a plot of African Wonder Grass, and two trees containing suitable forked resting places for the cub to sleep in were cut down and placed upright in the cage. One half of the cage was covered and protected from the prevailing wind and sun, while the other portion was open to the elements, and allowed her to bask in the sun, bathe in the rain, or shelter at will.

Holes were bored in the branches of the dead trees, and at feeding time (sunset) small branches from the only gum trees suitable to her palate (York, Flooded, and White) were placed in the holes to imitate a natural feeding place. After a year or so of giving the milk from basin by hand, a basin was fixed on a bracket in the cage close to a comfortable forked branch, where she soon learned

to come and drink in comfort during the night. I have watched her at all hours throughout the night, and found her alternately eating, drinking, and resting.

After three years at Geraldton, where she was the idol of the children, as she still is, the cub was taken to Adelaide for six months, and thence to Fremantle and Albany, Western Australia, where she now resides in perfect contentment, having travelled a total distance of 7,200 miles so far in her life, but always under the same careful circumstances.

At first I feared the colder climate might prove fatal, but here (in Albany) it was necessary to erect two cages, one 8 ft. x 8 ft. x 10 ft. high, thoroughly protected from all weathers and the very heavy rains, with a domed iron roof covering the trees so that she can sleep warmly, and another of the same dimensions built out on a Buffalo grass lawn, where on fine days she basks in the sun. Fortunately there is an unlimited supply of blue gum, and she has never been in better condition.

Occasionally while being watched she is allowed to roam about the garden, and frequently licks up gravel or earth as if necessary to assist the digestive organs. Her habits are most regular and it seems as if once familiar with anything she never forgets. Every morning about eight I go to the cage and she at once comes down, and upon the door being opened follows me into the house, and is there allowed to run about, eventually walking upstairs and climbing on to one of the beds.

After being given about six small peppermint lollies, which are greedily devoured, she is placed on a cushion in one of the rooms and there rests for about three hours. Subsequently she is taken to the day cage, if weather permits, and sleeps there until sunset when she comes down from her perch and waits at the door to be taken to the night cage and fed. Upon occasions a large toy "Teddy" has been hung upon a branch in the cage. This is immediately noticed and after a little preliminary sparring she attacks it vigorously with teeth and claws, hugging the body in the fore arms and tearing with the hind feet somewhat like a kangaroo. She takes no notice of our Irish Terrier, but if any other dog enters the yard she comes down to the ground and while making the wild cry, tries to attack it. On moonlight nights she sits in the open and makes a peculiar little call like a spoilt child, and continues this at intervals for an hour or more until sleep claims her.

The daily diet now consists of ½ a pint of cow's milk and as much young blue and flooded gum as she can eat, all of which is placed in the cage after sunset, as she seldom touches anything during the daytime.

She has now been 8½ years in captivity and has never been in better condition, her coat changing each autumn. I am satisfied that these little creatures require almost as much attention as a child, including petting, if they are to be reared successfully, and they should be given only their natural foods, otherwise digestive disorders soon arise and end their lives.

FLEAS.

By Eustace W. Ferguson, M.B., Ch.M.,

(Department of Public Health, Sydney.)

Plate xvii.

To most people fleas are merely a nuisance, to be destroyed on every possible occasion; they are, however, of great interest, both from a scientific and an economic aspect. It is my intention to present here a few of the most interesting features as regards the distribution of the species of fleas found in Australia, and to indicate some of the numerous gaps in the knowledge of our native species.

The Common Flea (*Pulex irritans*) is generally regarded as essentially a human species; it is however found on other animals, in many cases so rarely as to make its occurrence an accidental one, but in others its presence appears to be normal. Bishopp states that it is such a common parasite of pigs that it might well be called the Hog Flea. Other investigators have found that it probably develops usually on the Hedge-hog.

The human Flea is world wide in its distribution, but varies in prevalence in different localities. Probably it is universally distributed in Australia, but information is wanted on this point.

The Cat and Dog Fleas (*Ctenocephalus felis* and *canis*) occur both on cats and dogs, and are also of universal distribution. Both appear to be widely distributed in Australia; recently I received two fleas brought back from Central Australia, both were specimens of the Cat Flea. The Hon. Dr. Strong, of New Guinea, on another occasion sent some specimens of fleas taken from a native village 300 miles up the Fly River, which had only once before been visited by white men or civilised natives. They proved to be Dog Fleas. The Dog Flea is also common in the Solomon Islands.

Three other species of fleas have been introduced into Australia with the introduction of rats and mice. These are of great economic importance, as one of them is the flea that is responsible for the spread of plague. This species, generally known as the Indian Rat Flea (*Xenopsylla cheopis*) occurs both on the Brown or Sewer Rat (*Rattus norvegicus*) and on the Black Rat (*Rattus rattus*). It is, however, a flea of tropical and subtropical countries, and its distribution in Australia has been by no means properly worked out. It is present in Sydney throughout the year, and in summer it is the predominant species on rats, reaching its maximal seasonal abundance in February. It is also present in Western Australia and in Queensland, but information is wanting in regard to the Southern States. *X. cheopis* has been recorded from Melbourne and Port Adelaide; most of the records are however from shipping. No information is available as to the prevalence of this species among the shore rats. Mr. Nicholls informs me that the species appears to be absent from Tasmania, or at least from Hobart. The knowledge of its distribution is of importance on account of the relation of the species to the spread of plague, and the immunity which the Southern States have hitherto enjoyed from this disease may well be due to the absence of *Xenopsylla cheopis*. A second species of *Xenopsylla* has recently been received, taken from a native rat (*Leporillus jonesi*) found on Franklin Island, in the Nuyt's Archipelago, by Prof. Wood Jones. This has not yet been positively identified, but it appears to belong to an African species *X. nubicus*; this identification has been confirmed by Dr. K. Jordan. If so, its

occurrence in an out of the way place in Australia is of extreme interest and suggests the need for further investigation; quite possibly it will be found to replace *X. cheopis* in the adjacent portion of South Australia. The other rat flea of importance, the so-called European Rat Flea (*Ceratophyllus fasciatus*) is common in the southern portion of Australia. In Sydney it is fairly abundant on rats during the cooler months, but relatively uncommon in the height of the summer. In Europe it has been stated to be a vector of plague, but it is doubtful if it exercises such a rôle here, or at least anything more than a very subsidiary one.

The third rat flea is the Mouse Flea (*Ctenopsylla musculi*) which appears to be of relatively little importance. It does not appear to bite human beings, and, although I have found plague bacilli in these fleas, the species can be of little importance in the spread of the disease except from rat to rat.

I have dealt so far with introduced species of fleas. There are, however, a fair number of native species already known, and these are of greater interest to the Australian scientist. Unfortunately our knowledge of them is practically restricted to the adults, and in most cases to a bare record of the hosts upon which they were taken. Many parts of the Continent have not been searched for these parasites, and, while undoubtedly many of the species are widespread, the information available so far indicates that there are many species so closely allied to each other that they may almost be regarded as geographical races.

As regards their hosts, the majority have been found on marsupials or rodents, but do not appear to be necessarily always found on the one host; for instance, *Stephanocircus dasyuri* is found on both marsupials and rodents, while *Echidnophaga myrmecobii* is found on a large number of animals.

No records appear to exist of fleas from the larger marsupials, with the exception of the tree kangaroo (*Dendrolagus*). This is probably connected with the habits of these animals. On the other hand the smaller marsupials such as Bandicoots, Tiger Cats, and the like are often heavily infested with fleas. Many of these animals will harbour two or even more species of fleas.

Fleas may also be taken in the breeding nests of the smaller marsupials and rodents, and it is in these situations that the larval and pupal stages are doubtless passed.

The family *Pulicidae* is represented in Australia by some 12 genera. The dominant group is probably that comprised by *Pygiopsylla* and its allies. These are the Australian representatives of the old world genus *Ceratophyllus* and some of our species were originally described under that genus. Quite recently the genus *Pygiopsylla*, in which all the species were contained, has been split by Jordan and Rothschild into 5 genera, *Pygiopsylla* being restricted to species from Australia and New Guinea. In this genus 9 species are now listed. *P. hilli*, the type species, is a Western Australian form, only known from a single specimen taken from *Bettongia penicillata*. In the Eastern coastal districts of Australia and Tasmania two species—*hoplia* and *congrua*—occur commonly on the smaller marsupials and rodents: there is no restriction to any particular species as host and both species may inhabit the same host. One of them, *P. hoplia*, has even been taken from the Platypus in Tasmania. *P. zethi* has a similar distribution from Tasmania to Sydney, being also found on the same class of animals; the male of this species is unknown.

In the case of *P. solida* from Queensland from a rodent, only a single male is known. The remaining 4 species from a second group in the genus, one—*laciniosus*—is from New Guinea, the rest are Australian; all have been taken from rodents and in the case of *P. rainbowi* also from a bandicoot. The species as far as known show a marked geographical distribution, *P. rainbowi* being re-

corded from New South Wales, *P. gravis* from Victoria, and *P. colossus* from Tasmania, the last species being known only from a single female.

Of the genera split off from *Pygiopsylla*, one—*Stivalius*—includes all the extra-Australasian species formerly placed in *Pygiopsylla*. 5 species are also recorded from New Guinea, and one, *S. rectus*, from North Queensland from a "Grey Scrub Rat."

Choristopsylla contains 3 species, *ochi, thomasi* and *tristis*: the genus is apparently restricted to the South Eastern portion of the Continent, *C. ochi* is recorded from Victoria and New South Wales, and *C. tristis* from Victoria, while the habitat of *C. thomasi* is unknown. It is noteworthy that unlike *Pygiopsylla*, which is found only on ground mammals, the species of *Choristopsylla* are confined to arboreal marsupials, *C. ochi* being found on the Common Opossum (*Trichosurus vulpecula*), *C. thomasi* on the Pigmy Flying Opossum (*Acrobates pygmaeus*) and *C. tristis* on the Yellow-bellied Flying Opossum (*Petaurus australis*) and the Pigmy Flying Opossum.

Bradiopsylla contains but one species—*B. echidnae* which occurs in Tasmania, Victoria and New South Wales, and is restricted to the Echidna (*Tachyglossus aculeatus*).

The remaining genus of the group—*Acanthopsylla*—comprises 4 species, *A. rothschildi*, the type species, being further subdivided into 3 geographical subspecies—*rothschildi, nereis* and *victoriana* from New South Wales and Queensland, Clarke Island (Bass Strait), and Victoria respectively; the first subspecies occurs on *Dasyurus viverrinus, Phascologale flavipes* and the Paddymelon (*Macropus thetides*); the second on *Potorous tridactylus*, and the third on *Phascologale swainsoni*. *A. woodwardi* from Western Australia is only known from the female and the host is unrecorded. *A. saphes* from Victoria was taken from a Native Cat (*Dasyurus*). *A. pavida* from Queensland and Northern New South Wales has been taken from a large number of hosts, mostly arboreal, and including the Tree Kangaroo (*Dendrolagus lumholtzi*), Ringtail Opossum (*Pseudochirus* spp.) and Flying Opossum (*Petaurus breviceps*). There is also a record of a specimen having been taken from the Paddymelon (*Macropus thetides*).

Close to the *Pygiopsylla* group but differing in its large triangular 8th tergite is another genus—*Uropsylla*—which contains but one species, *U. tasmanicus*, described from Tasmania from *Dasyurus viverrinus*.

Australia possesses representatives of two genera of non-combed eyed *Siphonaptera*—*Lycopsylla* and *Parapsyllus*.

Lycopsylla is a somewhat aberrant genus containing one species, *L. novus*, described from the Wombat (*Phascolomys mitchelli*).

Parapsyllus contains the flea (*P. australiacus*) found on the Little Penguin (*Eudyptula minor*). The type came from Western Australia, but specimens are known from Tasmania, Flinders Island and New South Wales.

The genus *Stephanocircus* contains possibly the most distinct of all our Australian fleas, though it is nearly allied to the South American genus, *Craneopsylla*, the members of which were originally described under *Stephanocircus*. Five species of the genus are known, the first described and best known—*S. dasyuri*—occurs commonly on the Native and Tiger Cats and on Bandicoots, its range extending from South Queensland into Tasmania. It has also been recorded from Rats (*R. velutinus*).

Of the remaining species of the genus, *S. simsoni* occurs in Tasmania on *Dasyurus viverrinus* and *Rattus velutinus*; *S. jervisi* in Victoria on *Phascologale swainsoni*; *S. pectinipes* in Victoria on *Rattus assimilis*; while *S. concinnus* was described from Queensland from *Rattus* sp. The genus is characterised by the curious helmet on the head.

The next genus *Stephanopsylla* also possesses a helmet, though of somewhat different shape, and the unique species *S. thomasi* was originally described as a *Stephanocircus*. The species was found on a specimen of *Pseudomys ferculinus* from Barrow Island, North-west Australia.

Macropsylla is another extraordinary Australian genus which contains but one species, *M. hercules*. It is the largest of all our Australian fleas, and occurs on various species of rodents in Tasmania, New South Wales and South Australia. The genus possesses combs on the abdominal segments.

The family *Ceratopsyllidae* contains the bat fleas of which two species only have been recorded from Australia, one—*Ischnopsyllus caminae* from Perth taken from a bat, and the other *C. reductum* from Melbourne from *Vespertilio macropus*. The latter species is however regarded by Baker as merely a variety of *C. caminae*.

The third family of *Siphonaptera*—the *Sarcopsyllidae*, contains the Chigoes or Jiggers and the Stick-tight Fleas.

The genus *Echidnophaga* was erected by Olliff to contain a curious flea—*E. ambulans*—found on the Echidna. The genus has however since been found to include a number of species found in various parts of the world and occurring on many different animals, so that the generic name is not an appropriate one.

Like the rest of the family, the species of *Echidnophaga* are characterised by the reduced thoracic segments, by the relatively weak legs, and the serrated mandibles. These modifications are related to the mode of life of these insects. Having found its host, the flea proceeds to settle down on a suitable spot, inserting its rostrum deeply and not moving away: this habit has given rise to the name Stick-tight Flea.

Undoubtedly the species of greatest economic importance is *E. gallinacea*, the Stick-tight Flea of poultry. Originally described from Ceylon, this species is found over the greater part of the world, and has been responsible for much damage to poultry, particularly in the United States of America. About two years ago the species made its appearance as a pest of poultry in Western Australia, and now is widely distributed over the State, attacking poultry, dogs, horses, rats and even man. Although only recently causing trouble, the species has been present in Western Australia since 1914 at the least, as Mr. Clark has sent me specimens taken in that year on *Peragale lagotis* in the Geraldton district. The Stick-tight Flea is gradually spreading eastwards; I have seen specimens from rabbits from the Eucla District and from a dog and a child from Ooldea on the East-west railway line.

The introduction of this pest into the eastern States would be a dire calamity for poultry farmers, and the importation of birds from Western Australia should be subject to rigorous quarantine.

Another species that requires watching is the closely allied *Echidnophaga myrmecobii*. This was described from specimens taken from a number of native animals, including *Trichosurus vulpecula, Bettongia lesueuri, Myrmecobius fasciatus, Peragale lagotis* and *Diemenia superciliosa*. The specimens from *Trichosurus* were from New South Wales and Victoria, the remainder from Western Australia. Recently the species has been found attacking the introduced rabbit in New South Wales and the introduced rat in South Australia and Sydney.

Specimens have also been received from Prof. Wood Jones, taken on Franklin Island from *Leporillus jonesi*. The species is so closely allied to *E. gallinacea* that a critical examination of the tarsal joints is necessary to separate them; *E. gallinacea* has two apical ventral bristles on the fifth metatarsal joint of all the legs, and *E. myrmecobii* a single one in this situation.

Jordan and Rothschild express the opinion that *E. myrmecobii* may be merely

a geographical race of *E. gallinacea.* That it may also become a farmyard pest is not beyond the bounds of probability.

Of the remaining species *E. ambulans* and *E. liopus* both occur on the Echidna (*Tachyglossus aculeatus*), *E. liopus* appearing to be the western representative of *E. ambulans*; *E. macronychia* is described from Western Australia, occurring on *Bettongia leseurii.*

This concludes the review of the described Australian species, the types are mainly in England and of comparatively few species are there examples in Australian collections. The number of species (33) is small, considering the vast area of Australia and the peculiar marsupial fauna; doubtless many more species await discovery.

Excepting for a limited area in North Queensland fleas are practically unrecorded for Northern Australia. The list of hosts could in all probability also be greatly amplified; the bats, for instance, have not been at all thoroughly examined. Nests of marsupials and rodents might with profit be searched for these insects.

From the public health aspect a knowledge of our fleas is of importance. Information is lacking as to whether native species will attack man or be able to act as vectors of such a disease as plague. That marsupials are not immune from plague was shown in a former Sydney outbreak when a number of these animals died from plague in the old Moore Park Zoological Gardens. Possibly, or, indeed, probably, fleas may act as the vectors of many of the haemo-parasites of our native animals. There is a further field for research in this direction. The possibility of the native Stick-tight Fleas developing into pests has already been mentioned.

For the purpose of gaining further knowledge of the geographical distribution of our Australian species, specimens would be welcomed from any part of Australia. These may be forwarded in small tubes in alcohol, and should be accompanied by a small slip of paper inserted in the tube with the name of the animal from which each example was taken, with the date and locality written in ordinary pencil.

THEORIES ON THE EFFECT OF CERTAIN PHYSICAL CONDITIONS ON THE DISTRIBUTION OF *DIOMEDEA EXULANS.*

By C. Horton-Smith, B.Sc., R.A.O.U., late of S.S. "Beltana."

During several voyages made across the southern Indian Ocean from South Africa to Australia and vice versa, I have kept records of observations made on various species of marine birds and in particular on the species *Diomedea exulans* or Wandering Albatross.

On looking through these notes I find a certain relationship between the appearance of the bird in the vicinity of the ship and temperature. I propose to set down a few theories in the hope that they may open up an interesting subject, and that perhaps someone who has had greater experience in observation work on the Pacific, may compare his results with mine.

I have found that the Wandering Albatross evidently dislikes a high temperature. The following records will illustrate my reason for making this statement.

Temperature: Notes on Diomedea exulans: Southern Indian Ocean:

55°F—Birds about ship in great numbers.

63°F—Number of birds slightly decreased.

69°F—Number of birds greatly decreased.

73°F—Several birds seen in vicinity of ship.

77°F—Birds absent altogether.

The mere fact of temperature influencing the distribution of a bird is hardly enlightening, so I have thought it advisable to examine in detail other physical conditions, which are, in the first place, caused by temperature, and in the second place influence the temperature of an adjacent area. For example, *Ocean Currents,* are, in part, caused by the differences of temperature in different parts of the ocean, and, as they proceed, say, from a warm area into a cooler area, the atmosphere immediately above the water in the cooler area is bound to be affected somewhat, and in this particular case it will be warmed. The reverse naturally takes place under reverse conditions. The effect of ocean currents, therefore, will receive my attention first.

If we examine a chart of the ocean currents we find that a cold current (The Antarctic Drift) makes its way round the Cape of Good Hope and flows across the southern Indian Ocean between (roughly) the parallels 30°S and 60°S. In longitude 120°E (roughly) we see that a warm current (West Australian Current) passes immediately to the south of Albany and round Cape Leeuwin and eventually joins the South Equatorial Current. The Antarctic Drift flows to the south of this warm current and flows across the Pacific, and so completes the circle. Down the S.E. coast of Africa we have the Mozambique current which eventually merges into the Agulhas Current—this is a branch of the South Equatorial Current, and is naturally warm. Up the S.W. Coast of Africa we have a cold current (Benguela Current) which eventually joins the warm S. Equatorial Current (roughly between 15° and 20° S. Lat.). Invariably I have seen the Wandering Albatross in the greatest numbers in regions affected by these cold currents, and a distinct decline in numbers when in regions influenced by the warmer current.

Practically all the way across the Indian Ocean from Australia to South Africa the Wandering Albatross will be seen in the vicinity of the ship, when we are steaming in latitudes varying from 30°—47° S., (this is as far south as I

have been), i.e., when we are under the influence of the Antarctic Drift. But when nearing the South African Coast (off Port Natal) it gradually disappears. I have seen this species on very few occasions when sailing from Durban to Cape Town, i.e., when under the influence of the warm Agulhas Current flowing south. Again, on leaving Cape Town, we come under the influence of the cold Benguela Current, and the Wandering Albatross is again seen, accompanying the vessel until we reach Lat. 18½ S. (this is the lowest latitude record I have). Here it is well to note that the position of their leaving us is approximately that in which the Benguela Current (cold) merges into the S. Equatorial Current (warm).

Let us now examine the influence of these ocean currents in relation to the food of the Albatross, which is undoubtedly a bird of the temperate and sub-frigid zones, and therefore partial to temperate or sub-frigid forms of life as diet.

Currents flowing from tropical regions into higher latitudes must bring along tropical plankton fauna into higher latitudes. These creatures will survive in spite of the colder atmospheric conditions, because marine fauna are not subject to such extremes of temperature as are the air-breathing animals. There will be a much greater number of tropical than of temperate forms of life in these currents—for the current has passed through several degrees of tropical latitude, and, in some cases, for great distances between two tropical parallels. On the other hand, currents flowing partly in subfrigid and partly in temperate zones, like the Antarctic Drift would carry along plankton fauna more to the taste of the Albatross. The velocity with which the current travels, must also influence the distribution of marine fauna, i.e., certain nektonic forms which, though capable of swimming against a current of a velocity, say of 1 mile an hour, may be unable to withstand another current, the velocity of which is 3 miles an hour. It is not improbable that strong nektonic forms would drift with the current rather than labour against it, and would thus be far removed from their native environment. These theories would seem to hold good in the case of the Agulhas Current —flowing from tropical latitudes—for here the scarcity of the bird is marked. As the Agulhas Current flows to a position some way south of the Cape of Good Hope it is only reasonable to suppose (acting on the above theory) that this would form an effective barrier between the smaller S. Atlantic Wandering Albatross and the Wandering Albatross of the Indian Ocean. By observation this seems to be the case. In the plankton fauna we can number many of the creatures upon which the Albatross feeds, such as fishes, tunicates, crustaceans and molluscs, etc., and there are also a number in the nekton fauna such as fishes and cephalopods which belong to the planktonic fauna in their early stages. All these, however, differ largely according to the latitude in which they are found. I will deal with these differences and their effect on *Diomedea exulans,* later, under the heading Latitude. Again, we should hardly expect to find temperate forms of Pisces (for example) in the immediate neighbourhood of a strong south flowing current in the S. Indian Ocean, as it would seem unlikely that "temperate" fish could sustain themselves on tropical plankton forms. On the other hand, many fishes do live on plankton forms, and so we should suppose that "temperate" forms of fish life inhabit areas coming under the influence of temperate currents, for the drifting fauna of these currents would surely constitute their natural food. Numbers of temperate zone fish would naturally take their place in the diet of the Wandering Albatross. This again would offer some explanation for the appearance of the bird over areas of water influenced by cold currents.

We will now consider the *influence of winds.* These, too, are chiefly due to temperature, and must affect the distribution of *Diomedea exulans* to a great extent.

The prevailing winds of the Southern Ocean are westerly, this is due to the absence of land in the forties of the southern hemisphere. This wind does not vary considerably within a short space of time. Let us examine the lower latitudes. Near the Equator we have a calm belt, then the S.E. Trade Winds, and then a belt of variable winds and then the strong westerly winds already mentioned. Birds like the Albatross may well be termed "sailing birds," i.e., the wing beats are slower and fewer than in the smaller winged birds, slower because of the greater resistance the large wing surface experiences on the downward beat, and fewer because the air cells will bear up a large surface for a greater length of time than they would a small surface. Does it not seem likely, then, that as the Albatross is a bird of few wing beats, he will find flying not so difficult in winds which are constant than he would in an area of variable winds? Again, strong winds make high seas, and I think it is proved that the Albatross invariably rises from the crest of a wave—for his large wings would not permit of his rising from calm water (1) and so if he ventured into tropical seas and therefore tropical calms, he would naturally experience great difficulty, and probably would, when once afloat, be unable to take to the air at all. Of course there must be times when the Albatross is blown great distances by abnormally strong winds, and thus enters areas which we could hardly say he regularly inhabited. Winds not only affect the flight of birds—but also the distribution of the marine creatures, upon which these birds feed. Planktonic fauna are carried along by winds as well as by currents. We know that the larvae of both the demersal and pelagic forms belong to the Planktonic system, besides many mollusks, copepods, pteropods, etc., which permanently come under the heading of planktonic.

In the Southern Ocean we have the prevailing winds from the west, and these, in combination with the Antarctic current, will surely bring along many species of larvae of temperate pelagic and temperate demersal forms of life of the planktonic system, most of which must supply the Albatross to some extent with food. Winds, too, are largely dependent on areas of high and low pressure, and these in their turn, must influence the distribution of bird life to some extent, one would think.

We will now consider the question of *Latitude* in relation to distribution.

Temperature in its turn is greatly governed by latitude. In the paragraph on currents I mentioned the various forms of animal life brought down from tropical into temperate latitudes. Let us examine these forms in slightly greater detail, and see if there could possibly be any relationship between their appearance in warm currents in temperate latitudes and the absence of *Diomedea exulans*. We learn from authorities that the creatures of tropical seas are in many cases more numerous than they are in temperate and frigid seas—but are not so highly developed physically. Mr. Johnstone in his "Life in the Sea" says "all experience shows that the polar and temperate seas, are, generally speaking, far richer in life than are the tropical ones—the marine and anadromous fishes of the sub-polar and temperate seas are far more abundant, and are generally larger than those of the tropics—mollusks are much more abundant in the temperate seas."

From my own observations I find, as a general rule, that tropical marine birds are smaller than "temperate or frigid" birds of the same family. This is

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1. This is not quite in accordance with our observations. The Wandering Albatross has been seen to rise from the calm waters of Port Jackson (Sydney) by taking a number of gradually accelerated steps with its feet, until sufficient impetus has been gained to enable it to rise.—Ed.

only to be expected, for colder climes have the tendency of producing larger and hardier races. Again, when we consider that the fishes, etc., which form the diet of tropical marine birds are less highly developed physically than those of the colder seas, it seems logical to assume that the birds also will be smaller. Regarding these creatures Sir John Murray states in his "Ocean": "It seems evident that the organisms captured in the cold polar waters are of very different ages, eggs and young and adults being found in the same hauls; the actions of bacteria and of putrefaction are all slowed down in the low temperature conditions. In tropical waters, on the other hand, all these processes are accelerated, and the various phases in the life-history of these organisms are passed through rapidly."

The antithesis of this applies to *Diomedea exulans*. For what is more natural than a bird of the Albatross's dimensions requiring for its sustenance creatures of greater physical development, such as those of the temperate and sub-frigid zones?

The small size of tropical birds would also appear to be accounted for as follows:—

When the atmosphere is warmed, as it is in equatorial regions, it becomes more rarified and therefore the density decreases. Smaller birds require a more rapid series of wing beats than larger birds, to sustain flight, and therefore do not allow much time to pass in which they would fall—as they do between each successive wing beat. The Wandering Albatross whose beat of wing is slower, would naturally fall to a great distance if in warm air as the support it offers him is not so great as that of cold air. So if we placed the Albatross in heated areas we would expect to find him endeavouring to maintain his altitude by a rapid series of wing beats. As the pectoral muscles are large and short, and are encased in the lateral cavities of the sternum—this would be impossible. This would also offer some explanation for the smaller size of the South Atlantic form of *Diomedea exulans*.

In the case of a bird, like *Diomedea exulans*, which spends a greater proportion of its life at sea, and many miles from land, we are led to believe that its supply of fresh water must be obtained from the moisture contained in the atmosphere. This means, that when mists, etc., fall, we should expect to see the scattered Albatrosses assembling in the mist area in order to quench their thirsts! I certainly have observed them at such times—but would hesitate to term them "reliable observations." If it be that they actually do so, then must mist and moisture-laden areas affect their distribution, though only to a slight degree.

I certainly have watched great numbers of these birds in attendance on Whales when "spouting." Can it be that they actually inhale the vapour caused by the condensation of the hot air discharged from the mammal's lungs? (2) This would sustain them through flight over a moistureless area. If this be the case then even the distribution of whales would seem to affect the distribution of the Albatross—more so, of course, when the atmosphere is dry! These theories on moisture are purely of a secondary nature, and are not based on any reliable information.

When all these points bearing on the relationships between physical conditions and the presence of the Wandering Albatross were taken into consideration and applied, during my twelve voyages across the S. Indian Ocean, they appeared to hold good. I would, however, again state that what I have written are merely theories based on observation work which was performed as accurately and as faithfully as possible, under the circumstances.

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(2). The presence of *Euphausia* would probably account for the visits of the Albatrosses to the spouting whales.—Ed.

REVIEW.

"Der Insektenkörper und seine Terminologie," by Dr. Heinrich Karny. (A. Pichlers Witwe & Sohn, Wien, 1921.)

By A. J. Nicholson, M.Sc.

I wish to bring before the notice of entomologists and others who have occasion to refer to entomological literature, a small book which I think will be found to assist materially when reading German entomological literature. The German method of forming scientific terms from purely German words, instead of following the almost universal practice of constructing such terms from Latin or Greek roots, a practice which results in the formation of an almost international terminology, makes it difficult, and sometimes impossible, for a non-German reader to assign the exact meaning to a particular term. German dictionaries are practically useless in this connection, so that any work which will assist in arriving at the exact meaning of German scientific terms is of great value.

From the entomological point of view such a book has recently come to my notice and, in the hope that others may find it useful, I have decided to publish this short review.

The primary object of "Der Insektenkörper" is to give German collectors who are specialising on a particular group of insects, a general, though elementary, knowledge of entomology as a whole, and to explain such terms as are most frequently used. The book is divided into two distinct parts. The first deals with the morphology, and classification of insects (60 pp.) and the second is an explanation of the more important entomological terms, the Latin, as well as the German term, being given in each case (32 pp.). From the English-speaking reader's point of view it is the explanation of terms, and the use of the terms in the text, which will be found of the greatest use. The subject matter of the first portion of the book, which is written in a very concise and simple manner, will, however, be found to be well worth reading, even if the result is merely to stimulate one's ideas on the subject of the classification of insects by having it dealt with from a somewhat unusual viewpoint.

The first portion of the book deals with the morphology, metamorphosis, classification and phylogeny of insects. The classification is found to differ considerably from that which is generally accepted. Fifteen orders are recognised and, as is almost invariably the case in different systems of classification of insects, it is the Neuropteroid group of insects which receives unusual treatment. For instance, the Ephemeroptera, Odonata and Perlaria are treated as a single order, "Pseudoneuroptera," and the Neuroptera is made to include the Megaloptera, Planipennia, Mecoptera and Trichoptera. It is conceivable that this is merely a "lumping" classification evolved for the convenience of those who require only an elementary knowledge of the subject.

It is satisfactory to notice that the Anoplura *sensu stricto* and the Mallophaga have been brought together under a single heading, the Anoplura, but the inclusion of this as a sub-order of the Corrodentia, which amongst other things is made to include the Embiidina and Isoptera is by no means so satisfactory. Again this is probably due to a desire to form a simple classification which can be handled easily by elementary students, but to my mind it is dangerous as

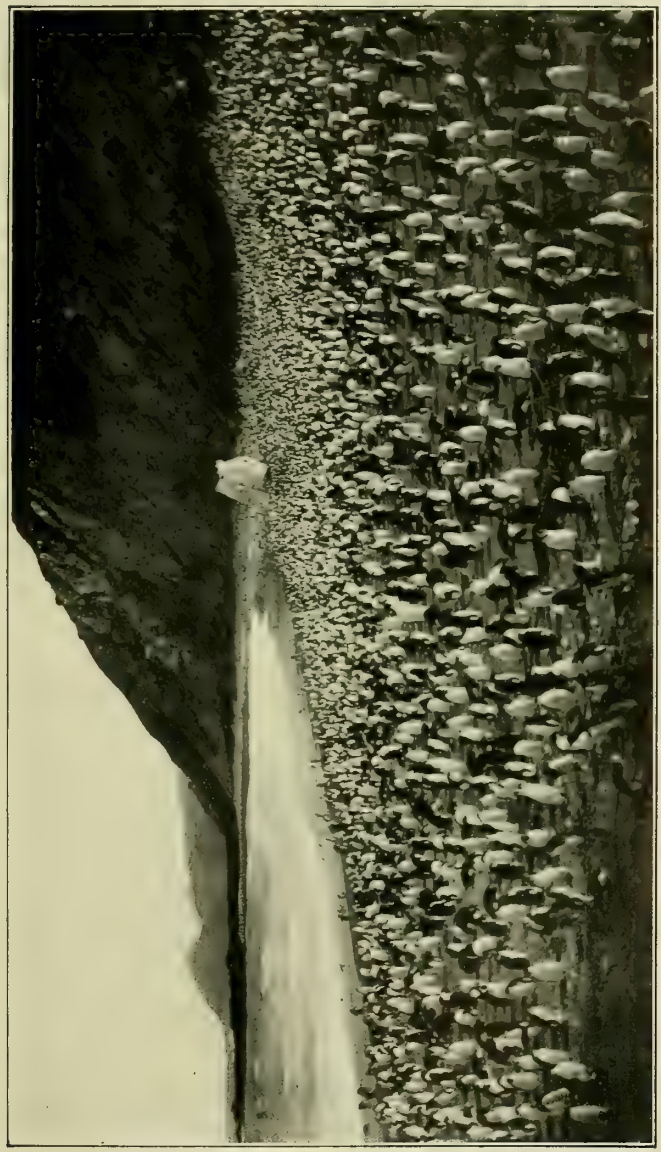
giving students an erroneous conception of the relationships of insects from the start.

In this connection I should like to draw attention to an oft repeated mistake with regard to *Pediculus*. The head of this insect is figured as possessing well developed mandibles, the structures so named having long ago been shown to be merely thickenings of the head capsule.

In spite of these criticisms I am convinced that entomologists will find Dr. Karny's excellent little handbook very useful and I have no hesitation in recommending it to all who have occasion to read German literature.

A Macquarie Island Gully.

(Henderson, photo.)



The Nuggets Beach, Macquarie Island.

(Henderson, photo.)

Bull Sea-Elephants, Macquarie Island.

(F. Hurley, photo.)

Skua Gulls, Macquarie Island.

(R. L. Blake, photo.)

Victoria Penguins, Macquarie Island.
(H. Hamilton, photo.)

Bull Sea-Elephant, Macquarie Island.
(Henderson, photo.)

Group of Marsupials likely to become extinct. Bridle Nail-tail Kangaroo and Rufous Rat Kangaroo.
Note bridle mark and way of crouching in a form.

1. Native Bear (Koala) cub, 3 months old; captured at Proserpine, North Queensland, 20 August, 1914, by A. S. Faulkner. From a photograph taken on the day of capture.
2. Native Bear, after eight years in captivity. Photograph taken October, 1922.
3. Native Bear resting in in her favorite position in her owner's arms. Photograph taken after three years in captivity.
4. Native Bear, eight and a half years of age, basking in the sunshine at Albany, Western Australia.

FLEAS.

Figure 1. *Acanthopsylla rothschildi* Rainb. ♂.
,, 2. *Parapsyllus australiacus* Roths. ♂♀. (Penguin Flea).
,, 3. *Stephanocircus dasyuri* Skuse ♂.
,, 4. *Macropsylla hercules* Roths. ♀.
,, 5. *Ischnopsyllus* sp. ♀. (Bat Flea).
,, 6. *Echidnophaga gallinacea* Westw. ♂. (Stick-tight Flea).
,, 7. *Echidnophaga myrmecobii* Roths. ♀.

Royal Zoological Society of New South Wales.

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"The Australian Zoologist."

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Royal Zoological Society of New South Wales

ANNUAL REPORT, 1922-3.

The sixth annual general meeting of the Society was held at the rooms, Bull's Chambers, Martin Place, Sydney, on Wednesday, 18th July, 1923, at 8 p.m. Twenty members were present.

The President (Dr. E. W. Ferguson) read the following report:—

Membership.

Although there has been a somewhat heavy loss of ordinary members through death and resignation, the aggregate membership shows an increase over that of last year, owing to the large number of associate members elected. The following are the details:—

	1921-2	1922-3
Honorary	7	8
Ordinary	311	294
Associate	75	98
Totals	393	400

In addition there are 17 members whose names are still on the register, but who have failed to renew their subscriptions or to notify their desire to resign. Under Article 13, these members are not entitled to any right or privilege in the Society.

The Council.

Nine meetings of Council were held during the year, the attendances at which were as follows:—Mr. Campbell, 8; Dr. D'Ombrain, 1; Dr. Ferguson, 7; Mr. Finckh, 8; Mr. Froggatt, 7; Mr. Goldfinch, 6; Mr. Halloran, 6; Professor Harrison, 1; Mr. Hedley, 3; Mr. Hull, 9; Mr. McCulloch, 3; Mr. Musgrave, 6; Mr. Rolin, 2; Mr. Shipway, 5; Mr. Shiress, 2; Mr. Stewart, 8; Dr. Walkom, 7, and Mr. Waterhouse, 8.

Mr. Hedley was absent part of the year in America, and Mr. McCulloch was absent in Papua for several months.

Reference to the Balance Sheet will show that the financial position of the Society is eminently satisfactory.

For the first time the Society has been in a position to issue three Parts of the *Australian Zoologist* during one financial year. It is hoped in the present year to increase the issues to four Parts.

The Society has lost by death three very old members—Sir Thomas Dibbs, Mr. Henry Gorman and Senator J. T. Walker. The two first were life members of the old (unincorporated) Society, and did much to further its objects in its early stages. Mr. Geoffrey Oberlin Harris, a more recent member, died during the year.

The work of the Sections is proving of increasing interest to members, and attendances were in all cases most encouraging. During the year a Section of Economic Zoology was established.

On the other hand the attendances at the general meetings have been most discouraging, the meetings generally lapsing for want of a quorum. Members will be asked to express their opinion as to the advisableness of discontinuing these meetings.

PRESIDENTIAL ADDRESS.

(By Dr. E. W. Ferguson.)

The selection of a subject on which to address you this evening has occasioned me a considerable amount of time and thought. My predecessors in this Chair have on two occasions chosen as the subject of their addresses the question of the establishment of a Biological Survey of Australia. Unquestionably no one subject is of greater importance to Biologists in Australia to-day, and it seemed to me therefore that if I could in any measure aid the efforts that are being made towards this end it was my bounden duty to contribute what I could to the discussion of the problem. At the same time I do not wish merely to reiterate what has already been said by abler advocates than myself. Mr. Froggatt in his Presidential Address in 1920, urged the necessity for the foundation of a Bureau of Biological Survey and outlined very ably the most important subjects requiring investigation. Mr. Campbell in his address to you last year approached the subject more from the financial standpoint. To-night I have chosen a somewhat different aspect, and that is to point out what has been done in another country where the legislators are more fully alive, not only to the necessity for a Biological Survey, but also to the vast advantages to be gained from the study of the various problems bound up in the question. I allude to the Bureau of Biological Survey of the United States of America. In the Annual Report of the Chief of Bureau for 1922, Dr. Nelson points out that recent investigations have revealed the fact that in the aggregate, wild life resources capitalised on the basis of a 6 per cent. annual income, represent an enormous sum, possibly exceeding $1,000,000,000. On the other hand certain forms of wild life, such as stock killers and rodents, annually destroy property exceeding $500,000,000 in value.

Mr. Froggatt in his address alluded briefly to the work of the U.S. Bureau, but it seems to me that as a model of what we may yet attain to, I might outline in more detail the work of this remarkably efficient organisation. The material on which my summary is based has been kindly supplied by the Chief of Bureau—Dr. E. W. Nelson, who has also sent me many interesting publications, pamphlets and the like, issued by the Bureau and illustrating its work.

The U.S. Bureau of Biological Survey is a division of the Department of Agriculture. In brief the functions of the Bureau are laid down as follows:—"The Bureau of Biological Survey studies the distribution and habits of native wild life, makes biological surveys of areas and from these investigations maps the natural life zones of the country; investigates the relation of wild birds and animals to agriculture and stock raising with a view to the control of the harmful and the conservation of the useful species; conducts campaigns for the extermination of predatory wild animals, destructive rodents and other injurious forms; experiments in fur farming and studies the diseases to which fur bearers are subject in domestication; makes investigations for the improvement of Alaskan reindeer herds, and administers Federal laws relating to game and bird reservation, to migratory game, non-game and insectivorous birds, to importations of foreign wild birds and animals, to inter-State commerce in wild birds and game, and to Alaskan land fur-bearing animals." (List of workers in subjects pertaining to Agriculture. Publication of U.S. Department of Agriculture; 1922, p. 40).

These objects—*mutatis mutandis*, are those sought by Australian Zoologists in their advocacy of the establishment of a Bureau of Biological Survey, 1921-22.

For the purposes of handling the considerable number and variety of the problems involved in such activities the Bureau is organised into 6 divisions.

each of which is further subdivided into sections dealing with special aspects of the problems. Each of these divisions is in charge of a special assistant, while each section has a scientific staff, certain officers may however be on the staff of more than one. section. These divisions and sections may be considered in more detail:—

I. *Biological Investigations*:

(a). *Investigations of Wild Animal Life.* Under this project field investigations are made to ascertain the geographical distribution and life habits of native wild animals and birds, and technical studies are made to determine their relationships and classification as a foundation for the efficient handling of most of the problems of the survey.

The information obtained is especially useful in the conservation of valuable species, particularly game birds and mammals, and fur-bearing animals and in restocking areas in which species have become extinct; also in connection with plans for the control or extermination of species injurious to agriculture and stock raising. Maps are made of the distributional areas of each species and of the summer and winter ranges and migrational routes of birds. These studies, together with counts of birds on selected areas throughout the country, serve as a basis for Federal and State protective legislation.

(b). *Biological Surveys of States and Territories.* Surveys are made of States or other definite areas to determine the range, habits, and abundance of the native wild animal life occurring therein and the distribution of native plant life, to obtain information of use in the conservation of wild life and the determination of boundaries of natural life zones. The life zone work in each State serves as a unit in completing the mapping of the life zones of the entire country. The published results of these studies appear in the North American Fauna Series of the Biological Survey.

I have here for exhibition to-night several of these reports on the surveys of individual States which will show you how thoroughly this work has been carried out.

(c). *Biological Investigations of Migratory Birds.* Investigations are made of conditions in breeding grounds and winter resorts of migratory birds; enumerations are made of migratory waterfowl; and general studies are conducted in bird migration as a basis for determining suitable regulations for promulgation under the migratory bird treaty Act.

(d). *Life Habits of Injurious Animals.* Studies are made of the life habits and geographical distribution of rodents and predatory animals injurious to agriculture, horticulture, forestry, animal husbandry and wild game.

II. *Economic Investigation*:

This division handles the necessary investigations of injurious mammals and provides the organisation and leadership of campaigns for the destruction of predatory animals and injurious rodents throughout the country. It also maintains an experimental fur farm and investigates all matters related to fur farming for the benefit of this industry.

The division is divided into several sections, but the nature of the work is sufficiently indicated by the above summary which is taken from the annual report of the Chief of Bureau of Biological Survey for 1922.

III. *Food Habits Research*:

(a). *Relation of Native and Introduced Birds to Agriculture.* Field and laboratory investigations are made to determine the economic relations of birds

to agriculture, horticulture and forestry, and thus provide a rational basis for their popular and legislative treatment; to devise and recommend methods of encouraging and protecting the useful species and of controlling the harmful ones; and to study methods of attracting desirable species to home grounds and bird sanctuaries, and methods of propagating and caring for cage, game and ornamental birds. The food habits of waterfowl and upland game birds are investigated and surveys made of the wild fowl resorts for the purpose of aiding in the improvement of their food resources. Studies are made of the diseases of wild birds, and laboratory investigations are made of the food habits of mammals also.

(b). *Relation of Reptiles and Amphibians to Agriculture.* The objects of this section are similar to the last.

(c). *Economic Investigations of Migratory Birds.* The object of this project is to determine the economic value of birds protected by the migratory bird treaty Act as a basis of continuing their protected status or of modifying it when found advisable; to study the food habits of migratory game birds as related to the maintenance and increase of their numbers; and to make surveys of the feeding resorts of these and other migratory birds with a view to improving them and locating areas which may be set aside as bird refuges.

IV. *Game and Bird Reservations*:

This division has supervision over the Federal big game and bird reservations. It restocks national reservations by capturing, purchasing and transporting big game and administers the refuges, nesting grounds and public shooting on the bird reservations.

V. *Enforcement of the Migratory Bird Treaty and Lacey Acts.* The Treaty and Act are enforced by game wardens, each assigned to a particular district, who are rendered aid by the game authorities of most of the States, and in addition by approximately 400 U.S. deputy game wardens who render co-operative service and receive only nominal salaries. Information concerning game is prepared for publication; summaries of State and Federal Game Laws and laws relating to fur-bearing animals are issued annually. Violations of these Acts are investigated, the necessary evidence collected and the first steps taken in preparing each case for legal action.

VI. *Alaska Investigations*:

This division being of local (American) interest need not concern us further.

From the summary I have given above it may be seen how extensive are the operations of the U.S. Bureau of Biological Survey. Such a Bureau requires a tremendous staff, which it would be impossible for the Australian Bureau to maintain. Though divided into separate divisions it is obvious that the work of the various divisions dovetail in many ways, each depending on the other for help and information. In addition to the staff maintained by the Bureau, information is obtained from a large number of individual unofficial helpers, farmers, trappers, hunters and the like, and the Bureau arranges for the issue of the licenses to collect specimens, and also advises as to trapping and other methods of catching animals and preservation of specimens.

It also distributes bands for ringing migratory birds and collects the information so obtained. A very elaborate system of card indexing is also maintained on all the various activities of the Bureau.

The publication work of the Bureau covers a wide field. The pamphlets, reports and larger works in the nature of monographs issued by the Bureau have now reached a high figure.

In addition to the faunal surveys to which I have already alluded, there are pamphlets which are issued to farmers, trappers, etc., giving information as regards friends and foes; what friends are to be protected and what enemies to be eradicated. Another series deals with methods of preparing specimens, the use of rings for bird banding and the like. Examples of these various types of pamphlets I have brought to-night for your inspection.

The Bureau is of course a Federal institution, but must of necessity work in collaboration with the various States. This co-operation is arranged in a variety of ways. In some instances the States appropriate money, provision being made in the law that it shall be expended in co-operation with the Bureau of Biological Survey. In some instances the representative of the Bureau and of the State serve jointly in directing the co-operative work made possible by State and Federal funds. Provision is also made in most States whereby county officials are empowered to contribute funds to the work.

The Bureau has also established a predatory animal inspector and a specialist in rodent work to co-operate with each of the States in which work along the respective lines is in progress. In the case of Biological Surveys of States expeditions are so planned that members of State organisations accompany Bureau parties, the specimens being divided between the participating institutions, and the results published jointly or by the States.

Joint investigations of game conditions on National Forests and National Parks are also made matters of co-operation between the Survey and the Forest Service and National Park Service respectively.

Co-operation is maintained between the Bureau and the State Game Departments of most of the States in connection with the enforcement of the game laws, as well as with sportsmen's organisations, individual sportsmen and conservationists. Close co-operation between the Bureau and these agencies is of great aid in securing an efficient enforcement of the Federal Game Laws. In most of the States numbers of State deputies are also invested with Federal authority—as U.S. Deputy Game Wardens.

The establishment of an Australian Bureau of Biological Survey is essential if we are to obtain an adequate knowledge of the distribution of our unique fauna before it is completely wiped out by the advance of settlement. The aims and objects of the Bureau have been advocated by Mr. Froggatt in his address as President of this Society, and by Mr. Waterhouse in the Presidential Address before the Linnean Society, and I need not further elaborate them here. The questions of distribution will, however, appeal less to legislators than the advantages that will accrue through the activities of such a Bureau in the protection and regulation of the fur and skin trade, and it is on the economic aspect of the subject that our appeal for the establishment of the Bureau can be urged with the greatest prospect of success.

I have endeavoured to outline the constitution of the American Bureau. As a beginning it would be difficult to obtain such an elaborate scheme in Australia, but it would be possible to start on a smaller scale with the ultimate object of regulating all questions of animal preservation and study.

Such a Bureau would of necessity be a Commonwealth institution, but close co-operation will be necessary between the Commonwealth and the States to ensure the smooth working of the Bureau and to obtain uniformity in methods of protection and in legislation.

In conclusion, I may say that questions of distribution will occupy a prominent place among the discussions of the Zoological and Entomological sections of the coming Pan Pacific Congress, and it is to be hoped that these discussions will materially advance the project of the establishment of a Bureau of Biological Survey.

The Hon. Treasurer presented the Balance Sheet. (See page 131).

The Hon. Treasurer's report and balance sheet were adopted.

The following members were elected to fill the six vacancies in the Council, occurring through the operation of Article 23:—

J. H. Campbell, M.B.E.	A. R. McCulloch.
E. W. Ferguson, M.B., Ch.M.	A. Musgrave.
W. W. Froggatt, F.L.S.	E. F. Pollock.

It was resolved to discontinue the bi-monthly general meetings, the attendance having been unsatisfactory. Arrangements will be made to hold sectional meetings instead.

A sub-committee was formed to arrange an outing to which zoologists attending the Pan-Pacific Science Congress will be invited.

Mr. Chas. Hedley gave an interesting account of a recent visit to the Great Barrier Reef.

Election of Officers.

At a Council meeting held at the close of the Annual Meeting, the following officers were elected for the year 1923-4:—

President: Professor Launcelot Harrison.

Vice-Presidents: Dr. E. W. Ferguson, Dr. E. A. D'Ombrain, J. H. Campbell and W. W. Froggatt.

Honorary Secretary and Editor: A. F. Basset Hull.

Honorary Treasurer: D. G. Stewart.

Honorary Librarian: Phillip Shipway.

Honorary Photographer: E. F. Pollock.

DATES OF MEETINGS—1923—AUGUST TO DECEMBER.

Section.

8th August.—Wednesday: Entomological, 7.30 p.m.
17th August.—Friday: Ornithological, 7.30 p.m.
12th September.—Wednesday: Economic Zoology, 7.30 p.m.
21st September.—Friday: Ornithological, 7.30 p.m.
10th October.—Wednesday: Entomological, 7.30 p.m.
19th October.—Friday: Ornithological, 7.30 p.m.
14th November.—Wednesday: Economic Zoology, 7.30 p.m.
16th November.—Friday: Ornithological, 7.30 p.m.

New Members.

The following new members have been elected since the publication of the last list (7th June, 1923):—

Ordinary Members:—C. W. Chambers, T. Desmurchelier, J. T. Middleton, H. J. McMichael, S. G. Rawlinson, J. P. Rawlinson, W. A. Robertson, R. S. Sands, and A. Webster-Wedderburn.

Associate Members:—B. Bertram, B. Cherniayeff, D. Dickison, and A. S. Faulkner.

BALANCE SHEET AS AT 30th JUNE, 1923.

LIABILITIES.	£	s.	d.
Capital	591	5	0
Income Account	78	17	4
Handbook Publication Fund Account	164	3	3
	£834	5	7

ASSETS.	£	s.	d.	£	s.	d.
Investments				591	5	0
Income Account—						
Commercial Banking Company	2	4	6			
Government Savings Bank	76	12	10			
				78	17	4
Handbook Publication Fund—						
Government Savings Bank				164	3	3
				£834	5	7

INCOME ACCOUNT FOR YEAR ENDING 30th JUNE, 1923.

RECEIPTS.	£	s.	d.	£	s.	d.
Balance from 30th June, 1922				146	18	11
Annual Subscriptions—year ending 30th June, 1923				249	6	3
Annual Subscriptions—for year ending 30th June, 1924—(paid in advance)				44	15	1
Life Subscriptions				32	5	9
Donations				2	1	0
Sales "Zoologist"—(inc. Reprints)				5	9	7
Interest—						
Commonwealth Stock	32	0	0			
N.S.W. Govt. Stock	2	15	0			
Govt. Savings Bank	5	16	7			
				40	11	7
Exchange					6	3
				£521	14	5

DISBURSEMENTS.	£	s.	d.	£	s.	d.
Publication "Australian Zoologist"—						
Printing	146	1	4			
Blocks	25	19	10			
				172	1	2
Appropriation to Capital Account				50	0	0
do. Handbook Fund Account				100	0	0
Office Accommodation				52	0	0
Printing and Stationery				16	7	9
Books—(Matthew's Birds)				10	10	0
Petty Cash—						
Postage	14	1	2			
Duty Stamps		3	3			
Stationery	2	2	3			
P.O. Box	1	0	0			
Exchange		8	7			
Sections	3	1	9			
Sundries		6	0			
				21	3	0
Payment to Taronga Park Trust for members in excess of 300				8	8	0
Sundries				12	7	2
Balance on 30th June, 1923				78	17	4
				£521	14	5

HANDBOOK PUBLICATION FUND ACCOUNT FOR YEAR ENDING 30th JUNE, 1923.

RECEIPTS.	£	s.	d.
Appropriation from Income Account	100	0	0
Government Grant for year	50	0	0
Donations	25	0	0
Handbook Sales ("Fishes of N.S.W.")	35	0	4
Savings Bank Interest	2	9	2
	£212	9	6

DISBURSEMENTS.	£	s.	d.
Balance from 30th June, 1922	48	6	3
Balance on 30th June, 1923	164	3	3
	£212	9	6

D. G. Stewart, Hon. Treasurer.

We have examined the books and vouchers of the Society for the twelve months ended 30th June, 1923, and certify the above statements of Receipts and Disbursements and Balance Sheet to be in accordance therewith.

Sydney, 16th July, 1923. (Sgd.) Coates, Cunningham & Co., Public Accountants.

ORNITHOLOGICAL SECTION.

Chairman's Summary.

(Dr. E. A. D'Ombrain.)

On the occasion of the ending of our first year as a section of the Royal Zoological Society of New South Wales, I feel that a few remarks upon the work of the Section and its bearing on our environment would be appropriate.

Although an official record and report has been submitted by the Secretary, I can nevertheless broadly refer to some of the activities of our Section and results therefrom.

At first I wish to congratulate members on the undoubted success of the Section. Our meetings, which sometimes have been naturally and necessarily of a general and political character (our own politics, I may add), have been well attended, and many discussions, suggestions, and the like on the subjects of Sanctuaries, Bird economics, Legislation, Bird export, etc., have been earnestly entered into.

Later these meetings have been made more enjoyable and instructive by the taking of fixed bird-subjects for a lecturette by various members, and as some of these were delivered at the Australian Museum, with the opportunity for the exhibition of the forms lectured on, the enjoyment and benefit were considerably increased, and the Section is much indebted to the Museum authorities in consequence, and our thanks are due to them.

During the year, our member Mr. J. Ramsay presented the Section with a very fine lantern and slides complete. This has been a great acquisition, and, although the gratitude of the Section has been officially recorded, I feel sure the donor has been somewhat gratified by the success of his gift, as shown by our appreciation of the exhibition of slides, which have from time to time been given. In connection with this I wish to point out that our endeavour has been to get series of lantern photographs of birds, and I am pleased to be able to state that quite good progress has been made, notably in the Bower birds and Frogmouths.

With regard to the activities of the Section and its environment, i.e., the general community, I need only refer to the result of insistent efforts of the Section in general, and to some members in particular, viz., Messrs. Ramsay, Rolin and Cayley, which have resulted in the public being thoroughly aroused over the destruction of timber, and disturbance of nature generally in the National Park.

It is due to societies such as ours that such vandalism is kept in check. Indeed, one of the public, not knowing how we had for months been working to this end, asked "What is your Society doing letting things like this go on? Are you all asleep?" He and the general public have to thank us and kindred societies for being on guard while the damage was being insidiously carried on.

Again, we have looked after the interests of the birds, and thus those of the public, who care about their bird friends, in recommending that certain areas be made "Sanctuary."

The efforts of our member, Mr. Rolin, who, as Vice-president of the Wild Life Association, took up the matter in a very earnest manner, resulted in the amendment of the laws relating to the protection of the native fauna, and our own Society with kindred societies has just recently deputationised the Acting Premier (represented by the Minister for Labour and Industry, Mr. Farrar, M.L.A.), with reference to this Act and other items of outstanding necessity relative to birds and the community.

Through the public press the Section has invited the public to forward notes

on observations of the economy of the imported Bul-bul, and from evidence thus obtained it is hoped to be able to state a fair case, both for and against this bird, before deciding to recommend its destruction "without trial."

Recently we were honoured by the attendance at a special meeting of Dr. Casey Wood, of America, and were pleased to have been able, through our members, to afford this eminent ornithologist and oculist some very intimate observations at National Park of the Satin Bower bird and the Lyre bird. Dr. Wood was greatly pleased, and was most enthusiastic in his remarks about the good our Section with kindred bodies was doing.

In conclusion, I personally wish to thank members for a harmoniously worked year, and to offer my best wishes for a still more successful existence during our coming year.

ENTOMOLOGICAL SECTION.

The Entomological Section held during the year six meetings (five ordinary and one special), the average attendance being 11 members.

At the June meeting it was decided that the members of the Section would entertain the entomologists attending the meeting of the Pan-Pacific Science Conference in Sydney.

SECTION OF ECONOMIC ZOOLOGY.

Two meetings were held, the attendance at which was satisfactory. Several interesting exhibits were displayed by members, reference to which has been made in this journal (ante p. 45). At the May meeting two remarkable models of Chitons, enlarged for museum purposes, were exhibited by Mr. Reginald Hawkins, who submitted the following note on their preparation:—

The use of enlarged models of minute organisms has long been recognised as the most successful method of illustrating specimens, which, from their small natural size, would otherwise be overlooked by the ordinary visitor to a museum, or by those not possessing more than the ordinary facilities for studying minute objects.

With the enlarged model a very wide avenue of interest is opened up, permitting the study of minute mollusks, some of which are remarkably beautiful, both in colour and sculpture.

The task of selecting a suitable subject was by no means easy, owing to the wide choice contained in the many groups or individual species lending themselves to such treatment. From the point of view of symmetry, structure, and colour, selection was eventually made of the Chitons as the first objects upon which to make my first attempt at modelling. Chitons are small rock-clinging mollusks, possessing a large sucker-like foot, and a soft body protected by a shell composed of eight overlapping plates inserted in a leathery girdle. They are found chiefly below low water mark, attached to the under surface of small stones. Unless viewed through a powerful microscope much of their beauty is unseen.

The subject being decided upon, the choice of a species resulted in the selection of *Rhyssoplax jugosa*, one of the commonest but most highly developed of our Chitons. Careful measurements were taken, and a quantity of clay worked up to correspond with the shape and dimensions thus obtained. This clay shape resembled an upturned boat, without any superstructure. I next measured and marked off the eight plates, care being taken to allow sufficient material to remain to permit of the sculpturing of the lateral and central areas. When the carvings were finally completed, a mould was made, from which in turn a cast

was taken. This plaster cast required a little preparation before the interesting stage of applying the colouring was entered upon. Viewed through a lens, the riot of colour, when considered from a reproductional point of view, is astounding, shades of blue, bluish-grey, green, brown, red and pink, and all these in darker and lighter tones makes a truly wonderful display, calling for infinite care in reproduction. The model exhibited shows an enlargement to 11½ inches of a shell about 20 millimetres in length.

The next species modelled was one of the vermiform group *Cryptoplax*. Though presenting a quite unattractive exterior to the unaided eye, its remarkable girdle, covered with spicules arranged according to most intricate patterns, afforded great scope for careful modelling. The soft, spongy nature of the girdle renders it practically impossible to make a life-like dried specimen, and the measurements and data had to be taken from a living specimen. The method of modelling the body was the same as in the case of *Rhyssoplax jugosa*, but the bristles or spicules offered the chief difficulty. For these pins were used, the points being burred and cut to the requisite length, and separately inserted in the cast by hand. Examination of the model will show that these spicules are arranged in tufts at the sutures; directed forward over the greater part of the girdle, and radiated towards the outer margins. Some 14,000 individual pins were used to produce this effect.

MR. TOM IREDALE.

Mr. Tom Iredale has arrived in Sydney to attend the Pan-Pacific Science Congress, and he will probably remain here for some time after the Congress concludes its session; possibly he may make Australia his permanent home.

Mr. Iredale has been for upwards of ten years associated with Mr. Gregory M. Mathews in the production of the latter's monumental work, "The Birds of Australia," which is now approaching completion, the last part issued being Part V. of Volume X. He also collaborated with Mr. Mathews in the compilation of a Handbook of the Birds of Australia, of which Volume I. has been issued, the two remaining volumes being in the press.

Mr. Iredale's activities, however, have not been confined to Ornithology. In 1908 he organised an expedition to the Kermadec Islands, where he collected both birds and mollusks. He has published the results of his shell collecting in the Malacological Journal (London), and has also written many original papers on Conchological matters. For some time past he has been gathering data and material for a monograph of the Polyplacophora of Australia, in which work he will collaborate with Mr. A. F. Basset Hull, who has written or joined in the production of several papers on the Chitons of New South Wales, Lord Howe and Norfolk Islands. The joint labours of these authors should result in a copious and up-to-date work of reference, useful alike to collector and student.

AUSTRALIAN BLEPHAROCERIDAE.

Corrections and Additions to Parts I. and II.

By A. L. Tonnoir,
Research Student in Diptera, Cawthron Institute, Nelson, N.Z.

(*Communicated by Dr. R. J. Tillyard.*)

When studying the pupa of *Edwardsina* in the process of formation under the larval skin, I assumed that a transformation of the breathing filaments into lamellae was taking place (this Journal, Vol. III., p. 54), although I had not seen the intermediate stages. This process, however, was never quite clear to my mind, and I was therefore anxious to find the intermediate stages of this transformation. So, when I was in Sydney recently, I was glad to see in Mr. Nicholson's collection a fair number of *Edwardsina* larvae that he had collected at the same time and on the same spots as Dr. Tillyard on Mt. Kosciusko. He very willingly gave me this material for study, for which loan I am very much indebted to him as it led me to see the error I had made and which I intend to correct in this paper.

Among these larvae I found one specimen, within which a pupa was in formation, and this pupa presented breathing organs with perfectly well-formed lamellae, a case that I had looked for in vain in Dr. Tillyard's material; but a close comparison with a larva in which the pupa in formation presented only filaments as breathing organs, showed me that in reality I had to deal with two different species of *Edwardsina*, however faint were the characters of distinction between them.

I then referred to the imagines of Dr. Tillyard's collection and saw that in fact two species of *Edwardsina* had been described by him under the name of *E. australiensis*. This mistake occurred because he took to make his mounts a specimen preserved in spirit and collected on the last day of his sojourn on Mt. Kosciusko in a spot lower down Digger's Creek, and not one of the numerous specimens collected higher up on the previous days, and which happened to belong to another species.

As this mounted specimen served for the description of most of the morphological features of *E. australiensis*, it has to be considered as the type. I give hereafter the alterations that have to be made to this description, and, at the same time, the description of the new species with its larva that I have the pleasure to dedicate to Dr. Tillyard, its discoverer.

The correction to be brought to the description of the early stages consists only in a change of name. The pupa described and figured, p. 53, is the one of *E. tillyardi* instead of *E. australiensis*, but on the other hand, the different stages of the larva described have in all probability to remain under the name of *E. australiensis*, although a pupa with breathing filaments has not been found up to now which would give us a definite proof of it. It is a most curious fact that of the 135 larvae collected by Dr. Tillyard and Mr. Nicholson, only a single one belongs to the same species as the 95 pupae found at the same time on the same

rock, and that none of the pupae are to be referred to the same species as the other 134 larvae. This shows how careful one must be in working out the life-history of organisms which, by their mode of living, are not adapted to be reared in the laboratory.

However, in spite of this error of identity, none of my conclusions regarding the early stages of the Blepharoceridae have to be altered in any way, because even if the presumed larva of *E. australiensis* proved to belong to some other form, the larva of *E. tillyardi* hereafter described, differs so little from it that it can be taken without inconvenience to base these conclusions upon.

I also take this opportunity to describe the larva of *Neocurupira nicholsoni* Till., that Mr. Nicholson found in great quantity this year on Mt. Kosciusko, together with their corresponding pupae, in which the imago of this species could be identified with certainty.

It is remarkable to find that in this same creek on Mt. Kosciusko four different species of Blepharoceridae live together, i.e., *Edwardsina australiensis* Till., *E. tillyardi*, n.sp., *Neocurupira nicholsoni* Till., and *Apistomyia tonnoiri* Till.; it is therefore probable that many more species of this interesting family remain to be discovered in Australia. I found last summer in Tasmania half a dozen species of Blepharoceridae which all belong to the genus *Edwardsina*, and none of them is to be referred to the two forms known hitherto from the mainland.

Edwardsina australiensis, Till.

Imago. The dimensions given in the description, with the exception of those of the legs, are those of the next species.

The measurements of the type are:—♂. wing, 8.5 mm., total expanse, 18 mm., body, 4 mm.

Coloration.—Head with its appendages dark, only the two first joints of the antennae slightly testaceous; posterior border of the eyes with a greyish seam. Mesonotum blackish brown, slightly shining and with greyish reflection in some positions; its sides somewhat testaceous, chiefly and more extensively above base of the wings and on the middle in front of the scutellum, which is light brown; metanotum a little lighter; pleurae also testaceous, but sternum darker. Legs light brown, all coxae completely and base of femora testaceous; wings not infuscated; stem of halteres extensively rufous, knob dark. Abdomen dull brown.

The apical spur is absent on the middle tibiae and not on the anterior ones as stated by Dr. Tillyard by a lapsus calami (0.1.1. instead of 1.0.1.). The wing figured (fig. 1a, p. 162) does not belong to *E. australiensis;* because in this species the stem of R_{3+4} is less than a third of the length of R_3, and not half of it; the first part of R_3 is more curved downwards and a little more converging towards the end of R_2; the general shape of the wing is relatively broader, otherwise all other details of venation are correct.

The figs. 4a. and b. of Dr. Tillyard do not convey a right idea of the structure of the hypopygium; I give therefore a more accurate drawing beside the corresponding part of the next species for comparison.

The claspers are relatively long, not broader at base and with a blunt extremity; the penis is trifid, the titillators on the side are absent.

♀. The length of the wing is only 10.5 mm. The eyes are smaller than in the male, but not to the extent shown in Dr. Tillyard's figs. 2a. and b., which are to be referred to the following species; in this one the occiput is only half as wide as the eye and its lower swelling much less marked.

This species was not very abundant at the time of the year it was secured; only 18 specimens have been collected.

Larva.—The larva presumed as being the one of *E. australiensis* and described by me under that name, does not possess more than 4 instars, because now that I have studied more larval forms of this family I have come to the conclusion that a different shape of the mandibles is not a proof of a different instar, as I will explain hereafter. Therefore my figures 3c. and d. belong to a

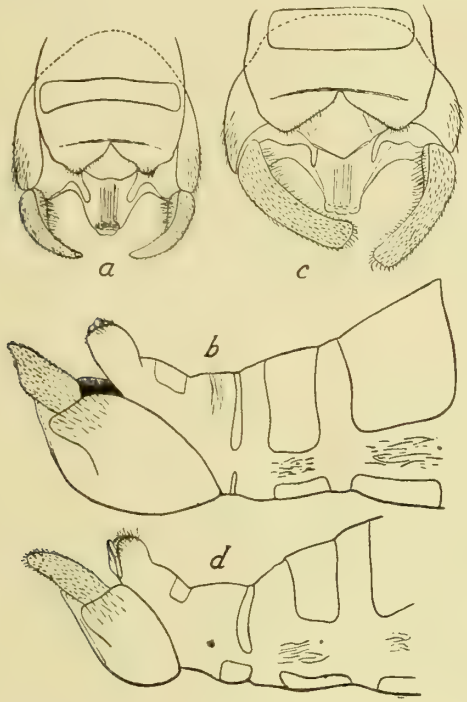

Fig. 1. a, hypopygium of *E. tillyardi* seen from above; c, the same of *E. australiensis;* b, end of abdomen of *E. tillyardi* in profile; d, the same of *E. australiensis* (these two last drawn to the same scale).

recently moulted larva in the last instar, the head of which not being fully extended on its posterior border presents a few folds that disappear when the larva reaches its full size.

Pupa.—The pupa of *E. australiensis* has not been found yet; it must be provided with breathing organs composed of tufts of filaments as shown in my fig. 1a. (p. 48) and 5b. (p. 54) made from a pupa in formation under the larval skin. The transformation of these filaments into lamellae is not probable, as I have found in Mr. Nicholson's material a larva in which the pupa was,—as one could judge by its dark colouration,—on the verge of emerging, and which presented the filaments as already described.

But if it is not true that this evolution of the filaments into lamellae takes place ontogenetically, it is at least very probable that it has taken place phylogenetically as the filamentous gill is a type much more generalised, such as we find in Simuliidae and Chironomidae pupae.

Edwardsina tillyardi, n.sp.

Very similar to *E. australiensis;* differing from it among other characters by the presence of one spur on the middle tibiae, the longer stem of R_{3+4}, the infuscated wing and the larger size.

♂. Total length, 5 mm., wing, 9.5 mm., antennae, 3 mm., legs: anterior fem. 6 mm., tib., 6, tars, 6.5; middle fem. 7 mm., tib., 5.5, tars, 6; post. fem. 9 mm.; tib., 8.5, tars, 4.

Colouration.—The head with its appendages blackish grey; the base of the antennae also dark. Mesonotum and scutellum velvety black with a greyish reflection in certain positions; side of thorax grey; metanotum and abdomen dark. Legs brown base of femora and coxae with the exception of the base of the front ones testaceous. Stem of halteres testaceous, the knob deep black. Wing uniformly infuscated.

The eyes are smaller than in *E. australiensis* and leave between them a much wider frons; seen from the side their width is not quite the double of the occiput. The relative length of the last joints of the antennae differ slightly from *australiensis,* as they increase slightly but gradually in length from the 13th on.

In the palpi the first and third joints are relatively shorter.

The labellum does not present at its forking the chitinous parts which Dr. Tillyard in his fig. 3a., of *E. australiensis,* shows erroneously as forming independent appendages and that he took to be the vestiges of the inner lobe. I do not think they can be homologised with anything else but the rod-like apodeme of the theca and its furca; at any rate, they are imbedded in the integuments of the labellum.

The wings are larger and more elongated than in *E. australiensis* and their colouring distinctly brownish; the venation is as shown by Dr. Tillyard's figure No. 1a., p. 162; the stem of R_{2+3} being about the half of R_2; the base of M_3 is slightly undulated. The main difference in the legs from *E. australiensis* consists in a terminal spur on the middle tibiae; the relative length of the legs is also somewhat greater. The claws of the hind legs carry 3 teeth in a series, increasing in size from the base and the smaller being preceded by a small comb of about half a dozen spines, also increasing in size from the base of the claws; this comb is also present in *E. australiensis,* but has been overlooked in the drawing by Dr. Tillyard; the claws of the other legs are similarly built, but in the middle legs the last spine of the comb is rather larger and could be taken for the first of a series of 4 teeth.

The hypopygium is as figured (fig. 1a. and b.); the claspers are relatively small and pointed at the tip; the 9th sternite is comparatively much more developed than the one of *E. australiensis* as shown by fig. 1d. and b. drawn to the same scale.

♀. Size wing, 11.5 mm.; body, 6 mm.; legs, ant. fem., 6.5 mm.; tib., 7 mm.; tars., 6.5 mm.; middle fem. 7. mm.; tib., 5.5 mm.; tars., 5.5 mm.; post fem. 9.5 mm.; tib., 9.5 mm.; tars., 4. mm.

Similar to the male but the eyes smaller, also the antennae, the last joint of which is but very little larger than the preceding one; palpi relatively shorter, the last two joints being together equal to the second, and the fourth only half the length of the third. Mandibles moderately pointed, finely ciliated on the inner edge, noticeably longer than the labellum, but not quite so long as the palpi; lacinia not larger than in the ♂, but much broader at their base where they touch each other, coming thus over the base of the labellum.

The end of the abdomen does not differ from the one of *E. australiensis,* the figure of which given by Dr. Tillyard (fig. 4c.), does not convey a right idea. I

therefore give a figure of the abdomen tip seen from below, showing the forked gonapophyses of the 9th segment.

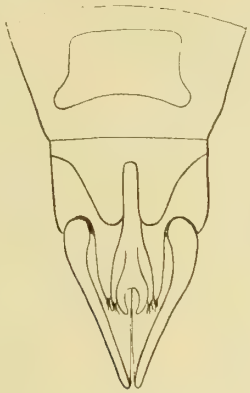

Fig. 2. End of abdomen of the female *E. australiensis* seen from below.

Larva.—The length of the full-grown larva is 9 mm., and its colour brownish without any pattern as in the supposed larva of *E. australiensis* to which it is very similar; it differs chiefly from it by the small secondary divisions being more rounded at the sides, by the constrictions on each side of the body divisions being more marked even on the last one and by the shape of the posterior end of the body, which is trilobed.

Besides there are some minor characters of differentiation such as the shape of the mandibles, which present at their distal end two very blunt teeth and are not provided with the large swollen inferior lobe. All the other mouth parts are similar to those of the larva already described, also the mentum and prementum are developed to the same extent. The head capsule widens suddenly at its posterior part and does not carry the two small dorsal processes of *E. australiensis;* the small spines in front of the thorax form only a very irregular row of four. The main divisions of the body do not carry any noticeable bristles, but besides the usual punctiform depressions they have on each side a rather deep foveole. Seen from below this larva presents the same aspect as shown in fig. 1c., p. 48, but for the three-lobed end of the body; the breathing filaments are also disposed on the small secondary divisions and form a tuft of five branches a little shorter in this species.

Pupa.—Inside the above described larva was found the pupa in formation presenting the peculiar breathing lamellae of the pupa described and figured by me under the name of *E. australiensis* (pp. 53, 54, fig. 4A.B. and fig. 5A.), and which must be referred now without any doubt to *E. tillyardi.*

Neocurupira nicholsoni, Till.

Larva.—The full-grown larva of *N. nicholsoni* is about 6 mm. long and is characterised by:—

1. The absence of any kind of lateral appendages on the 8th abdominal segment, the anal division being thus provided with only one pair of appendages.
2. The presence of rather long spines on the lateral appendages.

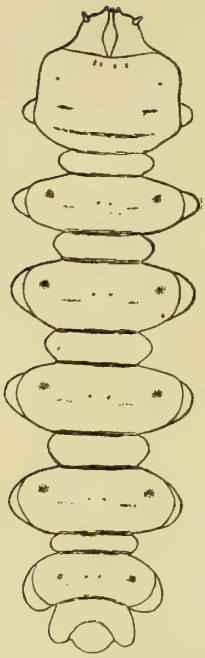

Fig. 3. Larva of *E. tillyardi.*

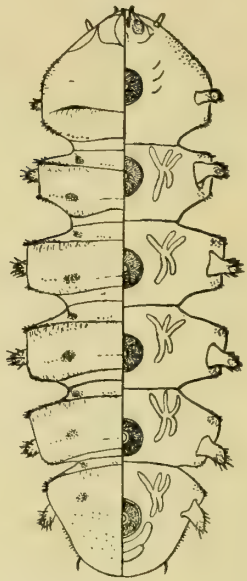

Fig. 4. Larva of *N. nicholsoni.*

3. The spines on the side of the anterior and posterior borders of the main division of the body.
4. The nearly complete fusion of the 7th to 9th abdominal segments.

Its colouration is dark brown, nearly black on the dorsum, with the exception of the anterior part of the cephalic division corresponding to the thorax, which is lighter brown.

The head is small, incomplete, because of the deeply notched lateralia on the dorsum, which do not extend ventrally, leaving thus the mouth parts without a chitinous frame behind them.

The mouth parts are similar to those of *A. tonnoiri,* the mentum is absent as is the case with all Blepharoceridae larvae so far as I know; the hard black mandibles are blunt on their biting end with no conspicuous lobe below.

The antennae are two-jointed, with the first cylindrical joint short, the second two and a half times longer, and tapering towards the end which bears a couple of sensitive cones.

The sides of the cephalic division present two groups of spinules; some numerous smaller ones immediately after the lateralia and 6 or 7 stronger ones on the posterior corner of this division; these are followed by a few smaller ones on the ventral side of the body.

The part of the cephalic division corresponding to the first abdominal segments is somewhat swollen and rugose, but does not present there any tubercules, spines or hairs, only a series of small punctiform depressions is to be seen on each side of the posterior border.

Each of the main divisions of the body is provided with an anterior and a posterior transverse ridge, but this last one is more or less obsolete towards the sides; the anterior one carries on each side of the body a row of about a dozen spines, the outer ones being the strongest, and the inner ones gradually decreasing in size toward the interior in a row containing a larger and a smaller spine alternately; the posterior corners of the main divisions bear only half a dozen spines, smaller than the anterior ones followed, as well as these by a few spinules on the ventral side of the body. The dorsum of the divisions is rather rugose, especially along the anterior ridge, where it is somewhat corrugated, chiefly on the sides; besides, each division presents in front of that ridge and on each side of the body, a well marked foveole and at some distance in front of the posterior ridge another deeper foveole containing a certain number of punctiform depressions, a series of which extends also on the external side of this foveole.

The last or anal division presents also an anterior ridge with the lateral rows of spines, and the sides of this division after the level of the lateral appendages carry a series of spinules, which ends in two much longer curved bristles, so closely adpressed against each other that they give the impressions of a single stouter bristle.

The dorsum of this division is provided with a good number of punctiform depressions, which, but for those forming the two anterior foveoles, are rather irregularly distributed; they are, however, more numerous along a very shallow and indistinct transverse depression, which seems to indicate the demarcation between the 7th and 8th abdominal segment; but no limit whatever exists between the 8th and the 9th, and the end of the body is regularly rounded.

The lateral appendages, which are testaceous, are provided with a broad base, and are more or less pointed towards the tips, when seen from above they seem to be olive-shaped; they carry besides some yellowish hair on their dorsum, an irregular number of rather strong, erect black spines about as long as the width of the appendage itself; on the appendages of the cephalic division, which are distinctly smaller than the others, the spines are also smaller and fewer in number—usually four—whereas on the other appendages there is an average of 6 spines, but their number may vary from two to seven; the last division of the body carries only one pair of appendages, which do not differ from those of the main divisions; the appendages of the 8th abdominal segment are thus completely missing, their situation is marked by the curved bristle already mentioned. The gill tufts are situated about midway between the centre of the suckers and the anterior corner of the divisions; they are composed of 5 filaments, the inner ones of which are the largest; the anal gills are normally composed of two pairs of filaments, one being twice as long as the other.

Among Mr. Nicholson's material I find two other stages of this larva that I take to be the second and third, but before describing them I have to point out a very curious fact concerning the development of the mandibles of Blepharocerid larvae.

When the smallest specimens of one given stage are examined, they are found to be provided with a toothed type of mandible such as shown in fig. 5a, whereas the larger specimens of the same stage present a hard, black, roundish type of mandible as shown in fig. 5b. In the next stage, again, the smaller larvae have toothed mandibles, and the larger, plain ones, and so on alternately. This is not only true of the present species, but of others also like *Paracurupira chiltoni* Campb. or *Edwardsina tillyardi* Tonn.

An explanation of this dimorphism is not easy to conceive. I do not think there is any ecdysis of the larva between the two types of mandibles, as no other hard chitinous structures are changed in any way, also that would not account for the alternate change of shape. I suspect that the type 5a is the one of the

Fig. 5. Mandible of *N. nicholsoni;* a, at the end of one stage; b, at the beginning of the same stage.

unexpanded mandible which remains in that state a certain time after moulting, and takes by and by its definite shape, color and hardness; the mandible in its first type is apparently not very hard, only the two first great teeth are blackish, and it presents three parts, 1, 2, 3, that may correspond to the three parts, 1, 2, 3 of the plain hard mandible.

Second Larval Stage.—Average size 2 mm., differs but little from the full-grown larva; the antennae are one-jointed and there is only one filament as gill, it is short and points forward; the 4 anal filaments are all of the same length. The spines on the side of the body are less numerous, especially on the cephalic division on which there are only 2 or 3 anteriorly and 2 posteriorly; on the anterior border of the main divisions there are 4 to 6 spines, and on the posterior one about 2 on each side; on the other hand the lateral appendages present the same number of spines as the adult larva.

Third Larval Stage.—Average size 3.5 mm., very near the preceding one from which it differs by the antennae with 2 joints, the gills with 3 filaments, two pointing forward and one backward, and by the more numerous spines on the sides of the body.

The larvae of *N. nicholsoni* have been found by Mr. Nicholson last year in great number on the surface rocks of a waterfall of Digger's Creek on Mt. Kosciusko on the 7th of December; the pupae were equally numerous.

Apistomyia tonnoiri, Till.

In the material collected by Mr. Nicholson, I find also some early stages of *A. tonnoiri* that I refer to the second and third ones.

Second Larval Stage.—Size 1.9 mm. The sculpture of the body is very inconspicuous; the spinules on the side are small and few in number; the sides of the main divisions are rounded, not angular. The antennae are two-segmented, the first segment being about one-third of the second in length. Second pair of lateral appendages of the anal division (those of the 8th abdominal segment) only represented by a pair of bristles. Gills formed of one single tube pointing forward.

Third Larval Stage.—Size 3 mm. Directly after moulting the larva with its unexpanded skin has a very spinulous appearance, its colour is then much darker, nearly black, and it could then be taken for the larva of some other species; but by and by this spiny sculpture disappears as the skin expands, and the colour becomes lighter. This occurs also at the beginning of the next stage. The spinules are still fewer in number than in the full-grown larva; the first segment of the antennae is now relatively larger, two-thirds of the second in length. The lateral appendages of the 8th abdominal segment are present in the form of very small callus with two curved bristles. The gills are composed of three filaments, two pointing forward and the other backward.

ANIMAL PHOTOGRAPHY.

By E. F. Pollock.*

(Plates xviii.-xx.—See also Plates v.-vii. Part 2.)

So much has already been written on the photography of animals that there is little new to be said. So far, therefore, from my remarks professing to be original they should rather be considered as the gathering together and setting out in a concise form of what appear to me to be the best ideas of several other writers on the subject, whose methods I have proved, from practical experience, to be sound.

Animal photography can be roughly separated into three sections: that of

(1). Domesticated animals.

(2). Wild animals in their natural state, and

(3). Wild animals in captivity.

Regarding the second of these—the photographing of wild animals in their native environments—few of us are likely to have much opportunity to practise it, and I therefore pass it over with the remark that much of the best work I have seen has been done with the aid of telephoto lenses in the day time, and by night with the help of special apparatus by which the animals have been made to photograph themselves, so to speak, by flashlight.

The methods of dealing with domestic animals, dogs, cats, horses, cattle and sheep, etc., and with wild animals in captivity, are practically the same, and therefore I will treat them here together.

There are, of course, other sections of animal photography, such as the photographing of insects and their larvae and pupae; birds and their nests and eggs; reptiles, fishes and so on, but I have had no practical experience to speak of in these branches of Nature photography and so I leave them alone.

A few suggestions upon the apparatus to be employed may be mentioned first of all. Unquestionably a reflex camera is the best to use. It is surprising the number of cameras of every description which may be seen any day at our Taronga Zoological Park. What is more surprising still is the very small number of results worth looking at that are ever produced by these cameras. This is generally due to the misjudgment of distances when small hand cameras are used, and the animal is found to have been out of focus when the negative is developed. It is not often in the gardens that it is safe to set the lens at infinity. Most of the exposures will be made on subjects varying in distance from 6 to say 30 feet, while at the same time a large aperture will usually have to be employed if the exposure is to be rapid enough to avoid the risk of movement. Under these circumstances extreme accuracy is required in estimating the distance from the object, for, however artistic—or inartistic—a landscape in a state of diffusion may be, a fuzzy picture of an animal is of no value at all.

A reflex camera gets over all these difficulties, and the image is focussed right up to the moment of exposure.

A lens of fairly long focus is advisable, and of large aperture. Most of my own work has been done with a lens working at F. 4.5. I have found a telephoto lens very useful in some cases, but, generally speaking, only for animals absolutely at rest. The one I have occasionally employed was a large Adon by Dallmeyer, working at F. 10. This, as compared with the other lens, gave an image magnified nearly three diameters.

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* A Lecturette, illustrated with lantern slides, delivered to members of the Royal Zoological Society of New South Wales, on 14th March, 1923.

Plates or films should be as rapid as possible, the faster the better. All my pictures have been taken on Australian made film, which, though not so good in my opinion as that of some other makes, is the only film readily obtainable here, thanks mainly to the prohibitive duty which our government has placed on the better article, thus benefiting a very few at the expense of the many.

A shutter of high efficiency, and capable of varying speeds, is essential to good work.

Suitable lighting of the animal itself is very important. This is often difficult to get, and I have found it especially so at Taronga Park. For instance, at times the sun seldom gets into more than mere corners of the installations for the lions and tigers, and in other places the trees and foliage are very thick around some of the pens and paddocks. These are obstacles which must be surmounted as best you may when they arise, and no hard and fast rules can be laid down.

Apart from the actual apparatus employed, I think the chief essentials to successful animal photography can be summed up in three words—Observation, Perseverance, and Patience.

Taking Observation first, you need to study your animal carefully, from every point of view, and above all try to catch him in a characteristic attitude. You may have to wait a very long time before you get a successful pose, but it generally comes if you are content to wait long enough. So much often depends upon position and expression that you must not begrudge several exposures on the same animal to achieve the desired result. I have often had to make 3 or 4 or even half a dozen exposures before I was satisfied.

This brings us to Perseverance. Make up your mind to get a good picture of your chosen subject and persist until you obtain it. Do not be disheartened if the animal moves just as you are snapping him—he probably will—but just try again. I remember once I was photographing the head of a thoroughbred horse, and I thought I had secured an excellent picture until I developed the film, and then I discovered that his near eye was completely closed. As I had given an exposure of about 1/200th part of a second it proved that he had actually chosen that fraction of time to wink at me! Had I not made another exposure on the horse, all my labor that day would have been in vain.

Always be ready to seize the opportunity when it comes. For instance, a lion in the act of yawning will not remain in that position while you light a cigarette. Seize the chance while you have it. Delays are dangerous, and he who hesitates is lost—at least for the time being—and must start over again.

Last—but most important of all—Patience. Make up your mind that an almost unlimited quantity will be required. Just about the same amount that is needed when you are dealing with, say, the Sydney Telephone Exchange! It may often be necessary—as at the telephone—to wait and watch for an hour, before your subject assumes a desirable attitude in a suitable part of its enclosure. The hour will not have been wasted if you "get on" eventually, or if a really successful picture is secured in the end. Never allow yourself to be hurried or bustled by a friend when you are taking photographs of animals. When I am on these missions I prefer to be entirely alone. And never make the exposure until you feel satisfied that the attitude and expression ars unlikely to be improved upon.

It is not always necessary to take a photograph of the whole animal; often the head only will make a more pleasing picture.

In conclusion, a word or two about backgrounds. Endeavour to eliminate from your pictures altogether, or at least as much as possible, all evidences that the animals are confined, such as buildings, fences, feeding troughs, and so on. The exclusion of all such distracting objects cannot be too strongly emphasised.

THE GREAT GREY KANGAROO (MACROPUS GIGANTEUS) AND ITS ALLIES.

By A. S. Le Souef, C.M.Z.S.

(Plates xxi.-xxii.)

Some confusion exists as to the relationship between the kangaroos belonging to the *Macropus giganteus* group; these are the Great Grey Kangaroo, the Tasmanian Kangaroo, the Black-faced or Mallee Kangaroo, and the Kangaroo Island Kangaroo.

Field observations, the study of many specimens that have passed through the Zoological Gardens of Sydney and Melbourne, together with examination of skins and skulls in the Museums of Sydney, Adelaide and Hobart, have enabled me in some measure to present this group in its right order (1). Mr. Oldfield Thomas (2), while admitting the difference between *Macropus giganteus* and *M. melanops*, considered the latter merely a sub-species, and apparently without having seen a specimen of the Kangaroo Island Kangaroo he thought (3), that it was identical with the Tasmanian Kangaroo. Swartz, in his admirable treatise on the genus (4) based on the specimens in the museums of Tring and London in 1910, and the literature to that date, maintains the same arrangement.

Body measurements of male kangaroos are not always reliable, as they seem to grow throughout their life, so aged specimens may reach a size that is much beyond the average. The females are a more reliable guide in this respect.

The typical females and adult males of *Macropus giganteus* of Eastern Australia are covered with a long, rather coarse hair, under which is a varying amount of woolly fur. The latter is thick and close in winter, and thin in summer. Ordinarily they are grey above with lighter under parts in autumn and winter, becoming darker, more evenly coloured, and suffused with brown, as the longer coarse hair becomes more prominent. The back of the ears is clothed with coarse hair.

In aged males the hair is short; in autumn they grow a downy woolly fur; this is more or less replaced in summer with a short, closely adpressed hair.

The western form, which is browner in general colouration, was separated by Gould as *Macropus ocydromus;* it is, however, merely a colour variety. It may stand as *Macropus g. ocydromus.*

Macropus giganteus is a forest animal living usually in the open timbered country, seldom more than two or three hundred miles from the coast. It is gregarious, being found in mobs of from 6 to 60.

The Tasmanian Kangaroo (not *Macropus fuliginosus,* of Kangaroo Island), is the same species, but with somewhat coarser fur and showing greater variation in colour. The colour of the upper parts may be sooty, sooty-grey, rusty-brown or rusty-red (Lord). As a rule the colour is rusty-brown with the under parts greyish. The skull and body measurements are the same as in the typical form. This I designate as *Macropus giganteus tasmaniensis.*

Mr. Oldfield Thomas in speaking of *Macropus giganteus,* var. *melanops*

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(1) My thanks are due to Dr. Anderson, Director of the Australian Museum, for permission to examine specimens, and to the Director of the Museums in Adelaide and Hobart for data supplied.

(2) Cat. Mars. and Monot. Brit. Mus., p. 20.

(3) Ibid., p. 19.

(4) Nov. Zool., 17, 1910, p. 86.

states (5) "Similar to *M. giganteus* in all essential characters but much smaller, more lightly built and darker coloured." Having paid particular attention to this species for many years I find that these characters are constant, and that as the animal differs also in habitat and habits, I consider that it should rank as a full species.

Actual measurements of Kangaroos of different ages are apt to be misleading. In my experience *Macropus melanops* is from one-fifth to one-fourth smaller than *M. giganteus;* the body proportions are also more slender (one might state that the difference is much the same as between the Deer Hound and the Grey Hound). The hair is shorter and finer; the hair on the back of the ears in the females and young males is very short, fine and closely adpressed, light fawn grey in colour, with a sharp line of demarcation from the hair of the head; in the adult and aged males the backs of the ears are blackish and almost bare. In Eastern and Southern Australia the body colour is dark chocolate; in the West it is more greyish; the chest is generally quite white in winter.

Macropus giganteus and *M. melanops,* although often found in the same districts, do not inhabit the same type of country; *giganteus* lives in the open forest, while *melanops* keeps to the scrub and the long grass, living in much thicker cover. Both may come into the same open spaces in the evening to feed. I have never known them to interbreed. *Melanops* is confined to the drier inland country and is not found near the coast. When surface water fails in any given locality, *giganteus* has to move on, but *melanops* remains, getting moisture from the bark and roots of shrubs. It is not gregarious like the larger animal, but is usually found in pairs. The males are more aggressive, and when chased by a dog they soon back up against a tree and put up a very good fight.

The Kangaroo found on Kangaroo Island, which has hitherto been considered to be the same as that from Tasmania, is a distinct species, described by Desmarest (6) as *Kangarus* (*Macropus*) *fuliginosus* in 1817.

Mr. Oldfield Thomas in speaking of *Macropus giganteus,* var. *fuliginosus* states (7) "The original habitat of this form was stated to be Kangaroo Island, South Australia, where Desmarest states, but with some doubt, that it was obtained by Peron and Lesueur. This doubt is confirmed by the fact that (*fide* Gould) it does not exist on Kangaroo Island, and by its common occurrence in Tasmania, where these collectors spent a considerable time." When Mr. Troughton visited the Island in 1921, on behalf of the Australian Museum, he found the animal fairly common, and secured several specimens. A comparison of these skins with the descriptions of the originals in the Paris Museum, shows them to be identical. The body and skull measurements given herewith show that *Macropus fuliginosus,* of Kangaroo Island, is distinct from *M. giganteus* and from the Tasmanian Kangaroo.

The Kangaroo Island Kangaroo, while clearly belonging to the *Macropus giganteus* group, is rather short and squat, having more the appearance of a wallaroo. The hair is long and coarse, and the colour ranges from almost black with a white chest in winter, to smoky chocolate with a greyish chest in summer. The face, outer side of the fore limbs, extremities of hind limbs and the end of the tail are darker. The inner side of the fore limbs and the legs all round are greyish-white.

Mr. Troughton found these animals living in small mobs in thick prickly acacia scrub.

(5) Cat. Mars. and Monot. Brit. Mus., p. 20.
(6) N. Dict. d'H.N., (2) XVII., p. 35, 1817.
(7) Cat. Mars. and Monot. Brit. Mus., p. 19.

COMPARATIVE BODY MEASUREMENTS IN MILLIMETRES OF *MACROPUS GIGANTEUS; MACROPUS G. TASMANIENSIS; M. FULIGINOSUS.*

	Head and Body.	Tail	Hind Foot	Tibia.
Macropus giganteus.				
British Museum .. .. ♂	1500	920	337	
Taronga Park .. .. . ♂	1120	830	325	460
Australian Museum				
M 3234 ♀	770	695	304	410
Macropus g. tasmaniensis.				
British Museum .. .. ♂	1350	1000	359	
Hobart Museum .. .	1400	1000	380	555
,, ,, D 602	1230	970	360	437
Macropus fuliginosus.				
Australian Museum				
S 1557 ♀	917	640	270	325
M 2816 ♂	1091	950	319	390
M 2818 ♂	869	661	280	330
M 2819 ♂	889	740	264	355

COMPARATIVE MEASUREMENTS IN MILLIMETRES OF SKULLS OF *MACROPUS GIGANTEUS; M. G. TASMANIENSIS; AND M. FULIGINOSUS.*

	Greatest length	Greatest width	Nasal length	Nasal greatest breadth	Nasal least width	Interorbitae breadth	Palate length	Diastema	Basi cranial axis	Basi facial axis	Length lower incisor	Breadth lower incisor
Macropus giganteus.												
Australian Museum—												
M 3234 ♀	159	79	64	20		18	93	43	38	100	23	9
S 1574 ♀	173	87	69	23	15	24	108	53			20.5	6
S 1000	193	99	87	30	20	30	134	64			24	9
British Museum ♂	196	108	86	30	18	27	138	67	52.5	145		
Macropus g. tasmaniensis.												
Hobart Museum	193	102	82	25				55				
Macropus fuliginosus.												
Australian Museum—												
2816 ♂	176	112	70	27	19	30	116	55			24	10
S 1557 ♀	152	92	55	22	14	24	116	43	48		21	10
Adelaide Museum—												
♂	173	104	64	25	15	28	119	55	49	150	23	10

THE "HONEY MOUSE," *TARSIPES SPENSERAE* GRAY.

By Ellis Le G. Troughton, Zoologist.

(Plate xxiii.)

(By permission of the Trustees of the Australian Museum.)

While engaged in general collecting, on behalf of the Trustees of the Australian Museum, in South-Western Australia at the end of 1921, I was very anxious to secure specimens of the elusive "Long-snouted Phalanger," *Tarsipes*. Once ranging from the Swan River about Perth to the eastward of Albany, these diminutive marsupials are apparently now restricted to small areas of the coastal districts of the extreme South-west. Even where they are plentiful, but few people have seen them as they go swinging with blithe agility from twig to twig, extracting honey from the flowers much as do our honey-eating birds, by thrusting their long, brushy tongues into the flowers. Alas, the time seems near when there will be no living representative of these unique little creatures to occupy the queer niche which the process of evolution has fashioned for them within its fabric.

Through the kindness of Mr. H. L. White, of Belltrees, Scone, I was placed in touch with Mr. F. Lawson Whitlock, of Tudor Siding, on the Albany-Denmark line, who had forwarded a specimen to Mr. White some time ago. It transpired, however, that the specimen had come from the property of Mr. David Morgan of the same district and, on Mr. Whitlock's advice, I assembled stores and gear and set out for Mr. Morgan's home. All there were kindness itself, and though I was prepared to camp out and cook for myself, Mr. Morgan established me in a comfortable room, passing my rations on to the capable hands of his hospitable wife. This last was a matter of great relief to me, not only because I am the worst of cooks, but also because it left me free to prosecute my quest.

The *Tarsipes* are known throughout the district as "Honey Mice," which is such an excellent vernacular name, when one considers the habits detailed later on, that I venture to submit it for general use. For several days I traversed acres of the countryside, peering under and through "Grass Trees" and the foliage of Bottle Brush and the local "Ti Tree" in search of the little marsupials, or their nests which, according to Mr. G. C. Shortridge, are "small round grass-nests, like a dormouse nest," placed "among the thinner branches of Ti-trees or Paper-barks." Various methods of trapping were tried, with baits composed of oatmeal and honey pellets or pure honey, but without success.

During my stay, however, other interesting specimens were secured and, though in the midst of the busy farming season, Mr. Morgan lent me every assistance, which included the use of a horse on which to extend the area of search ten miles coastward to the Leeuwin, where my volunteer guide and I stood and watched the sun set west of Australia.

Failure was not surprising, as all accounts in the Albany District confirmed Mr. Morgan's statement that the Honey Mice visit areas periodically, their movements doubtless depending on the flowery food supply, and that they are very rarely seen except when brought in by cats as trophies of the chase. Quoting Mr. Gilbert's notes, Gould wrote in 1863, in his Mammals of Australia, of the "rarity and difficulty with which it is procured. Notwithstanding the high rewards I offered, the natives only brought me four specimens."

Before leaving Albany fortunately I met Mr. Hugh Leishman, of Nannarup, near Albany, from whom I secured over a dozen specimens, including some pouch-young. These specimens had been brought in by house cats some years previously and, while hospitably offering to have me stay with him, Mr. Leishman held out no hope of my securing *Tarsipes,* which had apparently vanished from the district owing to the periodical burning off of the scrub and the ravages of cats.

A month or so after my return to Sydney the Honey Mice visited Mr. Morgan's home once more, and he forwarded two females captured by his cat, each with three pouch-young. As the animals rarely survived being mauled by the cat, a bottle of preservative was forwarded to Mr. Morgan with directions assuring that specimens of small mammals would not be wasted. So successful were his activities that he recently forwarded a splendid consignment of twenty *Tarsipes,* many with pouch-young, as well as five bats representing three species, and a native rat.

Some time ago Mr. Morgan wrote telling me he had secured two undamaged Honey Mice, and was keeping them in captivity. In reply I urged him to note down observations concerning them, and suggested the trial of various foods. As a result he has forwarded the following notes which are a tribute to his interest and patience, and it is with much pleasure that I record them here, acknowledging my indebtedness to him for the privilege. I append quotations from Gould and others, together with some observations of my own. Mr. Morgan says:—

"Previously I wrote you that I had Honey Mice in captivity. They were placed in a cage, three feet by two feet by one foot six inches, with two compartments, a ladder leading to the upper one in which we placed a fur-lined box for them to sleep in, with just a small entrance hole. The cage was supplied with slide doors so that we could clean it and supply food without handling the mice.

"We had two pairs at separate times, and each specimen died in from five to six weeks after being placed in the cage. They received every possible care, were lively, not timid, and partook of the food supplied, but as they died run down and emaciated we decided not to keep any more, concluding that it was impossible to keep them in captivity.

"*Food.*—We supplied them with bee's honey on which they gorged themselves. Alongside of the honey pot we placed a pot containing fresh water. Their habit was first to take honey and then water in the same manner, which was by darting out their tongues and drawing them back. We tried milk, as advised, which they never touched, also apples, sound and in decay, which they hardly touched. We also supplied a big bunch of native shrubs in blossom each day, which they climbed over, sucking the honey from the flowers with their tongues. They were very fond of the Bottle Brush, which appeared to us to contain nothing, and seemed to run all the spikes through their mouths, turning them down and nosing all about the cone of the flower as if there was some substance, such as gum, pollen, or other matter which they required.

"In this locality some variety of shrub is in bloom all the year round, which would enable the Honey Mice to secure a continuous supply of honey food, pollen, etc. Apparently they exist solely upon flowers, which means that it would require thousands of flowers each day to feed one mouse, and it would therefore be impossible to provide food for them in captivity. When first placed in the cage, they so gorged themselves with the ordinary honey that they seemed sick.

"*Habits.*—They seem, like opossums, to be nocturnal, which we concluded by

the time they were most active in the cage, and also by the fact that the cat brings them in generally in the evening, at dusk or later, or in the early morning. For a considerable time, we noticed that the cat generally brought us in a pair within twenty-four hours, and concluded that they were about in pairs, as the cat would then go for months without bringing any in.

"Your jar was filled owing to the cat finding what I think was a colony of them, as he brought them in every day for awhile; females first, then at last a few males. We watched him going out after them in the evening; there was a lot of Bottle Brush in flower around the edge of the clearing and the cat was getting them there. It is evident to us that they move about in colonies, and that their movements are guided by the flowers. That is, when the Ti-tree is out in bloom, they live there; when the Bottle Brush is in bloom they come out on to the wetter flats, and when the gums are blooming they go to them; this, I am almost certain, is their habit, and that they have no fixed abode, but are on the move in the locality all the time.

"They hang by their tails, being quite at home, feeding upside down if necessary. In climbing over leaves and twigs, they hold on with their tails and steady themselves as they seek amongst the leaves. Their agility in moving about is marvellous, and the weakest twig seems to bear them quite easily. The act of steadying themselves by gripping a stem with the tail, brings together the leaves as they hang over seeking their food, and they can thus move about without danger upon the very extremity of any tree.

"They roll themselves into a ball when sleeping, feet, legs, head and tail being hidden in the process, so that there seem to be no extremities."

The above interesting information is sufficient proof that Mr. Morgan's efforts to keep the animals alive were not in vain, though it is not surprising that he found it impossible to keep in captivity creatures so highly specialised, both in constitution and diet. He concluded that the Honey Mice fed solely upon the honey and pollen of flowers, though they are known to feed upon soft-bodied insects, such as moths and flies. It was doubtless the lack of this part of their diet, coupled with gorging upon refined honey and the absence of accustomed freedom and exercise, which proved fatal. The ancestors of *Tarsipes* were evidently mainly insectivorous, so it is to be expected that their descendents should retain a liking for insects during the transition to a mainly honey-eating existence, particularly as they must encounter many insects caught in the honey to maintain their penchant for insects as food.

Quoting Mr. Gilbert's notes Gould (*loc. cit.*) has written:—"It is strictly nocturnal, sleeping during the greater part of the day and becoming exceedingly active at night; when intent upon catching flies it would sit quietly in one corner of its cage, eagerly watching their movements, as, attracted by the sugar, they flew around; when a fly was fairly within its reach it bounded as quick as lightning and seized it with unerring aim, retired to the bottom of the cage and devoured it at leisure, sitting tolerably erect and holding the fly between its forepaws, and always rejecting the head, wings and legs.

"The artificial food given it was sopped bread made very sweet with sugar, into which it inserted its long tongue precisely in the way in which the Honey-eaters among birds do theirs into the flower-cups for honey; every morning the sop was completely honey-combed, as it were, from the moisture having been drained from it by the repeated insertion of the tongue; moistened sugar on the end of the finger would attract it from one part of the cage to the other, and an opportunity may be readily obtained for observing the beautiful prehensile structure of the tongue, which I have frequently seen protruded for nearly an

inch beyond the nose. The tail is prehensile, ... the ears are generally carried quite erect.

"When sleeping the animal rests upon the lower part of the back, with its long nose bent down between its fore-feet and its tail brought over all and turned down the back.

"Mr. Johnson Drummond shot a pair in the act of sucking honey from the blossoms of the *Melaleuca;* he watched them closely, and distinctly saw them insert their long tongues into the flower precisely after the manner of the birds above-mentioned."

When he forwarded the specimen, or specimens, which Gray described in the Annals and Magazine of Natural History in 1842 as *Tarsipes spenserae,* Captain Grey wrote the following observations, which Gray quotes. "The most interesting of these specimens, I think, is a representative of the family *Insectivora,* not, I believe, before found in Australia; it inhabits the low scrubby and heathy-looking bushes near King George's Sound, and can only be got at by setting the scrub on fire. I have a second species of this animal, which differs from the one I have forwarded in being larger and somewhat differently marked; it is however possible that this may be only a variety and not a distinct species. I have yet only obtained three of these animals."

A few months later Gray received a brief account of the habits of *Tarsipes* from Mrs. Grey, which he published in the same work in 1843, as follows:—"We had two of them for some time in our possession; the first specimen which is sent home died, I fear from starvation, for I was told that they feed on roots and nuts; but this I found was a mistake, for they are carnivorous and feed on moths and flies, at least the last we had did so; it used to take the moths, etc., by their two wings, holding them by its fore-paws; it ate the bodies, and the wings it threw away. I never saw it drink. It generally slept during the day rolled up like a ball, but of a night it became very lively, and was fond of climbing branches of trees; it would hang suspended by its tail to a small branch, and suddenly jump to another. They were both found by men while ploughing, lying in a nest of grass and fur in a state of stupor. The last lived for many months, and made its escape from us." "It was a great pet" added Captain Grey.

It may be noted that Mrs. Grey's account differs from foregoing ones in two respects. According to Shortridge's notes, and Lydekker's Royal Natural History, the nests are built in the taller trees, whereas Mrs. Grey's account suggests that the nests of "grass and fur" were found in, or near, the ground during ploughing. Gilbert's notes did not refer to *Tarsipes* drinking, and Mrs. Grey mentions that she "never saw them drink." Mr. Morgan's captives ate honey and drank water alternately, but this may have been due to thirst engendered by eating the refined honey.

Nomenclature.—The genus and species was first made known by Gervais and Verreaux who exhibited drawings of specimens in the Paris Museum at a meeting of the Zoological Society of London in January, 1842. These were obtained from the Swan River, W.A. They named the animal *Tarsipes rostratus,* but their description of it was not published until June of that year. In the meantime, specimens were received at the British Museum from Captain George Grey, who obtained them from King George Sound, W.A. These were described in the Annals and Magazine of Natural History for March, 1842, as *Tarsipes spenserae,* and as this name was apparently published before that given by Gervais and Verreaux, it unfortunately must be used instead of the well established name of *Tarsipes rostratus.*

The change of nomenclature was discussed by Palmer in 1904 in his Index Generum Mammalium, which paper is unfortunately not available to me.

Family PHALANGERIDAE.
Sub-family TARSIPEDINAE.
TARSIPES SPENSERAE Gray.

Tarsipes spenserae Gray, Ann. Mag. Nat. Hist. (1), ix., March, 1842, p. 40.

Tarsipes rostratus Gervais and Verreaux, Proc. Zool. Soc., June, 1842, p. 1.

Tarsipes rostratus, Thomas, Cat. Mars. Monotr. Brit. Mus., 1888, p. 133—*vide* references and synonymy; Id., Parker, Stud. Mus. Dundee, i. art. 7, 5 pp. 1pl.; Id., Caruccio, Boll. Soc. Rom., Zool., v., 1896, p. 147 (note); Id., Bensley, Trans. Linn. Soc., (2) ix., Zool., pt. 3, 1903, pp. 134-5, 169-170, 199, 210.

Text figure.—Showing the diprotodont lower incisors, lip flanges and the prehensile bristle-coated tongue and naked tail-tip. In the foot, note the widely separated and opposable first toe and the double nail of the united 2nd and 3rd toes.

A. R. McCulloch, del.

Tarsipes spenserae, Palmer, Index Generum Mamm., 1904, p. 664—footnote; Id., Thomas, Proc. Zool. Soc., 1906, pts. 3 and 4, pp. 475 and 770; Id., Shortridge, Proc. Zool. Soc., 1909 (1910), pt. 4, p. 826, text-fig. 261; Id., Gregory, Bull. Amer. Mus. Nat. Hist., xxvii., 1910, p. 215-6.

Description.—To supplement the above notes a brief description of the Honey Mouse should not be amiss. The fur is short and coarse, and the general colour is greyish-brown above with a dark brown stripe down the middle of the back from the back of the head to the tail-root; on each side of this central stripe are two lighter brown sub-lateral ones. There is a rufous tinge on the flanks and shoulders. The undersurface is buffy-grey.

Of small size and slender form it is admirably adapted for its arboreal life; the tail is longer than the head and body, cylindrical, tapering, thinly haired and prehensile, about 6 mm. of the underside of the tip being naked. There are five digits in both the fore and hind feet, the latter exhibiting the extreme form of syndactyly, in which the second and third toes are bound together to their tips by a common skin, so that they appear as a single toe which possesses two toe-nails.

The first digit of the long hind-foot is freely opposable to the others, as in all Phalangeridae, the whole member forming a gripping organ of the greatest use in climbing; from the small size of the nails, which are mostly embedded in fleshy parts and do not project beyond the toe-pads, the toes appear better adapted for grasping small twigs than for ascending tree-trunks.

The tongue presents the most striking evidence of the adaptation of the animal; it is elongate and very protrusile, so that it may be thrust into the bells of flowers; the upper surface is thickly coated with short erect bristles which are longer anteriorly and are produced into a lengthened tuft at the tip. The ridges of the palate are pronounced and so shaped as to suggest that they are of assistance in scraping glutinous food from the tongue-bristles as that organ is thrust out for a fresh load. Each lower lip is provided with an up-standing, naked, compressed flange anteriorly, which projects forward, and with its fellow forms a bifurcate lobe. These flanges close within similar, but less developed flanges on each upper lip, so that when the mouth is partially closed they form a channel, possibly to convey the honey sucked in from the flowers. The snout is very long, slender, and tapering; the eyes are placed very close together, about midway between the ear-bases and the nose-tip; the ears are rounded and of medium size.

The lower mandible is long and slender and the posterior end of each ramus lacks the pronounced inward bend, or inflection, which distinguishes every other species of marsupial from the placentals.

The characters of the teeth, degenerated from the original ancestral form, are highly specialised in their adaptation to a pulpy and honey diet. The teeth represented are:—the upper incisors; the diprotodont lower incisors, which are long and frail, and like all the teeth, semitransparent; the upper canines; the cheek-teeth, which are represented by a varying number of undifferentiated vestigial teeth.

The scrotum is very large, pendent and hairy. The pouch is large and well developed, but has only a very small opening, judging by specimens in preservative; there are four mammae or teats; in one female in the Australian Museum, the pouch contains four mammary fetuses, though the opening is only about 9 mm. long. Another small female with a head and body length of 70 mm., and a tail 82 mm. long, has two mammary fetuses in its pouch; the head and body of one of these is 26 mm. long, the measurement being taken from the crown (the head being bent at right-angles) to the tail-root; the tail of this juvenile measured 19 mm. The number of young in the pouches ranges from one, with traces of a second having been upon a teat, to four. The head and body length of the female with four young in the pouch is 73 mm., and the tail length is 82, while in one of the four young the head and body measure 18 mm., and the tail 10 mm.

The very large size of some pouch-young, as compared with the size of the parent and the pouch-opening, gives rise to conjecture as to how it is possible for the female to shelter four young within the pouch, each approximately 16 mm. long, until they are able to fend for themselves. If she does not, one must suppose that she discards one or more of her offspring, or leaves some in the nest after they attain a certain size.

The females attain a larger size than the males. The head and body length of the largest male is 71 mm.; tail-length 95. Head and body of the largest female 86, tail 101.

Aboriginal names are "Tait," "Noolbenger," and possibly "Deed," the latter name being quoted by Shortridge.

Origin and evolution.—So unique amongst marsupials is the Honey Mouse that it occupies a sub-family entirely to itself. This, the Tarsipedinae, is a division of the family Phalangeridae. It is characterised, as Bensley expresses it, by a dental retrogression, in opposition to the development of a more advanced stage of arboreal elaboration in the hind feet, than is found in the other sub-families of the Phalangeridae. An evidence of this progressive arboreal elaboration is found in the great enlargement of the fourth toe which, like the fifth, is provided with a nail instead of a claw, as in the placental Primates. The second and third toes are united under a common skin, their distinction being indicated externally only by the two nails which remain divided. Professor Wood Jones, in Part 1 of his "The Mammals of South Australia," classes this syndactylous condition of these toes as "in all probability, a structural adaptation to the function of performing the toilet of the coat . . . not a degeneration from disuse, or an instrument for use in climbing, but as a specialised toilet implement."

At one time the primitive appearance of the dentition and its arrangement, such as is found in *Tarsipes* and *Myrmecobius,* was believed to be due to their retention of the dentition of very primitive ancestral forms. Latterly, however, such authorities as Bensley consider *Myrmecobius* has really undergone a specialisation in development, characterised by incipient retrogression from the normal dentition of the Dasyuridae as a result of adopting the ant-eating habit.

It might be supposed that the dental characters of *Tarsipes* represent those of some primitive form which lived upon honey, and gradually acquired an insectivorous habit as a result of eating insects caught in the honey. It seems that the exact reverse has taken place, however, and that *Tarsipes* dentition represents a retrogression from an ancestral form. As Bensley puts it in his admirable paper quoted in the synonymy above, "The exact dental relations of *Tarsipes* with the remaining Phalangeridae are doubtful, and its mode of origin can only be conjectured from the association of its reduced dentition with its mellivorous habit. It is extremely probable that the omnivorous evolution of the Phalangeridae began with diminutive animals which, like *Acrobates, Distoechurus,* and *Dromicia,* were able to live among the smaller branches of trees, and to supplement their insectivorous fare with blossoms and honey. Certain of these must have continued the omnivorous evolution in a normal way, giving rise to the Phalangerinae and Phascolarctinae, while others resorted largely to a mellivorous habit, giving rise to *Tarsipes.* The reduction of the dentition is due to the same cause as in ant-eating forms, the food requiring no mastication, and its collection being perfectly provided for by the prehensile development of the tongue."

Thus the retrogressive specialisation of the dentition is considered to have been brought about as the result of changing from the original insectivorous, through the succeeding omnivorous, to the present devotion to a honey and soft-

bodied insect diet. The ancestors of *Tarsipes* were doubtless entirely insectivorous, having strong teeth and eating hard-bodied insects with ease. This diet was eventually supplemented with flowers and honey, and as the proportion of honey food increased, there were corresponding modifications of the dentition, so that now only the very soft bodies of insects can be assimilated.

Need for protection.—In conclusion, I may point out that *Tarsipes*, one of the most interesting of our fascinating marsupials, appears to be rapidly approaching extinction after a brave struggle and survival from ages beyond human ken. This is greatly to be regretted and is attributable to several causes. Chief among these are the activities of introduced, as well as native enemies, and the necessity for burning off large tracts of scrub every few years as a check upon the growth of poisonous plants.

Tarsipes is dependent upon the flowers and foliage of its native districts, and as paddocks have to be burnt off about every third year, the tiny marsupials are literally hunted from paddock to post and prevented from settling in any one area. Before the rapid advance of Western Australia's settlement schemes, the history of Mr. Leishman's property must be repeated, until the barren districts overlap, and fire and other enemies will send the Honey Mice to join their fossil forbears in comparative oblivion, leaving them represented only by a few museum skins and stray skeletons.

It is obvious that the interests of the fauna, even of such as *Tarsipes*, must give way to the needs of settlement and the productivity of properties. Therefore let me plead, with all sincerity, for the immediate setting aside of some small section, or sections, of the south-western corner of Western Australia as a national reserve. Flowers of exquisite beauty, and mammals of intense interest abound there, one sometimes being dependent on the other as in the case of *Tarsipes*. But much of this unique fauna and flora must disappear before the rapid advance of settlement.

Though I was fortunate in securing three Banded Ant-eaters, *Myrmecobius fasciatus*, in Western Australia, this animal, which is no less interesting or specialised than *Tarsipes*, can now only be found in a greatly restricted area. Among other instances of a fading fauna may be cited the two Rat Kangaroos, *Potorous platyops* and *gilberti* of Gould, neither of these species having been recorded since 1840, when Gilbert collected both near King George Sound. Again, Mr. J. T. Tunney, whose fame as a collector is world-wide, informed me that I could only hope to get the Crescent Wallaby, *Onychogale lunata*, along one obscure river, and a forlorn hope at that. Such a wallaby should be energetically sought, trapped, and placed, not in Zoological Gardens, but in the haven of a properly supervised national reserve.

In opposition to such reserves, it may be claimed that adequate supervision cannot be exercised, and that hunters will kill out the fauna, but it is essential to realise that the animals most urgently needing protection in south Western Australia are the Honey Mice and Banded Ant-eaters, neither of which will be hunted for monetary gain or "sport." Should the vanishing Crescent Wallaby be placed in a reserve, a heavy penalty could be inflicted on its destroyers. In the event of any animal in the reserve increasing rapidly enough to menace the surrounding properties, it could be judiciously thinned out by government order.

It would be strange indeed, however, if the establishment of a reserve caused alarm when the spread of the rabbit in the south-western corner of Australia arouses no apparent concern. One might have supposed that the ravages of rabbits, and subsequent economic losses elsewhere in Australia, would have led

to a most careful maintenance and supervision of rabbit-proof fences, and strenuous efforts to check the rabbits' advance. Such is the isolation of Western Australia, however, and the outlook caused by State control of such matters, that the pest has been allowed to become firmly established in many localities which I visited.

This introduction of rabbits must seriously affect the local fauna, and the only adequate method for dealing with the problems involved appears to lie in the appointment of a Commonwealth Bureau of Biological Survey, with advisory committees in each State. But the establishment of this recently mooted and much talked of Bureau will take a long time. Meanwhile one can only urge the Western Australian Government to extend the utmost consideration to their marsupial fauna, some members of which are in immediate peril of extinction, by the proclamation of adequate faunal reserves.

Apart from their scientific importance, Honey Mice are indirectly allies of man as insect-eaters. As a Museum worker I am glad to make this appeal for the protection of the native fauna, as such workers are often supposed to care only for dry-as-dust skin and bone, whereas the more dead animals we see, the more we wish to see them alive. Therefore let us unite in establishing national reserves for our hunted creatures, and thus prevent a gradual fade-out of the fauna and preserve representatives as a legacy to posterity.

My sincere thanks are due to Mr. and Mrs. F. Lawson Whitlock for their great hospitality during the days I was fortunate enough to spend at their home. To Mr. L. Glauert and other authorities of the Western Australian Museum, and the Government of Western Australia, all having shown the greatest consideration towards me as a visiting collector, the latter affording me most liberal railway concessions. Nearer home I wish to acknowledge indebtedness to my friend, Mr. Allan R. McCulloch, for his preparation of the accompanying text figure.

NEW AUSTRALIAN POLYPLACOPHORA, AND NOTES ON THE DISTRIBUTION OF CERTAIN SPECIES.

By A. F. Basset Hull.

(Plates xxiv.-xxvi.)

Part I.

Since the publication of a paper containing descriptions of new and notes on other Australian *Polyplacophora* (1):I have carried out a fairly comprehensive examination of the shores of Port Jackson and the coast northward to Broken Bay and southward to Port Hacking. Several new species have been discovered, and a considerable amount of information has been gathered as to the distribution of some of the rarer species. On most of my excursions I was accompanied by enthusiastic friends, to whose assistance I am much indebted.

South of Port Hacking my researches have extended to the Illawarra district, including Thirroul, Austinmer, Bulli, Wollongong, and Shellharbour, at which last-mentioned place I have had valuable help from Mr. G. McAndrew, who has followed up my initial examination with an exhaustive search, resulting in the accumulation of a magnificent series of rare species.

Further south on the New South Wales coast I have collected at Bateman's Bay and Montague Island, while to the north of Sydney I have examined Port Stephens, Broughton Island, Forster, Port Macquarie, and Coff's Harbour.

In July, 1921, I went direct by steamer to Rockhampton, Queensland; collected at Emu Park, the nearest suitable locality in Keppel Bay; and proceeded thence to Gladstone (Port Curtis), Facing Island, Bundaberg, and Caloundra, a point on the mainland immediately north of Bribie Island. In August, 1922, I revisited Caloundra, and extended my researches northward to Point Cartwright, Alexandra Headland, and Noosa Head.

During November and December, 1921, I visited Albany, Western Australia, collecting in Queen Charlotte Sound and King George Sound. From thence I visited Bremer Bay, Hopetoun, Esperance Bay, Lucky Bay, and several islands of the Archipelago of the Recherche.

Lastly, in December, 1922, I visited King Island in Bass Strait.

For valuable assistance and companionship on many of my excursions my acknowledgments are due and gratefully accorded to Mr. and Miss Foote, Buderim, Queensland; Messrs. H. S. Grant, J. H. Wright, W. Barnes, A. Livingstone, E. L. Troughton, and F. MacNeil, of the Australian Museum staff, G. and R. Lewers, and J. Webb. Mr. Charles Hedley, of the Australian Museum, to whose kindly encouragement and valuable advice I owe much, also accompanied me on numerous occasions.

The principal results of the above excursions are set out in this paper, and I have added notes relative to shells collected for me by Mr. Percy Hazell, of H.M.S. *Fantome,* at Pender Bay, N.W. Australia, Mr. S. W. Jackson, at Foul Bay, S.W. Australia; Mr. H. L. White, of Belltrees, N.S.W., at Thursday

(1) Hedley and Hull, Rec. Aust. Mus., 1909

Island; and Professor Harvey Johnston at Caloundra and Redcliffe, Queensland.

Owing to the immense extent of country covered by myself and my collecting friends, embracing points on the whole continent of Australia from Torres Strait to Bass Strait, and from the extreme east to the furthest west, but leaving great gaps of the coast untouched, these notes are necessarily disconnected to a degree. As my own journeys have aggregated over 10,000 miles, out from Sydney and return, and my correspondents have unitedly covered an even greater distance, it will be seen that the field has been a large one, embracing the tropical, semi-tropical and temperate zones. Nevertheless, I venture to place the results in one paper, relying on the limited scope of the investigations, relating as they do to the one Molluscan group, to justify my action.

The types of the new species described in this paper are in the Australian Museum, Sydney.

The plate figures were drawn by Miss Phyllis Clarke (Mrs. Arthur North).

Parachiton puppis, n.sp.

Plate xxiv., figs. 1-5.

Shell large for the genus, elongated, moderately elevated, dorsally rounded. Colour when alive, chalky white, which becomes stained to a pale buff when dried with the animal intact. The sculpture is uniformly grain-striate. Posterior valve abnormally large.

Anterior valve densely radially grained, upwards of 100 of the minutely grained striae may be counted at the anterior margin.

Median valves moderately broad, with straight posterior edge, frequently showing irregularity of outline owing to injury, and with a forward curve at the sutures. Lateral areas distinctly raised, radially striate, crossed by 3 or 4 deep growth lines; central areas longitudinally grain-striate, the granules larger than those on the lateral areas.

Posterior valve disproportionately large, with mucro prominent and projecting posteriorly. The central area regularly longitudinally sculptured; the posterior area radially striate.

Girdle densely clothed with small, very elongated, pointed scales; not marginally spiculose.

Interior pearly white; sutural plates rounded; sinus very broad and shallow, the projecting ends of the grain-striae of the tegmentum imparting a finely pectinated appearance to the jugal sinus.

Dimensions: 12 x 5½ mm. (dried).

Station: Under stones in sand or mud below low water mark.

Habitat: Bottle and Glass Point, Vaucluse, Port Jackson, N.S.W.

Remarks: The first example of this interesting shell was taken by me, in company with Mr. Charles Hedley, on 15th February, 1919. It was badly crushed, a fracture extending along the jugal tract and affecting all the median valves. On 13th January, 1922, Mr. Gerald Lewers was collecting with me near the spot where the first shell was taken, and he found a second specimen which became similarly fractured owing to the pressure in tying it down on the collecting slip. Again, later in the same year, Mr. W. Barnes, collecting with me, found a third specimen almost on the same spot as the second. The animal was very large, soft, and distended with water, the foot extending laterally beyond the shell on both sides. When dried, the body contracts forward, leaving the gill rows distinctly arranged in the posterior cavity. Extreme care was taken in preserving this specimen which dried gradually, made a perfect specimen and forms the type figured. Mr. Barnes has since taken three more specimens in the same locality, one of which has been disarticulated and placed with the type shell.

Another is larger than the type, being 10 x 8 mm. This shell differs from any other member of the genus in its extraordinarily long posterior valve, the shape of which, in its resemblance to the stern of a cruiser, suggested the specific name.

TERENOCHITON ERRATUS, n.sp.

Plate xxiv., figs. 6-9.

Shell small, elongate, delicate, low, rounded. Colour rosy-pink when alive, becoming dull white in dried specimens.

Anterior valve very densely covered with minute grains arranged radially in about 100 rows.

Median valves: lateral areas differentiated by the direction of the radial rows of grains, of which there are six principal rows splitting into twenty at the margin. Central areas with about twenty longitudinal rows of similar grains on each side, rather more widely spaced, and diverging outwardly towards the margin.

Posterior valve normal size for the genus; the mucro behind the centre, the posterior area concave, similarly ribbed to the anterior valve; pleural areas as in the median valves.

Girdle densely covered with small ovate scales; margin spiculose.

Interior white; sutural laminae small, angulate, distant.

Dimensions: 5 x 3 mm.

Station: On the under side of stones in deep water (below low water mark).

Habitat: Rabbit or Mistaken Island, King George Sound, Western Australia.

Material: Seven specimens.

Remarks: This shell differs from *Terenochiton* (*Lepidopleurus*) *badius* Hedley and Hull and *matthewsianus* in the disposition of the radial grain rows. Larger examples than the type were taken, up to 10 mm. in length; but, owing to their extremely fragile nature, they became longitudinally split.

TERENOCHITON BADIUS.

Lepidopleurus badius Hedley and Hull, Rec. Aust. Mus., 1909, p. 260.

I took several examples of this species at Point Cartwright, Queensland, a considerable northward extension of its range.

ISCHNOCHITON LUTICOLENS, n.sp.

Plate xxiv., figs. 10-13.

Shell small, elongated oval, not carinated. Colour buff or pale brown, sometimes stained with blackish-brown.

Anterior valve densely covered with minute granules, not arranged in any definite pattern.

Median valves with moderately raised, rounded lateral areas, covered with elongated oval granules diverging outwardly; central areas with granules diverging inwardly, rather larger and more clearly defined than those on the lateral areas

Posterior valve with granules as on the anterior valve, but tending to radiate, central areas similar to the median valves; mucro in front of the middle; the posterior portion concave.

Girdle densely clothed with minute striated scales.

Interior white. Anterior valve with 15, median valves 1, and posterior valve with 13 slits.

Dimensions: 11 x 6 mm.

Station: On the under side of small stones embedded in mud, below low water mark.

Habitat: Port Curtis (Barney Point), Queensland.

Remarks: This shell was found in considerable numbers in a locality that did not at first sight appear very promising. A stretch of mangrove-fringed, muddy shore is broken by Barney Point, a low headland having a stony beach. Below low water mark there are many loose stones embedded in the characteristic viscous blue mud of the mangrove swamps. On the under sides or at the edge of insertion of these stones this shell was found associated with *I. arbutum* Reeve. The only other species found on the Point was the common Port Curtis shell *Sycoumopleura curtisiana* Smith, which occupied the surface of a few larger stones above low water mark.

Ischnochiton examinandus, n.sp.

Plate xxv., figs. 1-4.

Shell rather small for the genus; broad, moderately elevated, carinated, side-slopes convex. Colour: shell covered with a reticulated pattern in dull pink, having darker brownish-pink mottlings. Scattered irregularly over the anterior valve, in the central areas, and (in some valves) on the jugum, are blotches of yellowish maculated with dark greenish; the whole having a distinctive marbled scheme of pink and green. The whole shell is rather coarsely granulose, the grains being low, flattened and polished.

Anterior valve with obsolete radiation; the lines tending to undulate towards the margin.

Median valves: Lateral areas faintly radially ribbed, two ribs, splitting to three or four towards the margin, traversed by longitudinal undulating growth lines; central areas with granulations arranged in quincunx, having lines radiating outwards.

Posterior valve: Mucro in front of the middle; areas similar to those of the anterior and median valves; slightly concave posteriorly.

Girdle densely clothed with very minute, flat, regularly striate scales; the colour mottled pink and yellowish.

Interior rose-pink. Slits 10—1—10.

Dimensions: 14 x 8 mm.

Station: On dead shell of *Turbo stamineus*, in rock pool, at low tide.

Habitat: Long Reef, near Manly, New South Wales.

Remarks: The figures (1-3) show colour pattern, the sculpture being inconspicuous. The type shell was taken by me in company with Dr. Torr, who also took one specimen, rather badly fractured. Dr. Torr's specimen was similar in colour to the type, except that the dark greenish blotches were less marked. The radial lines on the lateral areas were more distinct; the anterior valve was smooth, but the posterior valve showed numerous fine radial riblets. I have since taken several more examples in Port Jackson; Barnes has taken nine examples at the Bottle and Glass (Vaucluse), and McAndrew has taken two or more at Shellharbour. A closely allied shell from southern Queensland is next described.

Ischnochiton examinandus laetior, n.sub-sp.

Plate xxiv., figs. 14-17.

At Caloundra and Point Cartwright, Queensland, I collected a fine series of shells somewhat similar to the preceding species, showing a wide variation in colouration, some being typical pink-and-green marbled specimens, while others

ranged from ochraceous to deep pink, and several were decorated with a broad white dorsal stripe varying in breadth, disposed somewhat after the manner of the common colour pattern of *I. proteus* Reeve.

The sculpture in all, even the smallest, of the Queensland shells, is more marked than that of the Long Reef (N.S.W.) shell. The station is below low water mark, or in deep pools and crevices in the rock; it is always on the under side or at the edge of insertion of small stones in clean sand.

This is the shell which has been recorded from Queensland as *I. crispus* Reeve by Iredale and Ashby. It can be easily separated from that species by the smaller girdle scales and generally greater breadth.

Callistochiton granifer, n.sp.

Plate xxv., figs. 5-8.

Shell small, broad, not carinated. Colour buff, with a few scattered chocolate spots. The sculpture generally consists of coarse granules, mostly uniform in size, but very irregularly arranged, and becoming slightly larger towards the periphery.

Anterior valve with 15 radiating folds, with very narrow interstices, becoming obsolete posteriorly. Apex emarginate.

Median valves: Lateral areas distinctly differentiated; two submarginal rapidly increasing, elevated radial ribs, irregularly granose, their own breadth apart; the posterior shelf has the granules more regularly longitudinally arranged. Central areas with irregular rows of granules, crowding, and becoming smaller towards the jugum.

Posterior valve: Mucro elevated, central, posterior half with 12-13 folds corresponding to those of the anterior valve; anterior half with granules radially disposed, sharper and more regularly arranged than those in the central areas of the median valves.

Girdle densely clothed with uniform fluted scales.

Dimensions: 9 x 5½ mm. (dried and somewhat curled).

Habitat: Palm Island, Queensland.

Station: Dredged in 15 fathoms.

Material: One adult specimen.

This shell was obtained by Mr. Charles Hedley, of the Australian Museum. It differs from all other species of the same genus in the peculiarly separated character of the granules which form the sculpture.

Callistochiton antiquus.

Chiton antiquus Reeve, Conch. Icon., 1847, t. 25, f. 169.

Ashby has been investigating the Australian species of this genus, and has described two new subspecies from South Australia and Tasmania respectively. (Trans. Roy. Soc. S. Aust., 1919, p. 400). The addition of *C. granifer* and the accumulation of specimens from other parts of Queensland and Western Australia lead me to consider that this genus requires very careful study. Iredale now informs me that Reeve's type is the common Port Jackson shell, and that the shell described by Smith from Port Molle is distinct. [*Chiton* (*Callistochiton*) *antiquus* Smith, Rep. Zool. Coll. *Alert.*, 1884, p. 79.] For the present I content myself with mentioning that examples from Shellharbour, New South Wales, are of unusual dimensions. Reeve's type is stated to be 17 x 10 mm. One from Shellharbour in my possession, taken by McAndrew, is 33 x 17 mm.

Genus Rhyssoplax, Thiele.

In "The Chitons of the Kermadec Islands," (Proc. Mal. Soc., vol. xi., pt. 1, 1914, p. 39), Iredale gives his reasons for adopting Thiele's name *Rhyssoplax* (1909) for certain Australasian shells previously assigned to the genus *Chiton* Linne (1758). He says: "Whether the species is heavily sculptured like *Ch. canaliculatus* Quoy and Gaimard, and *Ch. vauclusensis* Hedley and Hull, or practically smooth, as *Ch. translucens* Hedley and Hull, the internal structure is exactly comparable." On p. 40 he says: "As noted previously, species referable to the genus *Rhyssoplax* vary from very heavily sculptured forms to absolutely smooth species. I examined a series of *Chiton aereus* Reeve, and found that the most juvenile specimens were unsculptured, then the sulcations on the pleural areas appeared before the lateral radial ribbing was formed. This implies that the primitive form was unsculptured, and the sculptured forms are more recent. It is most interesting from this point of view to study the Australasian *Rhyssoplax* when we find this primitive form surviving unchanged in the species *Chiton translucens* Hedley and Hull. The next stage is well known by means of *Ch. jugosus* Gould, *Ch. coxi* Pilsbry, etc., and the third stage by such species as the succeeding one (*Rhyssoplax exasperata* Iredale) and *Ch. aereus* Reeve. A further development of stronger and more pronounced sculpture still is seen in *Ch. canaliculatus* Quoy and Gaimard, and *C. vauclusensis* Hedley and Hull."

Chiton vauclusensis and *C. translucens* were described by Hedley and myself in 1909, the types being taken in the same locality. Subsequent experience has shown that these two species, representing the most primitive and most highly developed stages of the genus, are almost always found in company, and in very limited areas.

Rhyssoplax translucens.

Chiton translucens Hedley and Hull, Rec. Aust. Mus., vol. vii., No. 4, 1909, p. 263.

The curious fact that this species was first taken in 1864, but remained unnamed until 45 years later is related in our original description. Its occurrence at Caloundra, Queensland, was also noted. Since 1909 I have taken specimens at Green Point on the eastern side of Watson's Bay, at Obelisk Bay, Port Jackson, almost opposite to the type locality (Bottle and Glass Point), on the coast exposed to the full force of the Pacific rollers at Deewhy Head, north of Sydney Heads, at Shellharbour, New South Wales, and at both Caloundra and Point Cartwright, Queensland. Mr. W. Barnes has taken a number at Green Point, one of which measured 55 mm. in length, as compared with 38 mm., the length of the type. One of the specimens I took at Point Cartwright was 53 mm., but it was damaged, valves 2 to 8 being broken along the jugum, probably by a boulder rolling in the surf. The numerous specimens thus taken show considerable variation in shade and disposition of the colour and markings, but the general pale olive and buff of the type are constant. Some of the juvenile shells show some brilliant red markings, and the whole range of specimens collected displays the remarkable clean, polished surface attributed to the type.

Rhyssoplax vauclusensis.

Plate xxv., figs. 9-12.

Chiton vauclusensis Hedley and Hull, Rec. Aust. Mus., vol. vii., No. 4, 1909, p. 261.

The type specimens of *R. vauclusensis* were taken by me in from 4 to 5 feet of water at low tide, in the year 1908. One specimen was 33 mm. in length, and was preserved intact as the type; the other being considerably smaller was dis-

articulated for examination of the interior characters. The sculpture of the smaller specimen was much less marked than that of the larger. Although many visits were paid to the type locality (Bottle and Glass Point, Vaucluse, Port Jackson) during the succeeding 14 years, no further examples of the species were discovered until 13th January, 1922, when Mr. Gerald Lewers, collecting in my company, found two beautiful specimens, the larger of which was 34 mm. in length. During the latter part of 1922 and early in this year, Mr. W. Barnes has taken three or four more specimens, all in the same very restricted locality.

In July, 1921, I visited Caloundra, and took two shells, 21 and 23 mm. in length respectively. The sculpture of these two shells was finer and the surface of the tegmentum so much more highly polished than the smaller of the type specimens of *R. vauclusensis* that I was inclined to assign subspecific or varietal rank to these Queensland examples. However, on again visiting Caloundra and Point Cartwright, 10 miles further north, in August, 1922, I secured a splendid series of shells, ranging from 6 to 36 mm. in length, showing the gradual development of the sculpture, and differing only in the more uniform nature of the colouring from the largest of the Port Jackson examples. This series illustrates in a marked degree the accuracy of Iredale's description of the development of typical species of the genus *Rhyssoplax*, as exemplified by his examination of a series of *R. aereus* Reeve. In the smallest shell the lateral areas are practically smooth, there being only the appearance of a broad shallow depression widening towards the sutural margin, but the central areas show distinctly the commencement of the transverse sulcations so marked in the adult, the shallow pits appearing anteriorly, just behind the margins of the anterior valve; while the ridges are indicated by lines of darker brown colour extending almost across the areas. In a specimen measuring 13 mm. the sulci and ridges of the central areas have become as clearly defined, and extend right across the areas, as in the adult, while the lateral areas merely show the depression a little more accentuated. In a specimen measuring 21 mm. the two outer margins of the lateral areas have become raised and developed into distinct ridges, showing a tendency to bifurcate distally, and the depression is now occupied by a distinct riblet. As the shells increase in size the riblets on the lateral areas split up until they reach the maximum number of 5 with an occasional sixth on the second valve. Amongst the shells taken at Caloundra were two exquisite ivory-white examples, both found on the one stone, one on the upper and one on the under side. The only colour on these shells consists of one or two small spots of rich sienna on the posterior margin of valves 1 to 7, and one spot on each side of the mucro on the posterior valve. Examination of typical coloured specimens shows that spots of a darker brown exist in corresponding positions in all cases.

Towards the end of 1922 Mr. G. McAndrew discovered a fine specimen of *R. vauclusensis* at Shellharbour, about 50 miles south of Port Jackson. This was a typical shell in all respects. He has since taken about 14 specimens, all adult, ranging from 28 to 41 mm. in length. This series shows greater diversity in colour-markings than the Port Jackson series, some showing longitudinal bands of whitish throughout or on each side of the jugum. One magnificent shell, 41 x 21 mm. is creamy white with the exception of the darker or blackish-brown spots in the same positions as on the Queensland albinos, and with a series of blackish-brown spots arranged in triangles with bases anteriorly on the central areas. These triangular clusters of spots are characteristic of the usual coloured shells.

The fine series of this shell, previously so rare, taken during the past two years, and resulting in an extension of its recorded range over a coast line of approximately 600 miles, has afforded me the keenest satisfaction, and incidentally enabled me to fill a long felt want in the cabinets of some of my friends. All

the circumstances attending the collecting of the series go to prove that it is very restricted in occurrence, being found in each case within very limited areas of only a few square yards in extent. It appears to be a deep water species, i.e., it is not found above low water mark; and it prefers a position on the under side or below the margin of insertion of small stones embedded in sand or even (as at Shellharbour) in mud.

Rhyssoplax carnosus.

Chiton muricatus A. Adams, P.Z.S., 1852, p. 91, t. 16, f. 6.
Lophyrus muricatus Angas, P.Z.S., 1865, p. 186, 1867, p. 222.
Chiton carnosus. } (Carpenter MSS) Angas, P.Z.S., 1867, p. 222.
Chiton limans. }
Chiton limans. } Pilsbry (Carpenter MSS), described.
Chiton aurantius, } Man. Conch., 1892, p. 176.
Chiton carnosus. }
Chiton limans Sykes, Proc. Mal. Soc., 1896, p. 93 (*nom. nov.* for *C. muricatus* Adams).
Rhyssoplax limans Iredale, Proc. Mal. Soc., 1914, p. 41.
Rhyssoplax jacksonensis Ashby, Trans. Roy. Soc. Vic., 1920, p. 153.

This species was named *Chiton muricatus* by Adams. Carpenter applied the names *carnosus* and *limans* to shells of this species, both from Sydney, but did not publish the descriptions. These names were quoted by Angas in his paper on the Port Jackson shells over fifty years ago. Twenty-five years later Pilsbry published Carpenter's MSS descriptions in connection with *C. muricatus* Adams, and reversed the order of the names. He also added Carpenter's description of the variety *aurantius*. A few years later Sykes, noting that Adams's name *muricatus* was preoccupied (Tilesius, Mem. Acad. Sci. St. Petersb., 1824, p. 483) proposed to rename the Port Jackson shell *limans* (from Carpenter's MSS) as of himself. He, however, was dealing with a Victorian shell (*fide* Ashby, *loc. cit.*) which turned out to be *Chiton tricostalis* Pilsbry. I have since seen the shell in question (National Museum, Melbourne) and can confirm Ashby's identification. Ashby then renamed the Port Jackson shell *jacksonensis,* but this was superfluous in view of the three prior names available. Under the present International Rules of Nomenclature names published in synonymy are valid, and therefore *carnosus* must stand for the Port Jackson shell. Even if this were not admitted, *limans* of Pilsbry is anterior to *limans* of Sykes, it was given to the Port Jackson shell, and should therefore take precedence over the latter.

Examination of a large series of this shell proves that Carpenter's three descriptions fit the Port Jackson shell in one or other of its stages of growth or variations in colour. It has been my good fortune to examine several hundreds of examples taken within Port Jackson, from the ocean beaches on either side of the Heads, from Port Stephens (90 miles north of Sydney) and from Shellharbour (50 miles south of Sydney). The colour is extremely variable, and, while a dull olive green or a dark brown are the predominating shades, these are frequently relieved by the picking out of some valve with a bright contrasting colour such as purple, red, or pale green. Two brilliant shells from Shellharbour would admirably answer to Carpenter's *carnosus* and *aurantius,* being blood-red and golden-orange respectively.

The dimensions of Carpenter's shells ranged from 17½ x 10 mm. to 30 x 15 mm. My largest Port Jackson shell measures 26 x 16 mm., and from Shellharbour, where the species seems to attain its greatest development, I have a perfect example, 33 x 18½ mm.

As pointed out by Iredale this species represents the most highly specialised form of the genus *Rhyssoplax*. I think it is entitled to a section, in view of the remarkable girdle scales.

Rhyssoplax particolor, n.sp.

Plate xxvi., figs. 5-8.

Shell elevated, carinated, side-slopes convex. Surface smooth with a fine reticulated pattern covering the whole shell. Colour, lilac-rose, mottled with darker; some median valves partly yellowish; the girdle lilac-rose, with four yellow bands in opposing pairs at the sutures of the anterior and posterior valves respectively.

Anterior valve having about 12 indistinct indications of nodulose ribs, the nodules being more pronounced at the front and back margins; apex smooth.

Median valves: Lateral areas composed of two ribs enclosing a groove, the anterior rib having five indistinct nodules, the posterior margin with about five ungulate nodules, causing undulation of the margin; central areas having seven to eight narrow sulci, decreasing towards the jugum, only four extending right across the area.

Posterior valve with mucro prominent, in front of the centre, posteriorly concave; the radial riblets as in the anterior valve showing more pronounced nodules at the margins only; central areas as in the median valves.

Girdle scales small, pointed, regularly striate.

Interior white.

Dimensions: 13 x 7 mm.

Station: On the under side of a stone in a sheltered pool below low water mark.

Habitat: Caloundra, Queensland.

Remarks: Since the above description was written and the figures drawn, I have collected a fairly large series at the type locality, and also at Point Cartwright, about fifteen miles further north. This series shows a remarkable colour variation; dull green, brown, rose, canary-yellow, and variegated examples being taken. In size they range up to 22 x 13½ mm. The type is not fully developed, the pustulose ribs on the end valves becoming more definite and pronounced as age advances, and the sculpture of the lateral areas of the median valves shows progression in the splitting of the ribs up to four, with a maximum of sixteen nodules to a rib, with a tendency to coalesce. Girdle scales become more pointed, but do not present the striking mucronation of *R. carnosus* (*limans*), with which it has hitherto been confused, being recorded from Queensland under this name by Iredale. The sculpture of *R. particolor,* as a matter of fact, more closely approaches that of *R. tricostalis* Pilsbry from South Australia, than that of *R. carnosus* Angas from New South Wales. Typical examples of the latter species have not yet been found in Queensland.

Rhyssoplax venusta, n.sp.

Plate xxvi., figs. 1-4, 9-12.

Shell elevated, carinated, side-slopes slightly convex, surface smooth and rather polished, with a fine reticulated pattern covering the whole shell. Colour apple-green, except valves iv. and v., which are pompeiian red; the girdle yellow, except opposite valves iv. and v., where it is brick-red, and there are a few irregular splashes of brick-red appearing on the yellow portion. The colour of the whole shell consists of minute spots or freckles.

Anterior valve with 20 low radiating riblets, composed of large round, flattened pustules, 3 or 4 to each rib; the apex smooth.

Median valves: Lateral areas strongly raised, valve ii. with two grooves, the others with one groove, the raised ribs composed of 5 or 6 low flattened pustules increasing in size towards the margin; central areas with 7 to 10 narrow sulci extending right across the area, the intervening broad rounded ribs not being distinguished by any difference in colour.

Posterior valve with prominent mucro in front of the centre; 13 radiating riblets with oval or laterally compressed pustules, less clearly defined than those on the anterior valve; the central areas having each 6 shallow sulci, more uniform and less clearly defined than those on the median valves.

Juvenile form (Plate xxvi., figs. 9-12).

Shell elevated, carinated, side-slopes slightly convex; surface smooth, highly polished, finely reticulated.

Colour, variable, pale brown sometimes mottled with olivaceous.

Anterior valve smooth, save for a growth line near the front margin, and faint indications of about 7 very broad and shallow grooves.

Median valves beaked, having distinctly raised lateral areas with a shallow obsolescent groove and 3 to 4 low pustules on the raised portions; central areas with 2 to 4 sulci extending across the area, more indicated by colour than depth.

Posterior valve: Mucro prominent, in front of the centre; 7 or 8 low pustules regularly arranged along the posterior margin, suggesting the termination of obsolete riblets; 3 fine dark lines or sulci in each central area.

Girdle scales uniform, oval, flattened, smooth anteriorly, striated posteriorly.

Interior white. Slits 8—1—11.

Dimensions: 12 x 7 mm.; juvenile, 8½ x 5 mm.

Station: On the under side of a small stone in a sheltered pool above low water mark.

Habitat: Emu Park, Keppel Bay, Queensland.

Affinities: This shell suggests *Rhyssoplax carnosus* Angas, in the juvenile stage, but the girdle scales are not mucronated.

Material: One adult (?) and two juvenile, of similar dimensions, but varying colour.

Remarks: This probably represents a deep water species, attaining considerable proportions when fully adult.

EXPLANATION OF PLATES.

Plate xxiv. illustrates the whole shell of *Parachiton puppis* (fig. 1), the anterior valve (fig. 2), one-half of a median valve (fig. 4), the posterior valve (fig. 3), and a section of the girdle (fig. 5). *Terenochiton erratus, Ischnochiton luticolens,* and *Ischnochiton examinandus laetior* are represented by enlarged figures of the anterior valve, posterior valve, one-half of a median valve, and a section of the girdle respectively in the order given.

Plates xxv. and xxvi. illustrate the same four parts of the following species: *Ischnochiton examinandus, Callistochiton granifer* and *Rhyssoplax vauclusensis* (Plate xxv.), and *Rhyssoplax venusta* (2 forms) and *R. particolor* (Plate xxvi.).

ANIMAL STUDIES AT TARONGA PARK.

"The Mendicants."
Kadiak and Grizzly Bears.

"From Arctic Shores."
Polar Bears.

Photographs by E. F. Pollock.

ANIMAL STUDIES AT TARONGA PARK.

"Two of a Kind."
Zebras.

"That Tired Feeling."
Lion "Jerry." Born at Taronga Park.

Photographs by E. F. Pollock.

ANIMAL STUDIES AT TARONGA PARK.

"The Squatters' Conference."
Prairie Dogs.

"In the Shade of a Shelt'ring Palm."
Bridled Nail-tailed Wallabies.

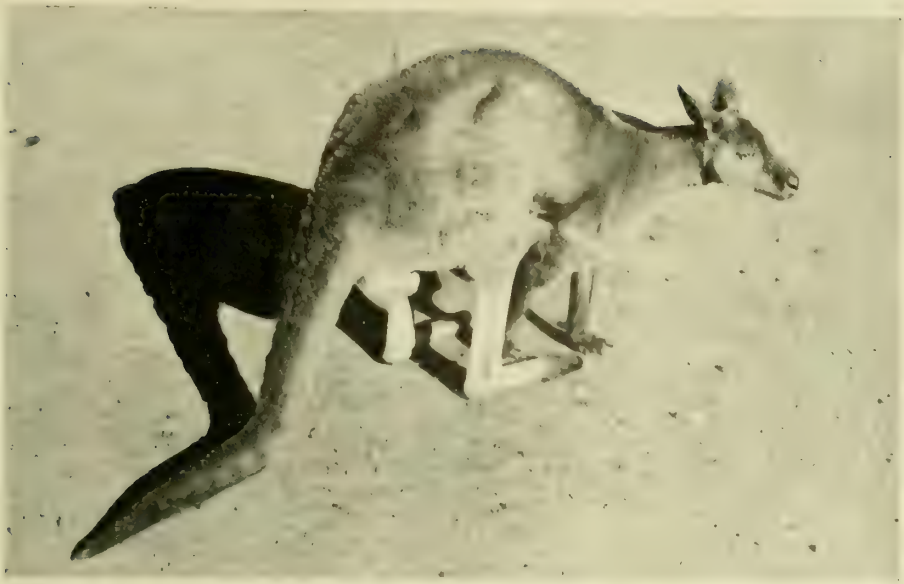
Photographs by E. F. Pollock.

Macropus giganteus.
Aged Male. Summer.

Photograph by E. F. Pollock.

Macropus giganteus.
Young Female. Autumn.

Photograph by Harry Burrell.

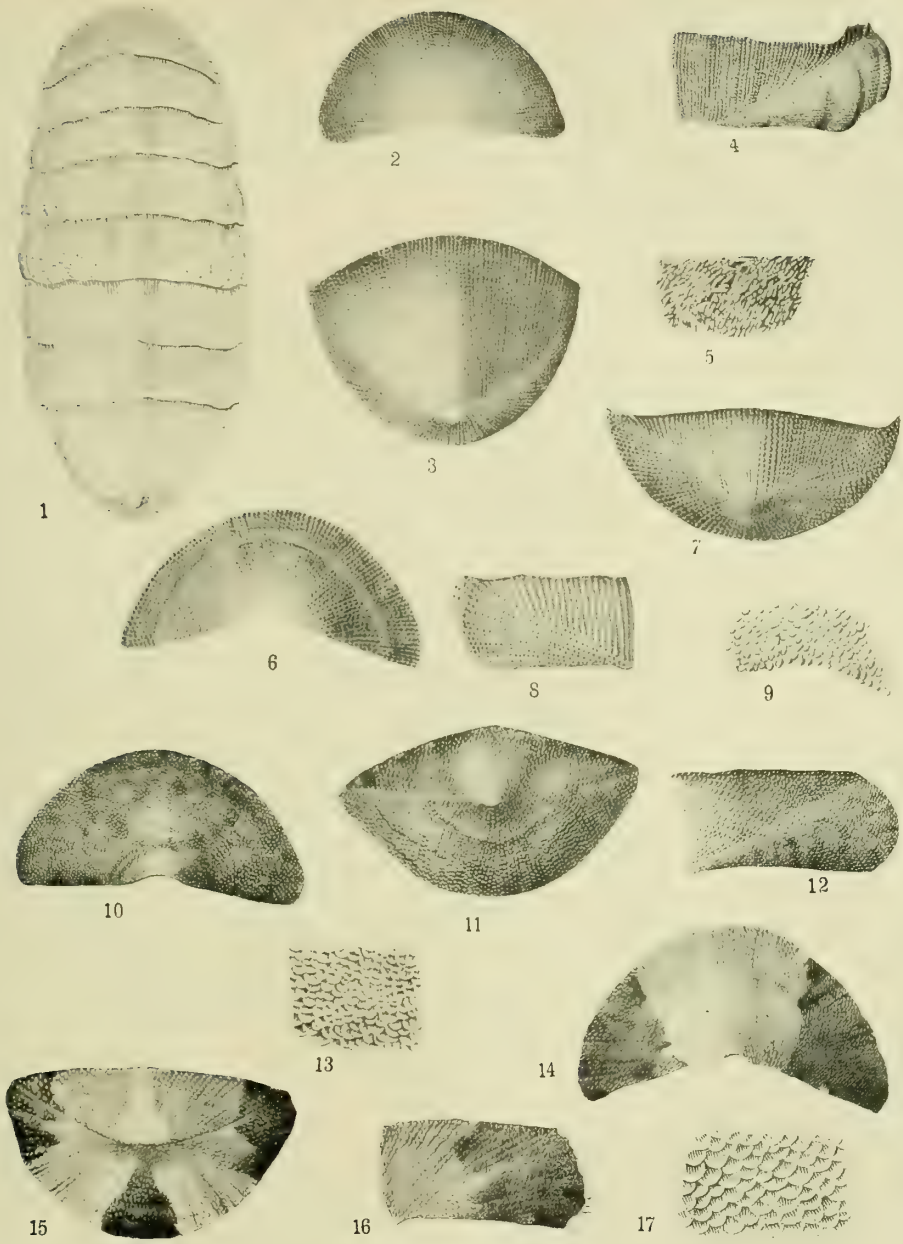


Macropus melanops.
Adult Male. Early Winter.
Photograph by A. S. Le Souef.

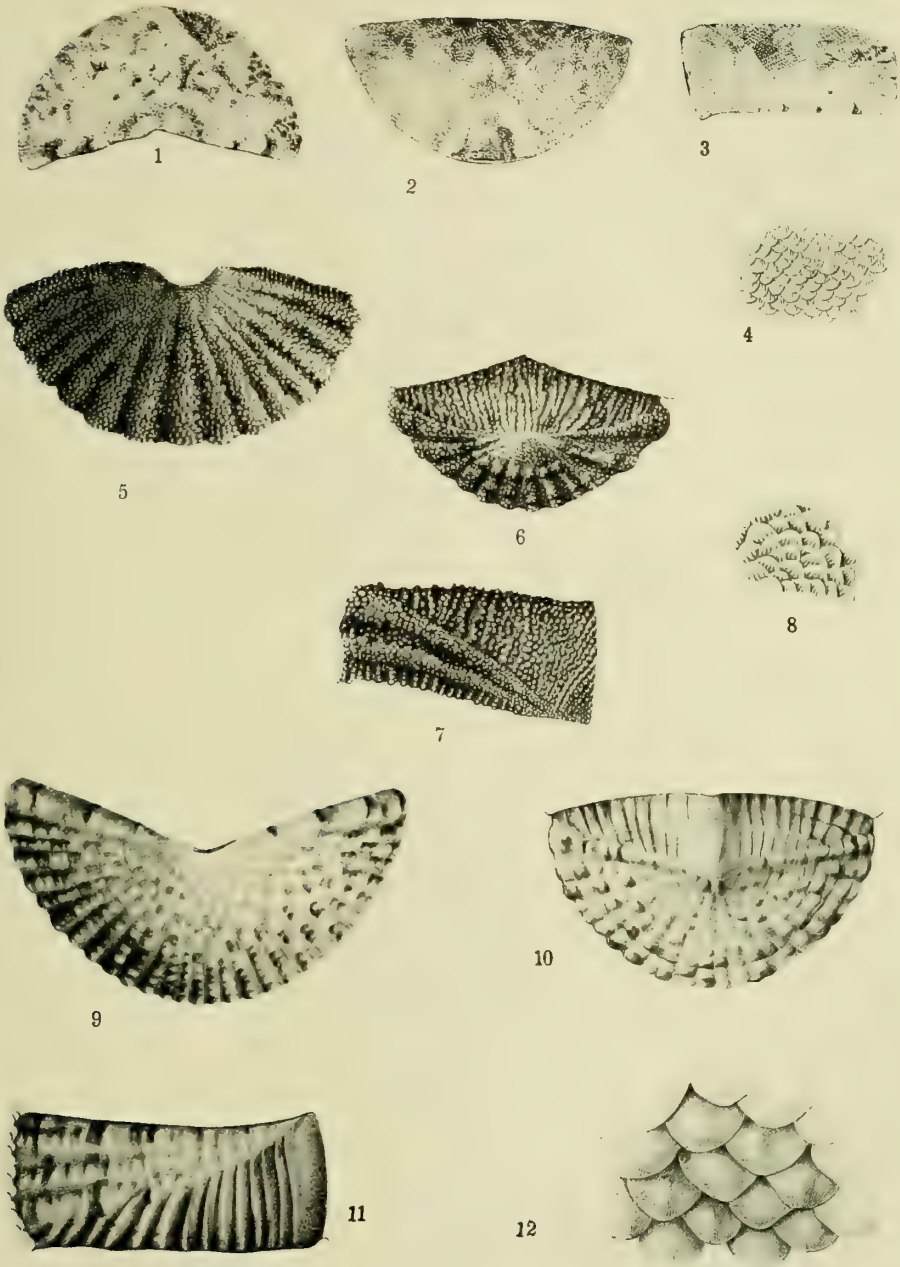
Macropus fuliginosus.
Winter coat.
Photograph by E. R. Sanborn.

Tarsipes spencerae.
The Honey Mouse.

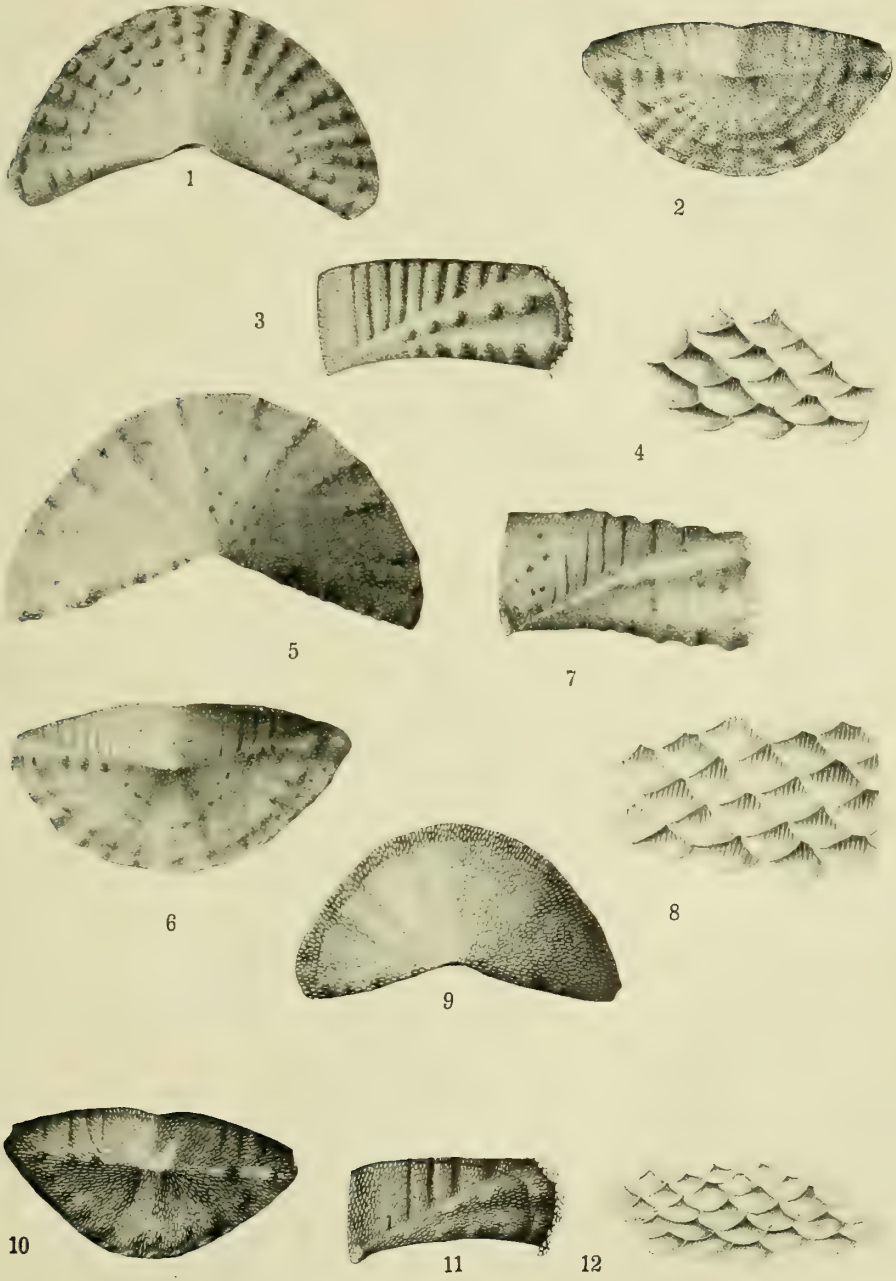
After Gould.



Figs. 1-5 *Parachiton puppis*, n.sp.
.. 6-9 *Terenochiton erratus*, n.sp.
.. 10-13 *Ischnochiton luticolens*, n.sp.
.. 14-17 *Ischnochiton examinandus laetior*, n. sub-sp.



Figs. 1-4 *Ischnochiton examinandus*, n.sp.
„ 5-8 *Callistochiton granifer*, n.sp.
„ 9-12 *Rhyssoplax vauclusensis* Hedley and Hull, immature.



Figs. 1-4 *Rhyssoplax venusta*, n.sp.
„ 9-12 „ „ juvenile.
„ 5-8 *Rhyssoplax particolor*, n.sp.

Royal Zoological Society of New South Wales.

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Royal Zoological Society of New South Wales

NEW MEMBERS.

The following members have been elected since the publication of the last list (15th August, 1923) :—

Ordinary Members:—Frank Hambridge, E. Howard, Leslie Johnson, David W. Lynch, E. E. L. Mutton, Camden Pratt, Lew Parks.

Associate Members:—Professor W. E. Agar, Sir James Barrett, William Barnes, Professor E. J. Goddard, His Excellency Sir Matthew Nathan, K.C.M.G. (Governor of Queensland, Life Member), A. W. L. Oliver, J. H. Simmonds, H. W. Simmonds, Dr. A. J. Turner, A. R. Taylor, Amos E. Williams.

EFFECTIVE PROTECTION.

The following paragraph appeared in the Sydney "Sun" of 21st October, 1923:—

GOULBURN, Saturday.

Mr. G. R. Williams, the Goulburn P.M., has announced his intention of dealing very strictly with any offenders against the Act which protects the fauna of the State. At the local police court yesterday Joseph Bell, of Marulan, was found guilty of having in his possession the skins of twelve kangaroos, three wallaroos, three brush wallaby, and one swamp wallaby. The magistrate allowed defendant the benefit of the doubt with regard to the wallaroo skins, but fined him £6 for the 16 other skins, in default two months' gaol.

"I am dealing lightly with you," said Mr. Williams, "as you are in poor circumstances, and you have a wife and seven children to keep. But the destruction of protected animals last winter in the Goulburn district was excessive. I have heard of men who called themselves 'sports' who drove out in motor cars and shot down three herds of kangaroos. This sort of thing will have to cease. If any offenders of that type are brought before me I intend to impose the maximum fine of £5 for each skin. I shall do my utmost to protect the native animals of Australia."

Mr. Williams is a member of this Society, and his example is one that has been followed by several other magistrates recently.

DATES OF MEETINGS, 1924, JANUARY TO JUNE.

18 January, Friday, Ornithological Section.
13 February, Wednesday, Entomological Section.
15 February, Friday, Ornithological Section.
12 March, Wednesday, Section of Economic Zoology.
21 March, Friday, Ornithological Section.
9 April, Wednesday, Entomological Section.
18 April, Friday, Ornithological Section.
14 May, Wednesday, Section of Economic Zoology.
16 May, Friday, Ornithological Section.
11 June, Wednesday, Entomological Section.
20 June, Friday, Ornithological Section.

All meetings commence at 7.30 p.m. in the Society's Room, No. 10, First Floor, Bull's Chambers, 28 Martin Place.

THE SNOWY ALBATROSS IN SYDNEY HARBOUR.

By Tom Iredale.

There were published in the "Emu" for October, 1923, pp. 96-100, some notes I made on Albatrosses and Mollymawks from Fremantle to Sydney. I there recorded the fact that the largest Albatross seen in the Great Bight was a form of the Snowy Albatross and was not the Wandering Albatross as commonly supposed. Moreover, that in Spencer's Gulf and through Bass Straits to southern New South Wales only the Wandering Albatross was seen.

Crossing Sydney Harbour from Circular Quay to Manly and vice versa I have been astonished to see a number of Mollymawks. These were present most days, flying, and also sitting on the water, and were often passed very closely. Two species were easily recognised, the Black-browed Mollymawk (*Thalassarche melanophris*) and the Yellownosed Mollymawk (*Thalassogeron chlororhynchus*). It may be noted that the Shy Albatross (*D. cauta*) has also been recorded for the Harbour, but I have not yet seen it. Lately, however, as well as Mollymawks, Albatrosses have been coming into the Harbour, and I was surprised to see birds that looked like Snowy Albatrosses among them. After criticising them day by day, sometimes very closely, I have little hesitation in recording that a form of Snowy Albatross visits the Harbour. I have passed very closely to such birds, both flying and settled, and have seen the stumpy form of the bill distinctive of this form. Though some of the birds are very white, there is generally a little dark tipping to the tail feathers, and the less white birds have more dark colour, but never the completely dark tail in the mottled-back Wandering Albatross. If these observations be later confirmed by the study of specimens it will become a necessity to revisit all the known breeding grounds, and re-investigate the species and forms, because these records do not coincide with known data of breeding colonies, and it becomes obvious that our ignorance of Albatrosses is greater than we hoped.

ADVISORY COMMITTEE, EXPORT OF BIRDS AND ANIMALS.

The Commonwealth Minister for Trade and Customs has appointed a Committee to advise him in connection with applications which may be received for permission to export prohibited Australian birds and animals. The Committee for New South Wales consists of the following members:—Professor L. Harrison, representing the University of Sydney, the Royal Society, and the Linnean Society, with Dr. A. B. Walkom to act as deputy in his absence; Hon. Fred. Flowers, representing Taronga Zoological Park, with Col. A. Spain as his deputy; Mr. A. F. Basset Hull, representing the Royal Zoological Society of New South Wales, with Mr. A. R. McCulloch as his deputy; Dr. C. Anderson, representing the Australian Museum, with Mr. E. L. G. Troughton (Mammals) and Mr. J. R. Kinghorn (Birds) as his deputies; Mr. W. W. Froggatt, representing the Naturalists' Society and the Wild Life Preservation Society, with Mr. E. Cheel as his deputy; Mr. Neville Cayley, representing the Royal Australasian Ornithologists Union (N.S.W. Branch), with Mr. J. S. P. Ramsay as his deputy; Mr. Frank Farnell, representing the National Park Trust, with Mr. W. F. L. Bailey as his deputy, and Mr. F. Lynne Rolin, representing the Society for the Prevention of Cruelty to Animals, with Mr. S. T. D. Symons as his deputy.

Professor Harrison has been elected Chairman, and Mr. Hull Hon. Secretary.

This Society is well represented on the Committee, no less than eleven of the sixteen members being also members of this Society.

AUSTRALIAN DESERT REGIONS.

Their Influence on Distribution of Life.

By A. G. Campbell, Kilsyth, Victoria.

I. Geographical.

Quite one-third of the total area of Australia lies inside the line representing an average rainfall of ten inches per annum, and this huge area, about eight times the area of the British Isles, occupies practically the centre or interior of the continent, embracing large slices of Western Australia and South Australia, with smaller pieces of Queensland and New South Wales. The 10 inch isohyet does not touch or include the coastline, except in the extreme west in the vicinity of Shark Bay, although it runs very near the coast at the head of the Australian Bight. The whole of this huge area is devoid of the many and varied geographical features that mark the more favored portions of the continent. There are no permanent rivers, nor any channels of any size except near the Queensland border, where torrential rains at the head, occasionally, that is once or twice in a decade, send down flood waters toward the great lake basins into which they lead. Evaporation, and to a great extent percolation, account for the disappearance of practically the whole of the rainfall. Lake Eyre, the largest basin, is actually below sea level minus 39 feet.

Secondly, there are no large mountain ranges which might act as catchment for rainfall and the betterment of the surrounding country, unless the McDonnell, Musgrave, and Everard Ranges are noted as exceptions, for around these rugged peaks storm water channels take their rise, but quickly lose themselves in open country.

Indications of other drainage systems occur in the extensive salt lakes and chains of salt lakes throughout the dry regions, without any defined river channels leading thereto. Lakes Amadeus and Macdonald near the centre and others nearer the Bight, possibly represent seepage from extensive areas of country, or they may be simply enlarged editions of what are known as clay pans.* In the interior of Western Australia, between parallels 25° and 32° are other series of salt lakes of entirely different origin. They occur on the plateaus of ancient rocks forming that portion of the continent, the elevation being over 1,000 feet above sea level. They represent the drainage basins of surrounding country which, if there were a greater rainfall than 10 inches to feed them, would be connected up into one or more river systems.

Then there is the desert proper, which, in point of size, may truly be called the chief geographical feature of the continent of Australia. Arid regions of thousands of square miles in extent, they have no physical features whatsoever, other than the monotony of rock, sand, spinifex and scrub; unbroken expanses of awful aridity and frightful desolation they will probably remain to the end of

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* Laverton and Wiluna, in mid-Western Australia, have a normal rainfall of just under 10 inches per annum, the highest record being 15 inches, the lowest 5½ inches. The rainfall, though low, is well distributed throughout the year, January to March being the wettest months, October to December the driest.

time. Explorers' journals teem with vivid descriptions of their journeys through: some passed in comparatively good seasons, some in bad, but none hesitate to call these terrible and inhospitable regions deserts, which they really are.

II. Vegetation.

Dead the desert regions are as far as human needs are concerned; impossible for settlement, difficult and dangerous for travel, the physical appearances and the vegetation are worth a little consideration. Many hundreds of square miles are barren rocky surfaces, relieved only by rudimentary gorges, creeks and depressions in which anything at all like forest trees occur. Hundreds of miles are covered with "gibber," the stony residue of the dessication of a continent. Still larger areas are covered with sand, the wind blown detritus from the breaking down of the rocks. In such parts are some of the most remarkable examples known of adaptation to environment. The spinifex or porcupine grass is an example of specialisation comparable to anything in the plant world. It is a true grass allied to *Eragrostis* and *Poa*, but with long acicular leaves that have become quite inedible. The mallee or marlock, comprising about twelve species of dwarf *Eucalyptus* are examples of trees which have decreased in size, toughened their leaves and often enlarged their rootstocks as a reservoir for sap water. Scattered throughout is another peculiar tree, the desert oak (*Casuarina decaisneana*) often standing a lonely isolated adaptation among the sandridges, with cylindrical branchlets bearing minute leaves, and wood like iron. Mulga is another remarkable drought-resistant tribe. It grows in belts not always in poorest desert places; the least beautiful of all acacias, stumpy in stature and casting very little shade, but its phyllodes dry as well as green, are like the desert oak, a useful fodder in time of need. There is great development of the order *Compositae*, everlastings and other herbage spring up after suitable rains and provide fodder nutritious for years even after it becomes dry. Remarkable development also is found in *Salsolaceae* or salt loving plants; saltbush and bluebush are essentially features of the pastoral belts of the interior, though rapidly disappearing. Samphire (*Salicornia*) is a more permanent form of plant, inhabiting the vast salty depressions and the margins of salt lakes. Rolypoly (*Salsola kali*), Parakylia (*Caladrinia balonensis*) and camel bush (*Pollichia zeylanica*) are all well spoken of as feed, contributing towards the wonderful herbage which in times of plenty appears even in the desert regions.

Real desert exists in South Australia in comparatively broken areas, particularly west of Lake Torrens and north of Lake Eyre, also to the north of the McDonnell Ranges, as shown in the journals of the first explorers who examined the real interior. But for practical purposes attention can be focussed on the far larger and more continuous deserts of the western portion of Australia.

West of a line representing the 134th degree of longitude is a huge area, embracing nearly half of South Australia and about half of Western Australia, where on the map the greatest vacant spaces occur. Probably there is very little to be known, beyond that they are waste places where rainfall is practically unknown and where there is no sustenance for man or beast.

In the deserts of Western Australia the disintegration of old sedimentary rocks, chiefly sandstone, results in an immense amount of sand, much of which is borne by wind across country, and arranged in more or less parallel ridges, the flats between being underlaid by porous rock. The monotony is occasionally relieved by low breakaway cliffs, miscalled ranges, but none more than 100 feet high. On one side the prevailing winds bank the sand right up against rocks, while on the other are strips of earthy flats. In the vicinity of breakaways are found rock holes and soaks that afford the only surface water.

In addition there are extensive sand plains nearer the coast, overlying granitic rocks which are slightly different from the desert proper, being intersected with belts of pastoral country.

The rainfall of the desert regions is unknown, because there are no meteorological stations where records are kept.

As we know them to-day, the settled portions of Australia are subject to occasional sharp periods of drought among many seasons of plenty. The desert regions may be subject to occasional periods of rain, but during many years they are stricken with aridity.

III. Conclusions.

Extracts from explorers' journals demonstrate only too plainly the character of the dead heart of Australia—which term, originally intended for the vicinity of Lake Eyre, is even more appropriate to the vast central regions as a whole. It is clear that there are desert regions in Australia which are zoologically dead, while many parts are so far affected by aridity that they are obviously in a dying condition.

The term desert as here used, applies to those areas which, owing to very low rainfall and to the consequent arid nature of the country, are practically unoccupied. The extreme condition of barren moving sand, Sahara-like in sterility, only occurs in limited patches, nevertheless there are true desert regions in the sense that they are zoologically unoccupied.

The Australian deserts, great though the area be, are singularly well clothed, but the vegetation is of that highly specialised character, peculiarly adapted to the exigencies of steadily increasing dryness of climate.

Australian desert regions in the main lie approximately between latitude 19° and 30°, and between longitude 122° and 129°. The boundaries may be stated thus: A line from Broome, Western Australia, skirting the Fitzroy River, within 25 miles; across Sturt's Creek, around in a semicircle beyond the State boundary line and back to Lake Macdonald: thence around the Warburton Range and back to Everard Range, South Australia; thence via Ouldabinna, around Queen Victoria Spring to Laverton; thence via Weld Springs to Broome.

Passing reference might here be made to the true centre of the continent, McDonnell Ranges. Giles and Tietkens proved that similar rocky and broken country extends westward to Rawlinson Range, and southward to Musgrave Range, more or less intersected however with strips of real sandy desert with which it is invaded. These ranges must not be included in the true desert regions because of a more varied fauna which seems to indicate better climatic conditions. Kangaroo, emu and the black man have existed there from immemorial times. These larger animals appear to have been gradually isolated by the development of desert conditions around them. They have passed out of existence in the desert proper, or at least only make excursions therein during occasional seasons of plenty.

The interior of Australia is more or less a gradation from the equable conditions near the coastline through various stages, represented in the dry climate of further inland, the liability to drought of out back, and finally the desert conditions of the far interior.

There should be, theoretically, a region about half way where conditions are half good, half bad, and such are found well back in all the larger States.*

Some records of Cooper's Creek, South Australia, illustrate the ebb and flow of the dry periods.** There were only eight years in forty when the rainfall was over double figures, the average for these being 12.50 inches. The great majority of years averaged only 5.32 inches, which perhaps gives a truer indication of what ordinary conditions are like.

While the desert was thus in process of development, the effect upon native animals and birds can easily be understood. Some species persist, but in every instance the race inhabiting the desert can be distinguished by smaller size and pallid colors. Distinct desert species have in other cases developed. But on the other hand very many forms of life, less hardy or less adaptable, must have passed right out of existence.

Explorers' journals may be quoted on the question of distribution of native life. Chas. Sturt, returning to the Depot in February, 1845, after his 400 miles dash to the north west, found "birds of all kinds collected as preparatory to migrating and soon we were wholly deserted." The summer, though intense, was apparently an average one for those parts, because good rains came in the autumn.

Cockatoos, parrots, pigeons, finches must regularly have water to drink, their morning and evening pilgrimages to a remaining pool in the ordinary dry season of the year, are a commonly recorded bush sight. But larger birds, pelican and ibis, disperse far and wide, only congregating in their accustomed breeding haunts when most favourable conditions are resumed. Their breeding season is not annual, and may occur in the depth of summer following a phenomenal year or years of rainfall and flood waters.

If conditions are good only once or twice in a decade can small birds exist? There is much against them, but if some do survive, they show in a very marked fashion the peculiar influences of their environment. Certain *Ephthianura* and *Artamus* are nomadic, probably having acquired this habit from force of circumstances. When dry periods set in they leave the interior lands and make nearer the coastline. Periods of super-drought have, within the history of Australia, been responsible for enlarging the habitats of other species, notably *Plectorhynchus lanceolatus*, *Philemon corniculatus* and *Geopelia placida*. Small birds like *Amytis*, *Malurus* and *Acanthiza* probably exist in many waterless regions by obtaining the moisture they require with their insect food.

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* The average annual rainfall at Innamincka, Cooper's Creek (about lat. 27deg. 40min., long. 140deg. 45min.), from 1882 to 1922 is 6.72 inches. I am much indebted to Mr Alfred Walker, late manager of the station, and to the Commonwealth Meteorological Review, for these figures. An analysis of the records showing the rise and fall of Cooper's Creek is interesting. In twelve different years during the period 1882–1908, the rise at Innamincka was from 1 to 10 feet: four years, 10 to 20 feet; two years it reached 20 to 30 feet; and five years, 30 to 38 feet. The greatest rises did not coincide with years of good local rainfall but were due to great rains in Queensland. Twice in this period the creek ran nearly all the year, that is eleven months in 1885 and ten months in 1906. But for two long spells there was no flow whatever; the creek stopped running on November 3rd, 1882, and started again on January 25th, 1885, after a lapse of 27 months. Again on May 31st, 1899, the creek stopped and did not again run till June 7th, 1901, an interval of two years.

** Since this was written the rabbit plague has made its appearance in Western Australia, having found its way overland, probably near the coastline from South Australia. Succulent plants of the salsolaceous order must have been the chief food supply.

A. C. Gregory, who had a long experience as surveyor and geographer, both in Western Australia and in Queensland, surmises in the last lines of his journals (1858):

"It is not improbable that the seasons of drought which proved so destructive to tree vegetation higher up the river (Barcoo) have proved equally disastrous in its effects on the aboriginal inhabitants of the interior."

Here then is a picture of the desert in the making. We read that dry periods nowadays cut off stations out back from travelling their stock to coastal markets for as much as two or three years at a time.

The Elder Expedition, 1891-2, saw abundant evidence of dry periods in Victoria Desert, mulga dead, even spinifex dead, and near Mt. Shenton "many bushes quite perished after the three years drought."

Hubbe, who in 1895-6 set out from South Australia to examine the country along Forrest's route, frequently refers to both mulga and spinifex being dead, sometimes mentioning 50%, 75% and in one instance 95% dead. He found natives collected at Ernabella (Glen Ferdinand of Giles) owing to scarcity of water in the surrounding country, and—this is a curious remark but very significant—

"December 24th.—Passed bodies of many small birds recently dead through heat or want of water, the parched appearance of the country being painfully apparent."

At Musgrave Range (1902) Maurice states "The blacks say they have had little rain for years past, and evidence of the prolonged drought is shown by the smaller gum trees and saplings in the creeks, the leaves on which are yellow and brittle as if scorched by fire and on being shaken by hand fall off in a shower." About the same place the blacks pointed out a child about seven years old as being born at the time of the last big rain. (See Geo. Sur., S.A., Bull. No. 5, p. 29, 1915).

Such records again pile up the evidence of the desert in the making. Though the face of the country may from time to time be refreshed with occasional seasons of plenty, yet the ordinary aspect is drought stricken and arid, which condition is aggravated by periods of super-dryness, when the long suffering flora and fauna is still further reduced. Maurice also refers to most of the mulga between Musgrave and Everard Ranges being "dead and presents a very drought stricken appearance," which is confirmed in the survey bulletin already referred to (see p. 33).

The question whether this area will be reafforested with mulga or other plants when a run of good seasons recur, has not been answered, except in the negative during the period under notice, 1902-1914.

Giles on his return trans-continental journey (1876) makes an important remark:—"The small marsupial wallaby exists throughout the whole of these deserts, they live entirely without water, as do small birds we occasionally see where there is a patch of timber."*

Such a small statement would easily pass unnoticed, but a zoologist might well consider it illuminating. Undoubtedly Giles was one of the most keenly observant of explorers, his writings stamp him as a virile and practical bushman. Few other journals are so full of descriptive accounts of the desert regions. Certainly no other explorer saw as much of the interior of Australia as he did. On his last trip from Adelaide to Perth and back again, he traversed 2,500 miles, more than half of which was through real desert. This being so, the very absence of statements about animal and bird life practically proves that

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*See Horn Exp. Rep., vol. III., p. 22.

nothing of the sort existed worth recording, and the presence of such a statement as that quoted above, is added corroborative internal evidence of this assumption.

Tietkens in his journal makes a regular practice of recording what animals and birds were seen each day, but when passing through desert, he has nothing to record beyond the significant statements. "No animals or birds were seen," or "No track or sign of any animal life."

The Elder Expedition:—"Saw a crow attracted by our smoke." This was an event almost on a par with Mawson's record when on the glacial plateau in the Antarctic, of sighting a Wilson petrel—the only living thing on the whole horizon. When entering the southern strip of desert between Ooldea and Rawlinson Range, Maurice writes of seeing galahs, minahs, ringnecks and diamond sparrows (the last are often mentioned living around native wells) a few lizards and two large snakes 7 feet long. He also "saw a dozen kangaroo rats, the first, from this judge that spinifex will soon be more plentiful." But on his journey northward from Musgrave Range to Tanami, there is very little reference to birds or animals, and that only of a negative description. "Animal and bird life rare." "No kangaroo or emu and few birds or animals of any description." "Country very deserted; saw no native smokes."

Maurice reported the introduced rabbit numerous about the Musgrave Ranges. "Shrubs and bushes are being barked and killed," though on a later visit he states they have thinned out considerably owing to drought. This is another aspect of the desert in the making. In all probability the rabbit will put the finishing touch upon the vegetation, and by preventing natural regrowth when seasons are favourable, will hasten the final desolation of the country.

What do these simple records mean? Taken at face value, they record the facts that man and beast, reptile and bird have almost reached extinction in the desert regions of Australia. The main conclusion being that the interior represents a gradation from good to bad conditions, and from bad to worse, until finally the desert resulted. This gives the key to the influences that have produced desert species or pallid races of animals and birds, where such exist, and this also explains why many well known forms are not found in the far interior.

How long this retrogression has been going on it is impossible to determine, but suffice it to say that all evidence points to the dry interior being of comparatively recent development. It dates from late Tertiary times, after Australia had become a continental entity with a most varied flora and fauna of its own (including aboriginal man). It has now become the greatest geographical feature of the continent.

As a matter of fact the drying out process still goes on, and when inland settled districts experience dry years or a more severe period of drought, they are feeling the effects of waves of aridity sweeping out further with more than usual intensity, from the already dried interior desert, the result of drought whenever it appears being to dry up the water supplies, scorch the vegetation and starve, drive away, or even exterminate the animal inhabitants.

Lean years are followed by years of plenty, during which the whole countryside is refreshed and to some extent rejuvenated, but inevitably in the course of time the spectre of the drought again appears to still further impress its hardening influences upon the face of nature. The last stage is reached when even the mulga, the mallee and other specialised plants die out in large tracts never to reappear. It is evident that when vegetation goes animal life must have predeceased it. Though the biology of the desert regions of Australia may not yet be fully recorded—a fascinating field here awaits research—nevertheless life has decreased as aridity increased until nowadays it is at the vanishing point.

THE EFFECTS OF SETTLEMENT ON WILD LIFE.

By Keith C. McKeown.

Since the earliest times the life of man has been intimately bound up with that of the other members of the animal kingdom—high and low. For a large portion of his food supplies man has been dependent upon animal life. Animals have proved themselves enemies of his crops and have, even some of the most insignificant in size, threatened his own life, yet in spite of this intimate association, it is remarkable how little man knows of his friends and foes; their habits and life-histories.

Creatures of long distant geological periods, now found only in a fossil state are better known to man than animals with which he is daily in close contact; this is a strange anomaly, but it is nevertheless true with regard to the deplorable ignorance which exists in the lay mind to-day as to the ways of birds, insects and other creatures which are of the greatest importance to economic life—possibly to man's whole existence.

How little is known as to the effects of settlement and cultivation upon the wild life of a country or even of a particular district, although these changes in the case of some countries have extended over many centuries. Possibly this is in part due to the slowness with which many of the changes have taken place, but also to that apathy and lack of observation on the part of members of an agricultural community that engender the spirit, now happily dying out, though only too slowly, expressed in the saying, "What was good enough for my father and his father before him, is good enough for me."

Man's interference with the balance of nature, in part inseparable from the progress of settlement, in part due to ignorance or even sheer wantonness, has in many instances been attended with the gravest consequences, as in the case of the introduction to Australia of the Rabbit and Fox, Starling and Sparrow.

The cultivation of crops in large areas, often under unnatural conditions, allows the increase of their insect and other enemies in abnormal numbers. With the spread of settlement, native insects and birds whose food plants have been destroyed in the course of clearing and cultivation are forced to adapt themselves to the changed conditions, and adopt new food plants or become extinct. Those birds which formerly kept the insects in control, unless they are adaptable, must give ground and retire before the ever advancing spread of settlement, to become confined to the fast diminishing areas of virgin country, and in many cases becoming extinct, being unable to withstand the exigencies of the changed conditions of existence.

The question of the changes brought about by man in the course of settlement and cultivation, manifold in its aspects as it is, has been engaging my attention for some years, and has been productive of rather voluminous notes. My enquiry has now progressed sufficiently far, so that a brief preliminary survey may prove of interest, although from many points of view it must necessarily be incomplete, more in some sections than in others. Fresh material is still coming to hand.

In most agricultural districts the growth of settlement has been so gradual, that changes have not been markedly noticeable until they had actually taken

place and become an established fact; definite information on any point was therefore hard to obtain. In this respect the Murrumbidgee Irrigation Areas are possibly unique, for, although settled in a sense, in that they were formerly a great sheep run, it is only in the last ten years that intensive culture has taken place: the change being intensified by the introduction of water for irrigation into a dry district where the rainfall only averaged 15½ inches per annum. It will readily be understood that such an event would be far reaching in its effects upon the wild life of the district, apart from any other changes brought about by man, such as the cultivation of crops and the introduction of naturalised animals and plants.

It might be considered that the evaporation from many miles of supply and drainage channels, together with that from several square miles of irrigated land, would have produced some marked change in the climate in the immediate vicinity of the irrigated area: but such is not however apparent to any appreciable extent. Comparison of the old meteorological records with those of the last few years does not disclose any noticeable change—not even in an increased humidity. Mr. E. T. Quayle, however, in a paper entitled—"Possibilities of Modifying Climate by Human Agency, with special application to South-Eastern Australia"—(Proc. Roy. Soc. Vic., 1920) states "As the evaporation from irrigated areas is at least equal to that from ocean surfaces, and the irrigated areas are already large enough, stations to the south-east and south from these should show some benefit from them: at all events, during the chief growing season. . . . . Data from stations bordering on or within the irrigation areas give some indications of rainfall effects, but these are necessarily indefinite." This paper indicates an improvement—although slight, in the rainfall to the lee of irrigation areas. A more recent paper "Local Rain Producing Influences (under human control) in South Australia" (Proc. Roy. Soc. Vic., 1921) further amplifies the earlier paper and is accompanied by an extremely interesting map. The whole theory, however, although one of the greatest interest, is at present hardly conclusive.

In a paper of this length it is of course impossible to do more than touch on many aspects of the question under discussion. The botanical side of the matter must be very briefly dismissed owing to its magnitude. Many plants and weeds are introduced and spread by means of the water for irrigation: floating seeds proving an efficient means of distribution, and is one which it is practically impossible to control. To this source must be placed the spread of Bathurst Burr (*Xanthium spinosum*), the Bushy Aster (*Aster dumosus*) and the Prickly Lettuce (*Lactuca scariola*) which appeared on the area for the first time on the channel banks during the watering season of 1915-1916. Many aquatic plants have also made their appearance, notably Eel Grass (*Valisneria spiralis*) which was first noted during the summer of 1922-23 and is now firmly established.

Further cases of these naturalised aliens could be cited, but it is not proposed to deal with the matter at greater length here as it is necessary to enter into the interaction of animal life and irrigation settlement.

The native mammals which formerly inhabited the areas are now practically all extinct. The Kangaroos, displaced by the sheep and cattle, are now only seen in small numbers when driven on to the area in time of drought. The Echidna is rarely seen.

The date of the introduction of the Rabbit into the district is not known, but it is now firmly established everywhere and plays its part in upsetting the balance of nature in the destruction of native flora. In the early days on the sheep stations Rabbits were in millions. It is recorded that 30,000 were killed in one drive on one of the stations now resumed and subdivided. With subdivision of the land into smaller holdings, the question of Rabbit control becomes simplified.

To combat the Rabbit the Domestic Cat was introduced by some of the station owners, and in some cases huts were erected to provide shelter for the animals, a fact still perpetuated in local place names, as Cat House Mountain. Many of the descendants of these cats are still to be found in a wild state in the dry areas, more remote from settlement. Some of the males are of a great size and so fierce that they are ugly customers if cornered. The Cats do not appear to have been effective in the control of Rabbits, but they, and also the Fox—another unfortunate instance of man's interference with Nature—have proved the greatest enemies of our indigenous bird life. The Fox has almost exterminated our ground-frequenting birds; while the Cat wages havoc among the other species, and before their combined attack many species are rapidly becoming scarce.

The birds have suffered from the spread of settlement, equally with the mammals, clearing having robbed many of their natural food, suitable cover and nesting places. The less adaptable are driven back beyond the borders of the settlement, while others, less specialised perhaps, have adapted themselves to the changed conditions, some feeding upon the insect pests which batten on the cultivated crops; others again, deprived of their natural foods, upon the fruits and seeds of these crops, which have replaced the natural flora. Several species of Honey-eaters, under drought conditions when other food is scarce, take toll of the soft fruits; Rosella Parrots (*Platycercus eximius*) feed upon the Almond buds, while Galahs (*Cacatua roseicapilla*) attack grain crops.

The Crow (*Corvus coronoides*) has proved itself too adaptable, both from the point of view of the grazier and the fruitgrower, it is practically omnivorous, but while valuable as a destroyer of insects, yet takes heavy toll in young and weak lambs by picking out their eyes; neither do ripe watermelons, apples, peaches, grapes and other fruits come amiss. With the exception of the introduced Starling (*Sturnus vulgaris*) the Crow bids fair to become the most important bird pest of fruits.

In severe droughts thousands of Wood Ducks (*Chenonetta jubata*) have invaded the irrigated areas and dug up and eaten the sprouting peas, grown by the settlers to supply the requirements of the local canning factory. The Black-tailed Water Hen (*Gallinula tenebrosa*) also invades the areas in dry seasons but has not attacked cultivated crops. Another bird affected by drought is the Emu (*Dromaius novae-hollandiae*), long since driven out of the area, it is forced to return from the plains for food and water: as is also the case with the Native Companion or Brolga (*Antigone rubicunda*).

The Curlew (*Burhinus magnirostris*) and the Mallee Fowl (*Leipoa ocellata*) are now almost exterminated by the Fox, and their inability to face settlement. The magnificent Bustard (*Eupodotis australis*) has long been gone and it appears to be only a matter of time before the Black-breasted Plover (*Zonifer tricolor*) and the Spurwinged Plover (*Lobibyx novae-hollandiae*) together with other species follow them, unless prompt action is taken to establish sanctuaries.

The magnificent Wedge-tailed Eagle (*Uroaetus audax*) has been wholly exterminated in the district by generally thoughtless and wanton destruction. Their abandoned nests may still be observed in the hills behind Griffith to show that these fine birds were once comparatively numerous.

Not only is man directly responsible in many ways for the destruction of birds, but the artificial structures with which civilised man surrounds himself also play some part in the slaughter of wild life. In the early days of the irrigation settlement when new houses appeared like mushrooms, all with roofs of glistening new galvanised iron, on moonlight nights many wild Ducks were destroyed by dashing themselves against the shining roofs, evidently under the mistaken impression that they were pools of water. The high-tension electric mains also take

their toll, Galahs being the chief sufferers; as many as 70 have been killed at one time as, in flying off after perching on the line, their wings touch the live wires, thus completing the circuit. Two birds, one on each wire, form a contact by reaching to each other to touch bills—a "kiss" followed by fatal results.

By the introduction of Starlings (*Sturnus vulgaris*), Sparrows (*Passer domesticus*) and the Goldfinch (*Carduelis carduelis*), man brought upon himself the greatest bird pests of his cultivated crops. The Starling and Sparrow first appeared on the irrigation areas about 1916, and the Goldfinch followed in 1920. The damage by Starlings and Sparrows alone runs into many thousands of pounds annually, but the result of their importation does not stop here, for by the destruction of the insect food of the district by thousands of aliens many valuable native birds are driven out, as well as by the action of the Starling in usurping their nesting places.

The introduced insect pests far outnumber, and are of far greater economic importance, than the destructive native species. To name only a few—the Red Scale (*Aspidotus auranti*) and the Codlin Moth (*Carpocapsa pomonella*).

The interaction of the introduced upon the native species of insects is as yet unknown.

Native insects, where their natural food plants have been destroyed in the course of clearing and cultivation, have in some instances adapted themselves to fresh foods; usually cultivated plants. Among the native insects that have found cultivated plants to their taste are the following:—

The Orange Peel Moth (*Paramorpha aquilina*) which, although orginally feeding upon aquatic vegetation and brought into the orchards in the irrigation channels, has found the orange to its taste, and boring through the peel, feeds upon the white pith, and there is every possibility of it becoming a serious pest to the citrus grower.

The Eucalypt Scale (*Eriococcus coriaceus*) has now adopted the orange as a suitable food plant, although it belongs to a family distinct from the Eucalypt. Although it is not yet common on the orange, still where it occurs it appears to flourish. The Meat Ant (*Iridomyrmex detectus*) also finds citrus trees to its taste, and somewhat after the manner of the South American Parasol Ant, cuts off the small leaves and twigs, and strips the soft bark from the young growth and carries the fragments off to the nest. This acquired taste is becoming more prevalent and widespread each season, and frequently causes considerable damage.

Man in growing the native trees, frequently under unnatural conditions in plantations and avenues, encourages their natural enemies to increase, and insects which under natural conditions rarely cause noticeable damage, increase and play havoc with their host when it is cultivated. The Eucalypt Scale (*Eriococcus coriaceus*) is one instance; the Ribbed Case Moth (*Thyridopterya herrichii*) usually a rare moth in collections, together with the Steel Blue Sawfly (*Perga dorsalis*) and various species of borers annually cause considerable damage to our avenues and plantations.

The whole question is of too great magnitude to discuss thoroughly here, but it is hoped that this paper may arouse some little interest in the effects of the settlement and cultivation of a district on its wild life.

A NEW GENUS OF DOLICHOPODIDAE (DIPTERA) FROM AUSTRALIA.

By Prof. M. Bezzi, Turin, Italy.

Among some Acalyptrate-flies collected on the sea shore near Southport, Queensland, I have found a female specimen of a wonderful Dolichopodid, which looks very like (the metallic colour not considered) a species of *Coelopa* or of some other Phycodromid-fly. It belongs certainly to the subfamily *Hydrophorinae,* and seems to be allied to the recently erected genus *Anahydrophorus* (a), the type of which, curiously enough, was described by Fabricius in 1805, as a species of *Scatophaga,* likewise a genus of Acalyptrate-flies. But it is distinguished from it, as well from all the other known genera, by the very different and unique form of the antennae.

In the recent work of Becker on the *Dolichopodidae* of the Indo-Australian Region (b), the true Australian Fauna is very poorly represented; some species described by old writers have been omitted and the paper of White on Tasmanian forms (c) has not been considered. But the new genus here described has nothing to do with both the genera erected by White (*Arachnomyia* and *Liparomyia*); some likeness seems instead to be present with *Hydroptorus cupreus* Macquart (d) from Tasmania, the type of which is described, however, without the antennae.

Mr. Hardy in Proc. Linn. Soc. N.S.W., xlvi., 1921, p. 300, is of the opinion that *Hydrophorus cupreus* of Macquart must be placed in the gen. *Archnomyia.*

The genus *Ostenia* Hutton (e) from New Zealand is evidently allied, but has very different antennae; likewise the genus *Phalacrosoma* Becker (f) from India and Formosa; even more different are the genera *Cymatopus* Kertesz (g) from New Guinea, and *Aphrosylopsis* Lamb (h) from the Bounty Islands.

I will call the new genus *Paraliptus* (from the Greek = overlooked), and I will describe it as follows:—

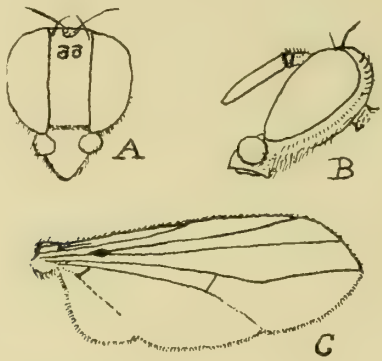
Paraliptus, gen. nov. Dolichopodidae, Hydrophorinae.

Elongate, rather bare, much flattened, metallic species with very peculiar antennae and with predatory front legs.

Head (fig. A.B.) rather small, as broad as the thorax; in front view it is distinctly higher than broad; in lateral view it is produced below, being above at the same level with the back of mesonotum. Occiput rather concave in the

(a) Becker, Nova Acta, Abh. d. k. Scop. -Carol. Deutschen Akad. d. Naturf., Halle, 1917, vol. cii., n. 2, p. 298.
(b) Capita Zoologica, Verhandl. op. syst.-zool. Geb. 'sGravenhage, 1922, Deel I. Afl. 4, 247 pp., xix. pl.
(c) Roy. Soc. of Tasmania: Papers and Proc., Hobart, 1916, p. 246-258.
(d) Mem. Soc. Sci. Lille (1849) 1850, p. 427, pl. xii., fig. 2, and Dipt. Exot., Suppl. iv., p. 123, Paris, 1849.
(e) Trans. N.Z. Inst., Wellington, 1900, p. 34.
(f) Capita Zoologica, 'sGravenhage, 1922, p. 44.
(g) Termesz. Fuzet., Budapest, 1901, xxi v., p. 408.
(h) Subart. Islands of N.Z., Wellington, 1909, vii., p. 132.

middle above the neck, a little swollen at sides below, and there clothed with numerous soft hairs; an irregular row of 6-7 strong but short bristles at upper border on each side; a pair of stout postvertical bristles. Frons flat, not at all prominent, parallel-sided, nearly subquadrate, gradually passing to the occiput at vertex; it is bare, bearing only one pair of strong orbital bristles near the vertex; directed inwardly; the ocellar tubercle is broad, flat, circular, bare, with one pair of bristles, which are widely separated and directed outwardly. Eyes proportionately small, oval, narrowed below, their vertical diameter being twice longer than the horizontal one; they are densely clothed by rather long, white pubescence. Face as broad as the frons, with the bisection line placed a little above the lower corner of the eyes; the upper part is flat, bare, not at all prominent in profile; the lower part is distinctly convex, a little shorter than the upper one and apparently bare, of triangular shape, being narrowed below; in profile it is pro-



A. Head in front view.
B. Head lateral view.
C. Wing. All the figures much enlarged.

duced below the eyes for a length a little greater than one-third of the vertical diameter of the eyes. Antennae inserted distinctly above the middle of the eyes; they are carried pendulous and are shorter than the face, but extending beyond the bisection line; they are close together at base and have two distinct tubercles above their root; the first joint is hairy above and is more than twice as long as the second, which is ring-like; third joint elongate, 2½ times longer than the two first joints together, gradually attenuated towards the end, without distinct arista or style. Palpi broad and flat, nearly circular, placed at sides of the lower part of the face, just below the eyes. Proboscis short and thick, simple, hardly prominent beyond the mouth-opening, which is narrow and rounded, the lower part of head being forwardly prolonged obliquely.

Thorax flat, elongate, parallel-sided, twice as long as broad; it bears two regular rows of short but stout acrostichal bristles, which are not extended to the scutellum; the dorsocentral bristles are placed on two rows on each side, and are likewise short and rather stout, extending from in front to the scutellum; the sides of back show some bristly hairs; of strong macrochaetae there are one humeral, two notopleural in front of the suture and very close together, one posterior supraalar. The pleurae are bare and without macrochaetae; only the sternopleura is hairy below. The transverse suture is less distinct, and visible only at

sides; the sides of back, at middle distance between acrostichal and notopleural lines, are elevated to form a longitudinal keel, which is sharper and more prominent above the root of wings. Scutellum flat, bare, margined, very small, being only one-seventh of the length of back; it bears one strong bristle at each side near the base. Calypters small; halteres short, but with a great knob. Mesophragma reduced to form a small horizontal plate just beyond the scutellum, resembling a first abdominal segment.

Abdomen not abbreviated, as long as thorax and head taken together; it is flat, parallel-sided, as broad as the thorax, consisting of five visible segments, which are all of about the same length; the tergites are bent downwards at sides, covering in part the sternites; there are a few hairs, but no bristles.

Legs rather short and stout. Those of the front pair are predatory; coxae elongate and thickened, without bristles, never spinulose; femora greatly thickened, armed below on inner side with a row of strong spines; tibiae shorter than their femora; tarsi as long as the tibiae, distinctly dilated at end. Middle legs thinner than all the others; coxae small; femora simple, not bristly, distinctly curved; tibiae with 3 rows of scattered bristles, shorter than the femora and as long as the tarsi; last tarsal joint dilated. Hind legs elongate; coxae short, without bristles; femora simple, but more thickened than the middle ones and likewise curved; tibiae longer than the femora, with long bristles and with rather abundant hairs; tarsi distinctly shorter than the tibiae, with the praetarsi about as long as the four following joints together, and devoid of bristles above; last joint less dilated. All the tarsi are broad and flattened; pulvilli very broad and rounded; claws thin, curved, not longer than the pulvilli.

Wings (fig. C.) parallel-sided, rounded at end, shorter than the body, with the lower half much developed. First vein ending a little before middle of wing. Second vein straight, ending nearer to the end of the third than to that of the second. Third vein straight, with distinct basal swelling. Fourth vein broadly curved beyond the hind cross-vein, but straight on its last portion and parallel with the last portion of third. Discoidal cell very narrow, its terminal cross-vein being placed about the middle of the wing; this cross-vein is therefore very short and distant from the hind border, being about one-third of the last portion of fifth vein, which is rather thin. Sixth vein not reaching the hind border, weakly chitinised. The costa ends at end of fourth vein, which is precisely at wing-tip. Axillary lobe broad and rounded; alula very small. Costae thickened and curved at extreme base; subcosta very thin, free at end.

Type: The following new species:—

Paraliptus mirabilis, sp. nov. A flat, elongate, parallel-sided, metallic fly with reddish antennae and legs and whitish wings.

Type ♀, a single specimen in the Health Department, Sydney, from Southport, Queensland, 7th January, 1923.

♀. Length of body, 5.5 mm.; of a wing, 4.5 mm.

Head metallic green; occiput with faint grey dust above, but densely white dusted below, the whole lower part of head being non-metallic. Frons shining, with whitish dust near the eyes and above the supra-antennal tubercles, near the vertex with cupreous reflections; ocellar tubercle green. Face densely grey dusted, the ground colour not visible. Antennae entirely reddish, whitish dusted, the hairs of the basal joints black. Palpi black, but densely grey dusted; proboscis black. All the bristles black; the hairs are whitish; postocular border white dusted with short and thin white cilia.

Thorax shining green, with cupreous reflections at sides; on the back the grey dust is disposed in three stripes, one acrostichal and two dorsocentral, but these stripes do not reach posteriorly the scutellum; moreover, on the sides, above

the notopleural line, there is a grey stripe from the humeri to the suture. The pleurae are not metallic, being densely clothed with opacous grey dust; the hairs of breast are pale yellowish. Scutellum green, but less shining because of the strong punctuation. All the bristles black. Mesophragma black, grey dusted. Calypters and halteres pale yellowish or whitish.

Abdomen metallic green, more shining than the back of mesonotum, not being punctate, broadly cupreous at sides and behind; each segment has a white shining hind border, narrowly interrupted in the middle and dilated at sides, more developed on the middle segments. Hairs whitish, those of the end darkened. Venter metallic green, whitish dusted.

All the coxae black, grey dusted and whitish pilose, but they are more or less reddish on the posterior side like the trochanthers. All the femora reddish, but more or less broadly darkened on the outer side; the hairs are whitish, but they are darkened on the blackish parts. Tibiae entirely reddish-yellow, with dark pubescence and black bristles; tarsi yellowish, with black pubescence and with the terminal joint black at end; pulvilli dark; claws black.

Wings whitish-hyaline, with a faint but distinct yellowish tint along the fore border to third vein. Costae and veins yellowish, a little darkened in their terminal portions.

Note: The unique specimen of *P. mirabilis* was collected by Mr. L. Wassell, it was not taken on the beach, though probably captured in the vicinity of water.

The types of the new species described in Professor Bezzi's papers will be placed in the Australian Museum, Sydney.

ON THE AUSTRALIAN LONCHAEIDAE (DIPTERA.)

By Prof. Mario Bezzi, Turin, Italy.

Very little is known about Australian Lonchaeidae. In my paper of 1920 (Bull. Ent. Res., xi., p. 204-210) I recorded only two species, viz.: *Lonchaea aurea* Macq. and *L. citricola* Bezzi. Among some material received through the courtesy of Dr. E. W. Ferguson and Mr. G. F. Hill I have found two additional new species, thus bringing the total number to four. Three subgenera are represented, and it is probable that many other species will be found in the future.

The species before me can be distinguished as follows:—

1 (6). Arista bare or microscopically pubescent; only one sternopleural bristle; squamulae white, pale fringed.

2 (5). Metallic species of a golden-green colour, with short antennae and with broad peristomialia; praetarsi of all the legs broadly yellowish at base; wings shorter than the body, with the first posterior cell narrowed at end, and with the sixth vein not distinctly prolonged to the hind border (subgen. *Lamprolonchaea*).

3 (4). Frons black, opacous, quite smooth or with two less distinct longitudinal furrows; last abdominal segment of the male semi-circular and not fringed . . . . . *aurea*, Macq.

4 (3). Frons bluish, rather shining, deeply rugose; last abdominal segment of male elongate-triangular and black fringed at hind border . . *rugosifrons*, sp.nov.

5 (2). Non-metallic species of a bluish-black colour, with long antennae, and narrow peristomialia; all the praetarsi black; wings as long as the body, with the first posterior cell not narrowed at end, with the sixth vein prolonged to the hind border (Subg. *Lonchaea*). . . . . *choreoides*, sp. nov.

6 (1). Arista plumose; two sternopleural bristles; antennae long; peristomialia narrow; praetarsi black; squamulae dark, black fringed (Subgen. *Carpolonchaea*). . . . . *citricola*, Bezzi.

1. *Lamprolonchaea aurea*, Macquart 1851 = *splendida*, Loew 1873 = *metatarsata*,* Kertesz 1901. This widely spread species (Mediterranean subregion and whole Ethiopian and Indo-Australian Regions) is said to be frequent in Australia, New Zealand and Pacific Islands; but probably it has been in part confounded with the following one. I have before me a specimen from Eidsvold (*Bancroft*).

2. *Lamprolonchaea rugosifrons*, sp. nov. Closely allied with the preceding species, but at once distinguishable by its greater size and by the very different frons in both sexes.

This is the second species of the subgen. *Lamprolonchaea* to be recognised. *L. browniana* Bezzi, 1919, being probably the same as *aurea;* it is possible that the present new species figures in some collection under the name of *splendida*.

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*Becker has described under this same name a very different species from South America (Miss. Arc. merid., Paris, 1919, x., 2, p. 188).

Type ♂ and type ♀ and some additional specimens of both sexes in the Health Department Collection at Sydney, New South Wales, from Sydney, December-January, 1920-1923 (*E. W. Ferguson*); Mt. Gambier, South Australia, December, 1920 (*Mr. Campbell*); Linga, North Western Victoria, October, 1922 (*F. E. Wilson*).

Length of body, 3.5-4 mm.; of wing, 3-3.5 mm.

A metallic shining species of a very brilliant, golden-green colour, except the head, which is black, somewhat bluish on the frons. Occiput entirely opacous, with a faint dark grey dust. Frons of the male narrow, only half as broad as one eye, 2½ times longer than broad; in the female it is almost twice as broad as in the male, only a little narrower than one eye; 1½ times longer than broad; it is shining black, with greenish or bluish reflections, and is deeply punctate, with broad impressed points, appearing thus very rugose. The small lunula is black or reddish-brown, white shining. Eyes oval, more developed in the male than in the female, unicolored, bare. Antennae inserted at middle of the eyes, broadly separated at base and diverging, being separated by a broad, flat, middle keel, which is more developed than in *aurea;* they are shorter than the face, the third joint being only 1½ times longer than the first two joints together; they are entirely black, the third joint a little whitish dusted; arista bare. Face entirely black, opacous, dark grey dusted on the antennal furrows, which are shining below; the middle keel is broad and complete, white shining in certain light. Parafacialia linear, white shining; peristomialia broad, broader than the third antennal joint, shining black and rugose, but less deeply and less irregularly than the frons. Palpi and proboscis black. All the bristles and hairs black; frontal hairs rather long and dense; vertical bristles of about the same length and rather short; occipital long; only one pair of orbital bristles, the superior one, curved behind. Thorax and scutellum entirely shining, quite devoid of dust; the rather long hairs of back and pleurae are black, like the bristles; two pairs of long dorsocentral, with some other shorter in front; 3-4 mesopleural, 1 sternopleural. Scutellum with four bristles and with only a few hairs between them. Squamulae whitish and white fringed; halteres black. Abdomen glistening and coloured like the mesonotum, with golden and cupreous reflections; it has rather long black hairs, chiefly at sides, but no bristles; the terminal segment in the male is about twice as long as the preceding one, triangular and fringed with long hairs at sides, almost divided in two tufts. Venter opacous black in both sexes; male genitalia black; basal segment of the ovipositor short and broad, black. Legs black, with the basal joint of all the tarsi reddish with a narrow black end; the four anterior femora are fringed with long and dense black hairs, chiefly in the male. Wings hyaline, iridescent, with a distinct whitish tint; all the veins are pale yellowish; costal cells dilated; second vein straight; third and fourth straight and distinctly, even if little, converging towards the end, the third ending a little before the tip of wing; costa ending at fourth vein; small cross-vein placed beyond the middle of the discoidal cell; hind cross-vein straight and perpendicular, more than twice as long as the last portion of fifth vein; first posterior cell narrower than the terminal half of the discoidal cell; sixth vein shorter than the distance between its end and hind border of wing.

3. *Lonchaea choreoides*, sp. nov. Very like the European *chorea* Fall; but distinguishable by the very different form of head and by the much broader frons in both sexes.

Type ♂ and ♀, a single couple of specimens in the Health Department Collection from Sydney, March, 1922 (*Dr. E. W. Ferguson*).

Length of body and wing, 4 mm. An entirely shining bluish-black species. Head distinctly broader than the thorax, in front view more broad than high,

but compressed in lateral view (in *chorea* the head is not broader than the thorax, and is moreover about as high as broad). Occiput black, shining above and near the eyes-border. Frons of about equal breadth in both the sexes, nearly subquadrate, being only a little longer than broad; it is black, silky, with shining ocellar and vertical plates; in front of the ocellar plate there is a broad but faint transverse furrow. Lunula semicircular, black, whitish shining. Eyes rather compressed, bare. Face broad and flat, entirely black, whitish dusted, with no distinct middle keel; parafacialia linear; peristomialia more narrow than the third antennal joint, black, opacous, smooth. Antennae inserted distinctly above the middle of eyes, separated at base, a little longer than the face; third joint about three times as long as the two basal joints together; they are black, the third joint grey dusted; arista bare, as long as the whole antenna. Palpi and proboscis black. Hairs and bristles black; frontal hairs dense; one superior orbital. Thorax and scutellum shining bluish-black, not dusted; hairs long and black; bristles long and black; two strong dorsocentral; several mesopleural but only one isternopleural; four scutellar, and between them rather numerous hairs. Squamulae yellowish (not white as in *chorea*), with whitish fringe; halteres black. Abdomen shining bluish-black, black haired; venter opacous black; ovipositor black. Legs entirely black, even on all the tarsi; hairs black; front femora fringed in the male. Wings long, hyaline, with a faint whitish tint; veins yellowish. Costal cells not much dilated; second vein straight; third vein curved below at end, ending at wing-tip; small cross-vein near the middle of the discoidal cell; first posterior cell broad; hind cross-vein straight, perpendicular, much longer than the portion of fifth vein beyond it; sixth vein with distinct spurious continuation to the hind border, curved in the middle. Costa ending at fourth vein; axillary cell very broad.

4. *Carpolonchaea citricola* Bezzi, 1913. One male specimen from Townsville, Queensland, "bred from fruit-fly larvae" (F. H. Taylor). Already found in Australia (Port Darwin), by Mr. G. F. Hill.

A MONOGRAPH OF THE AUSTRALIAN LORICATES.

(Phylum MOLLUSCA—Order LORICATA.)

By TOM IREDALE and A. F. BASSET HULL.

I. SYSTEMATICS AND STRUCTURE.

The marine mollusks comprised in the Order LORICATA were formerly classed as multivalve mollusks; "mollusks" being the name given to shell-forming animals with no bony structure, but generally carrying a shell of calcareous or horny structure. Gastropod mollusks were called univalves, the shell being in one piece. Lamellibranch mollusks were named bivalves, as the shell generally consisted of two pieces (although some of these have an accessory third piece), and the shells of the group now under consideration can be separated into eight pieces. The popular name given to the group was CHITON, from the Linnean name of the first recognised genus. Burrow wrote "The name of the Genus, CHITON, is derived from the Greek word χιτὼν, signifying a coat of mail; and aptly expresses the loricated appearance of the shell, arising from the position of the valves." The name LORICATA is derived from the Latin *Lorica,* which means equally a coat of mail or cuirass. As a popular or vernacular name for the group we suggest "Loricate." This name should prove more acceptable than Chiton, which is now the name of a very restricted genus of the group.

These shells are popularly known, more in a dismembered state than as entire shells, by various names, amongst which may be mentioned "Butterfly Shells," "Sea Butterflies," "Sunset Shells," and "Toe-nail Shells." The last name is current amongst the aboriginals of the Queensland coast.

Linné (1758) classed *Chiton* as a genus of the MOLLUSCA, and described four species. Cuvier (1799-1800) was content to follow Linné, and Dumeril (1806) accepted Cuvier's classification. Burrow (1815) also gave the multivalves generic rank only, and published the fact that Blainville had (in MS) separated the species we now know as *Cryptoplax* under the name *Cryptoconchus,* a separation independently confirmed by Lamarck, who published the name *Chitonellus* a year later than Blainville's *Cryptoplax* had appeared. Blainville prepared in MS (about 1814) a systematic classification of mollusks, in which he separated the multivalves from the other mollusks as a class. His paper was not accepted for publication in full, only an abstract being published in the Bulletin of the Société Philomathique, in which the class-name proposed was *Polyplaxiphores,* merely a vernacular name unaccompanied by any definition. Schumacher (1817) published in Copenhagen an elaborate "Essai d'un Nouveau Système des Habitations des Vers Testacés," printed in French and Latin in parallel columns. He separated the multivalves from the other mollusks, making them his second division under the vernacular name of "Les Armurées," with the corresponding Latin designation of "LORICATA." He provided a very full definition of the Class, and stated that there was only one known genus in the Division, namely, *Chiton* Linné. It is almost certain that he had not seen *Cryptoplax,* the only known specimens being in London and Paris. In his definition he states that the shells consist of "six or eight valves." It is now recognised that the former were

merely abnormal examples or malformations. Goldfuss (1820) proposed to separate the Loricates as an order under the name CREPIPODA. Gray (1821) proposed POLYPLACOPHORA as a name for the group, which he separated into two genera—*Gymnoplax* and *Cryptoplax*, but added a third genus *Acanthochitona*, and tentatively indicated two families. Blainville (1824 and 1825) in two separate publications proposed the Latin equivalent POLYPLAXIPHORA of his previously suggested vernacular *Polyplaxiphores*. Latreille (1825) separated them with family rank under the name *Lamellata*. Guilding (1829) proposed the emended form POLYPLAKIPHORA, and finally Dall (1870) proposed as a further emendation POLYPLACIPHORA, Fischer (1885), Haddon (1886), Pilsbry (1892), Sykes (1896), and Thiele (1910) all accepted Gray's name POLYPLACOPHORA. It seems remarkable that Schumacher's name should have been overlooked by all previous writers, especially in view of the fact that quite a large number of the generic names proposed by him in the same work were adopted and remain valid at the present time. Herrmannsen in his Index Gen. Malac. (1847) correctly included LORICATA Schum. 1817 = POLYPLAXIPHORA Blainville, 1824.

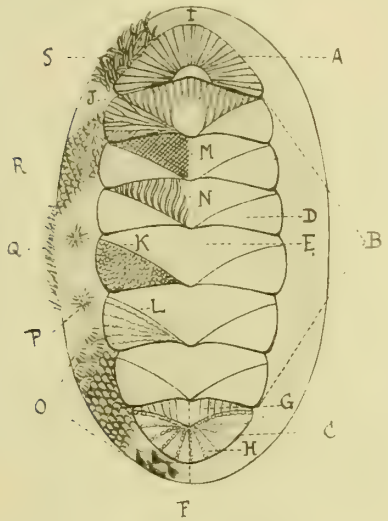

Fig. 1.—Composite diagram of a Loricate, showing the parts of the shell (A to H); the variations of sculpture more frequently occurring (I to N), and the principal varieties of girdle-covering (O to S).

A. Anterior valve. B. Median valves. C. Posterior valve. D. Lateral area. E. Central area. F. Mucro. G. Ante-mucronal area. H. Post-mucronal area.

I. Radially ribbed. J. Divaricating radially. K. Nodulose. L. Radially nodulose. M. Graduated in quincunx. N. Sulcate.

O. Scales (mucronate, smooth, and striate). P. Spiculose bunches. Q. Spicules. R. Scales and spiculose tufts. S. Calcareous spines.

The Shell.—The shell of the Loricates consists of eight pieces, called *valves*, held together by a leathery *girdle*. These valves, which are composed of a chitinous foundation, reinforced by carbonate of lime, may be separated from the girdle by soaking the shell in water for a few hours, or by boiling in a weak (5%) solution of caustic soda. They are of three forms; viz.—the head or *anterior* valve; six central or *median* valves, all of the same shape but differing slightly in dimensions; and the tail or *posterior* valve. They are occasionally referred to by consecutive numbers, 1 to 8, commencing with the anterior valve. The anterior valve overlaps the first median valve, which in turn overlaps the second, and so on, the seventh (or sixth median) valve overlapping the front edge of the posterior valve. Each valve is composed of two or more layers, the outer or surface being called the *tegmentum*, and the inner called the *articulamentum*. The tegmentum is in nearly all Loricates divided into more or less clearly defined *areas*, which are adorned with the *sculpture*, or *colour-pattern* which forms

the basis of specific variation. The median valves are divided into two *lateral* and two *central* areas, connected by a *dorsal* area, extending along the ridge of the valve, the posterior extremity of which, if projecting, is called the *beak*. The line of demarcation between each lateral and central area is called the *diagonal*. As a rule the anterior valve forms a complete area as regards sculpture, which generally resembles that of the lateral areas of the median valves; occasionally the *apex* is differentiated. The posterior valve is divided into two areas by a *mucro* or projection, more or less central. The area in front is styled the *ante-mucronal*, and the area behind is styled the *post-mucronal* area; the former is sculptured similarly to the central areas of the median valves, and the latter is sculptured similarly to the anterior valve. In some genera the mucro is so far behind the centre that the post-mucronal area is reduced to an inconspicuous tract, or is altogether absent.

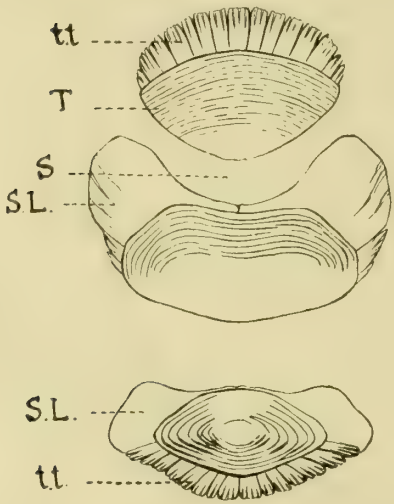

Fig. 2.—Anterior, median, and posterior valves of a Loricate, showing external features.
T. Tegmentum. tt. Teeth of insertion plate. S. Sinus. S.L. Sutural laminae.

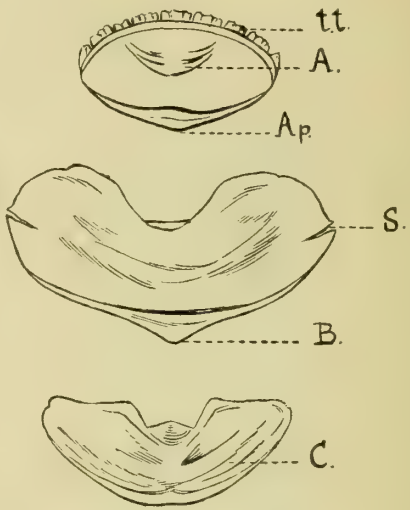

Fig. 3.—Anterior, median and posterior valves of a Loricate, showing interior features.
A. Articulamentum. tt. Teeth. Ap. Apex. S. Slit. B. Beak (or Umbo). C. Callus.

The articulamentum is larger than the tegmentum, projecting in front, as regards valves 2 to 8, in two *sutural laminae*, which are separated by a bay called the *sinus*. At the sides of the median valves and round the outer edge of the end valves, most Loricates have projecting *insertion plates*, to which the girdle is attached. These insertion plates are generally cut into by *slits*. From the slits to the apex of each valve inside run *slit-rays*. The edges of the insertion plates between the slits are called *teeth*, which are in some genera finely cut into combs or *pectinated;* in some thickened outside or *propped*, and in some cut quite square.

The Girdle.—The valves of the shell are linked together by means of a flexible integument, composed of muscular tissues in which the insertion plates or edges of the valves are embedded. This is called the *girdle*, and its surface is variously clothed with *scales* (which may be smooth and rounded, polished, striated

flat, regular, or irregular), *calcareous spines* (which may be uniform, irregular, straight, or curved), *spicules, hairy processes,* or a combination of two of such coverings. In some forms the girdle encroaches upon the valves. In those genera which have a posterior sinus in the tail valve, the girdle has a corresponding sinus or slit. The slitting of the insertion plates, and the covering of the girdle form the principal characters upon which genera are founded

Colouration of Shell.—The colouration of the tegmentum may be divided into three categories, viz:—(1) Specific, (2) Individual, and (3) Environmental.

1. *Specific.*—Many species have a fixed colour-pattern, which may extend over the whole tegmentum, or be restricted to certain definite parts, the remainder of the shell being variable in colouration, which is therefore individual. The specific colouration is always present and, within its extent, unvarying.

2. *Individual.*—Some species show no specific colouration but present a fascinating variety of colours, which may be either uniform for the whole shell, or picked out in contrasting colours and shades, the whole forming a beautifully symmetrical pattern, the markings extending over each valve in exactly the same manner on each side of the dorsal area.

3. *Environmental.*—Colour which has been absorbed or assumed as the result of some strong local influence, such as the presence of rusty iron in the pool, which imparts a reddish or brownish tinge to the shell; or the character of the rock which, if basalt or ironstone influences the shell to assume dark colours, and if sandstone or limestone causes lighter and brighter shell colouration. Evidence of protective colouration may be found in some species, but it is evanescent, dying out as the shell dries. The more brilliant shells of individual colouration are sometimes found in environments that suggest protective mimicry, but the fact that the animals are nomadic, and are just as frequently found in positions where their colour contrasts violently with their surroundings effectually disposes of the assumption that the colours are adopted for the purpose of protection.

Teratology.—Abnormal Loricates, having less than eight valves, are occasionally met with. We have collected specimens of several different species with five, six, or seven valves. Though some of these abnormalities are due to fracture and subsequent fusion in repair, quite a number are clearly of congenital origin. A specimen having only three valves is preserved in the British Museum, the six median valves having become fused into one.

The Animal.—The ventral surface of the Loricates consists of a fleshy foot, similar to that of the *Gastropoda.* Anterior to the foot is the head, with the mouth in the centre. The gills extend along and behind the edges of the foot from one-fourth to the entire length of the foot; commencing at the posterior end. The distinguishing feature of the Order is the symmetrical arrangement of the internal anatomy, all other Gastropods being asymmetrical in this respect. While there are no tentacles or eyes in the adult, many species have visible *ocelli* in the tegmentum, which are connected with the nerve-centre and are functional in conveying to the animal the sensation of light or darkness. Even where these ocelli are not visible, the animal is sensitive to light, and endeavours to escape from it.

The *radula,* the organ by means of which Loricates obtain their food consists of a long siliceous ribbon bearing numerous rows of hooklets, and as this is the only hard part of the internal anatomy of most mollusks it has been largely used in grouping. In the Loricates the radula, odontophore, or lingual ribbon, as the organ is variously called, is of a complex type and can only be used by a specialist familiar with microscopic work, requiring long and careful study. As it is easily seen with the naked eye near the head when Loricates are being cleaned

out, we may note the general features as follows:—Viewed with a lens it presents a spiny surface, the spines arranged in rows of about 16, two near the middle being much larger and more strongly hooked than the others. The total length of the radula may, in the larger Loricates of our coasts, measure 10 mm., with a breadth of 1 mm. It is used to tear away the algal food by a forward thrust, the small particles of food being conveyed to the stomach by retracting the ribbon.

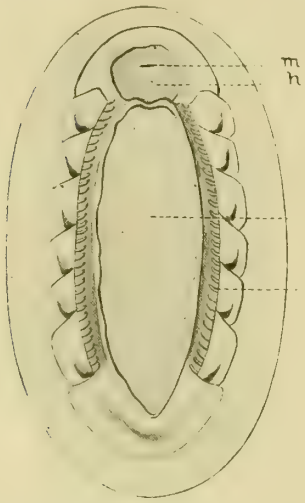

Fig. 4.—Loricate Animal, as dried in shell (when alive the foot is generally more expanded hiding the gills).
H. Head. M. Mouth. F. Foot (ventral surface). G. Gills.

Ecology.—This term is here applied to the position or *station* on the littoral or sea floor frequented by the various genera, and their interrelation with surrounding conditions. Generally speaking, the Loricates are of littoral habit, the range extending from mean high water mark to a few feet below low water mark. A small percentage of recorded species is found at greater depths below low water, those from the greatest depths being more or less degenerate forms. The station of the various genera differs, some being restricted to the upper side of the rocks; a much larger proportion being found on the under side of stones below median tide mark; while others are found attached to the leaves or stalks of sea grasses. Those genera which are emerging and gradually becoming established in stations where they are exposed to the sun and air for the greater part of each day are generally eroded or covered with marine growths which obliterate their sculpture. These forms appear to be sedentary. The occupants of the next lower zone are more nomadic, moving freely and changing their station in accordance with the seasons and the varying surface temperatures of the water. It may be noted that these factors are not always synchronous, the eastern coast of Australia affected by the Notonectian Current retaining a higher temperature through the early winter than those parts of the coast not so affected.

Reproduction.—Dall (Scientific Results of the Exploration of Alaska, 1878) states that these animals are of two sexes, the histological characters of the male and female gland resembling those of the Limpets. Clark (Annals and Magazine of Natural History, 1855) observed an individual of *C. marginatus*, placed in a vessel of sea-water, which "poured out for several minutes a continuous stream of flaky-white viscous matter, like a fleecy cloud, and then discharged ova—not in volleys, but one or two at every second for at least fifteen minutes, forming a

batch of from 1,300 to 1,500." Lovén (Transactions of the Royal Academy of Sciences, Stockholm, 1855) says that "some individuals kept in confinement laid their eggs, loosely united in clusters of from 7 to 16, upon small stones." One of us took specimens of *Heterozona subviridis* at King Island, Bass Strait, with clusters of eggs disposed along the outer margin of the foot. Dall (*loc. cit.*) summarises Lovén's observations in the following terms:—"The Chitons differ from most Mollusks in that the shell does not appear on the embryo until some time after they are hatched. The embryo of *Chiton cinereus* is oval, with no trace of shelly valves or depressions for them, and is divided into two nearly equal parts by a transverse depression, the margins of which are ciliated. On the middle of the upper part is a tuft of filaments which move slightly. At each end of the depression are two dark points, representing the eyes. The young when hatched become more elongated, the front part is finely ciliated, and the tuft occasionally vibrates. The hinder part extends more rapidly and becomes conic. The back is marked by seven furrows; between these the first rudiments of shelly valves make their appearance in the form of fine granulations. Soon after this, the animal can crawl as well as swim, and the mantle becomes separated from the foot by an indentation. The eyes are placed on the ventral side, and hardly visible from above. The upper anterior part of the animal is marked with acute tubercles. The mouth is not yet visible. The valves first appear in the form of seven narrow bands with irregular margins; the tuft disappears. The head and mouth then develop. The eyes are on distinct lateral protuberances. No gills have appeared. The mantle and front valve advance over the head and eyes; the tuberculated area in front of the valves is gradually diminished, and the tail-plate appears behind the seventh. The valves are at first irregular, but increase from below, and deep notches, persistent in the adult, are formed on the front edges, one on each side. It will be seen that the valves are formed each in one piece, and not by the coalescence of parts corresponding to the various areas of the adult valve."

Food.—So far as is known at present, the majority of Loricates are vegetable feeders, but there have been records of carnivorous habits in respect of certain individual species. Further investigation and observation in aquaria is necessary to determine whether the known carnivores are habitually or only occasionally addicted to an animal diet.

Region.—"Australia," for the purposes of this Monograph, means the Continent and Tasmania, but does not include Papua, Lord Howe, Norfolk, or Macquarie Islands. The coast line, exclusive of the minor gulfs and inlets, extends for about 7,500 miles, and embraces both tropical and temperate seas. The Loricate fauna is exceptionally rich, particularly as worked out in the southern portions, while there is much yet to be found in the unworked parts of the north and west. This vast area comprises three distinct faunal regions, which were first indicated by Hedley (Proc. Linn. Soc. N.S.W., Vol. xxviii., pp. 876-883, 1903) who differentiated four regions, to which he gave the names Adelaidean, Peronian, Solanderian and Dampierian Regions. He placed the limits of the Adelaidean Region in the vicinity of Wilson's Promontory in Victoria, and Geraldton in Western Australia, embracing the whole southern coast of Australia, and round the south-west corner, including north and west Tasmania. The Peronian Region comprised the east coast from Wilson's Promontory south along the east coast of Tasmania, and north to Moreton Bay in south Queensland. The Solanderian Region included the remainder of the Queensland coast northwards to Torres Strait; while the Dampierian Region extended westward from Torres Strait to Houtman's Abrolhos, scarcely north of Geraldton, Western Australia. One of us (Iredale, Proc. Zool. Soc. Lond., 1914) suggested that the shells from the Monte Bello Islands were almost entirely Solanderian, and we therefore now

propose to coalesce, in this place, Hedley's Solanderian and Dampierian Regions, under the former name, the Loricates showing no essential differences at present.

Collection and Preservation of Loricates.—A considerable number of species may be collected at low tide without even wetting one's boots, but to obtain the occupants of the lower zones it is necessary to wade into water to a depth of three feet. It is advisable, therefore, to take a change of clothing and a strong pair of boots to protect the feet from oyster shells and sharp stones. Rock eels and octopods are frequently met with in the pools, and some protection from the bite of the former and the tentacles of the latter is desirable. A short crowbar or a curved iron "crook" to lift heavy stones should be carried. To remove the Loricates from the stones to which they adhere a penknife is required, while a pin may be used for the smaller specimens. Slips of wood, one to two inches in width and eight inches in length, or of glass one by four inches, with tape or string to bind the shells thereon are necessary if "cabinet" specimens are required. Immediately upon removing the shell it should be placed on the wetted slip and gently pressed down until it assumes a natural position with the girdle well expanded. A few turns of the tape should be taken round the shell and the end left loose for the next specimen. With most shells the tape can be drawn quite tightly, but some of the more fragile shells, such as *Parachiton,* require a certain amount of care as the valves are liable to become crushed. Both sides of the slips can be filled if the shells are plentiful. In the case of the larger specimens it is as well to remove the animal before tying the shell down. This can be done by running the knife round the body, cutting from the tail forward, so as not to come into opposition to the sutural laminae. If it is desired to retain the animal for examination of the radula, etc., it may be allowed to remain and dry on the slip, or the slip when filled placed in alcohol. Formalin should never be used as a preservative. To make cabinet specimens of vermiform Loricates, such as *Cryptoplax,* the animal should be removed, and a boat-shaped piece of wood cut to the required length, with both ends pointed. This should be fitted into the shell, the flexible girdle adjusted, and the tape wound tightly round the whole.

If specimens are plentiful and time short, they can be rapidly transferred from the stones to the slips, and placed in a can of *fresh* water, in which they will drown, in most cases relaxing in dying. On reaching home the collector can remove the animals and tie the shells down at leisure. Those having spongy girdles, such as *Onithochiton, Lepidochiton* and *Plaxiphora,* should be manipulated by pressing the girdle outwards between the forefinger and thumb, both at the time of tying down and once or twice during the process of drying. The interior of the shell should be wiped dry after removing the animal and before tying the shell down.

When it is desired to make particularly fine cabinet specimens, too much care cannot be bestowed on the arrangement of the girdle and the disposition of the shell in as natural a manner as possible. Each specimen should be washed in clean fresh water to remove the salt, which crystallises and dulls the surface colouration. It is not advisable, however, to use any artificial varnish, vaseline or oil, for although such media may tend to restore the brilliancy of the colouring they invariably impart an unnatural appearance to the shell, or collect dust and hairs.

For the cabinet or display in a museum the shells may be mounted most effectively on neutral tinted cards, a very small quantity of gum tragacanth being used to attach the two ends to the card. This gum leaves no shiny trace on the card, and while holding the specimen firmly in place allows of its removal without damage. In every instance the locality where the shell was taken should be noted on the card, and in this respect the collector cannot be too precise. Such localities as "New South Wales" are too vague—the exact bay or headland should be specified, and the date of taking added, together with the name of the collector.

Classification.—Nearly every student has proposed an improved system in this group. Thus Dall improved upon the Carpenterian M.S., and Pilsbry put the group into good working order, so that only in detail did emendation seem possible. However Thiele, by means of intensive study of the radula, was able to indicate some amendments in Pilsbry's scheme which showed progress, and we have utilised Thiele's basis for the purpose of our reconstruction. Iredale has already suggested (Proc. Mal. Soc.) the rejection of Thiele's *Lepidopleurina* as a primary division, and we here omit all subordinal distinction, classing the Loricates in several families without intermediate higher groupings.

There is no necessity to discuss here extra-Australian groups, the Australian Loricates falling into a few families, well differentiated, with a few genera difficult to locate. Thus *Ischnochitonidae, Lepidopleuridae, Lepidochitonidae, Callistochitonidae, Loricidae, Cryptoconchidae, Cryptoplacidae, Plaxiphoridae,* and *Chitonidae* are easily separable in this sequence, but the exact relation of *Choriplax* is yet unknown.

The above sequence suggests that we regard the *Ischnochitonidae* as representing the most primitive stock and that the *Lepidopleuridae* are probably degenerates, a possibility Pilsbry was also inclined to accept when he placed the *Lepidopleuridae* as the most primitive forms. *Lepidochitonidae, Callistochitonidae,* and *Loricidae* are developed Ischnochitons, while the *Cryptoconchidae* and *Cryptoplacidae* may have evolved from an Ischnochitonid ancestor, with another branch developing into the *Plaxiphoridae,* and another into the *Chitonidae.* Thus the primitive Loricate might have had the tuberculose sculpture of the juvenile Ischnochitonids or Lepidopleurids, and the scaly girdle as seen in these. No Ischnochitonid in this region has developed a hairy or spinose girdle, but *Chaetopleura* (South America) is of that form. Complex sculpture has been produced, but the insertion plates are always of simple design. The Lepidopleurids have degenerated, losing the insertion plates though retaining primitive sculptural design. The Lepidochitons have modified the sculpture a little, but have developed the scaling so that in some species corneous processes are seen. It should be noted that a Lepidopleurid with a hairy girdle has been found, while a series of Lepidopleurids has developed the scales into spicules. The insertion plates of the Lepidochitons have also become modified, the teeth being coarse, irregular and brittle, but so far no loss of insertion plate is known. The *Cryptoconchidae* form a well-developed group in which the sculpture is mostly nodulose, a few developing linear sculpture as a result of the fusion of the nodules. The girdle is always spiculose, but in some cases there is almost a scale-like subordinate covering, while the insertion plates have become for the first time reducible to definite formula, the anterior valve being five-slit, the median valves one-slit, and the posterior valve with two side slits, more or less inter-slit. A further modification has produced the *Cryptoplacidae,* wherein an elongated worm-like body has been formed, the valves being diminished in size, the girdle proportionately very large, always covered with spicules, and the insertion plates long, in the anterior valve only three-slit, long in the median valves but unslit, and tending to reduction in the tail valve. Then the *Plaxiphoridae* have developed a formula of insertion plate slitting in which the anterior valve has eight slits, the median valves one slit, and the posterior valve only a callus; the girdle bearing hairy processes only.

The Chitonidae, as at present recognised, include a series of Loricates with the highest development, having varied sculpture, varied insertion-plate slitting, and varied girdle covering, with the two additional features of pectination of the insertion plates and visible ocelli in the tegmentum.

Key to the Families.—The differential features of the Families may be epitomised as follows:—

Girdle-covering scales only; insertion plates in all valves; more than eight slits in the head valve, all teeth smooth, and no scalloping present. . . *Ischnochitonidae.*

Girdle-covering scales, calcareous spicules, or corneous processes; insertion plates wanting, or if present, obsolete and unslit. . . . . *Lepidopleuridae.*

Girdle-covering of slender scales latitudinally very closely packed, sometimes with corneous processes present; insertion plates in all valves, teeth coarsely denticulate. . . . . *Lepidochitonidae.*

Girdle-covering scales only; insertion plates in all valves; teeth peculiarly scallopped. . . . . *Callistochitonidae.*

Girdle-covering scales and spicules or corneous processes of complex growth; insertion plates in all valves save posterior valve. . . . . *Loricidae.*

Girdle-covering of calcareous spicules with prominent bunches; anterior valve with five slits. . . . . *Cryptoconchidae.*

Girdle-covering of closely-packed calcareous spicules, bunches not very prominent; anterior valve with three slits; shape very elongate. . . . . *Cryptoplacidae.*

Girdle-covering of corneous processes of simple growth; anterior valve with eight slits. . . . . *Plaxiphoridae.*

Girdle-covering of scales or calcareous spines, never of corneous processes; teeth of insertion plates finely pectinate. . . . . *Chitonidae.*

These differential features apply more particularly to Australian forms.

(To be continued.)

NEW AUSTRALIAN LORICATA AND NOTES ON THE DISTRIBUTION OF CERTAIN SPECIES. 1.

By A. F. Basset Hull.

II.

Ischnochiton verconis.

Ischnochiton verconis Torr, Trans. Roy. Soc. S. Aust., 1911, xxxv., p. 102.
Ischnochiton verconis Ashby, Proc. Roy. Soc. W. Aust., 1921-2, viii., p. 33.

Dr. Torr's type of *Ischnochiton verconis* remained as the only published record until Ashby recorded a specimen in the Western Australian Museum taken at Bernier Island.

While on the voyage from Albany to Esperance in November, 1921, the s.s. *Eucla* called at Hopetoun, where I seized the opportunity afforded by an hour's loading, of examining the rocks near the jetty. Here I had the good fortune to take two fine examples of *I. verconis*, on opposite sides of the same stone, in about 2 feet of water at low tide. At first glance I took them to be *Ischnoradsia australis*, the dark slate colour, large size, and active movement away from the exposed surface of the stone all suggesting that species. Closer examination, however, soon convinced me that I had secured Dr. Torr's species at a distance of about 300 miles from the type locality and subsequent comparison with the type confirmed my identification. The Bernier Island record extends the range of this rare species over nearly 1,000 miles of the south and south-western coast of Western Australia.

Dr. Torr did not disarticulate his type, and therefore was unable to examine the slitting, but considered that there were eight teeth in the anterior valve. I have disarticulated one of my shells, and find that the formula is 12-1-12. In its girdle characters, sculpture, and general appearance this shell differs from all other *Ischnochitonidae*, and I therefore propose a new genus for it, placing it between Heterozona and Anisoradsia.

Strigichiton, *new genus.*

Shell broad, tegmentum very strongly reticulated and elaborately sculptured.

Girdle covering, scales of varying sizes, very deeply grooved or channelled. Anterior and posterior valves having 12 slits, median valve 1 slit. All teeth very sharply cut, not pectinated.

Type. *Ischnochiton verconis* Torr.

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1. In the first part of this paper (p. 157 ante) I used the ordinal name Polyplacophora (Gray, 1824). As shown in this journal (p. 186) Schumacher's Loricata has priority over Gray's name. The following corrections should be made in Part I: on page 158. For "Mrs. Arthur North," read "Mrs. D. S. North," and on page 164 for "Rhyssoplax carnosus" read "Rhyssoplax carnosa."

Ischnoradsia australis divaricata n. subsp.

Plate xxvii. Figs. 1, 1a, 1b, and 1c.

At Caloundra and Point Cartwright, South Queensland, I took numerous examples of an *Ischnoradsia* which, although belonging to the eastern Australian species *australis*, showed sufficient variation in sculpture to warrant its separation as a subspecies. The central areas are strongly sculptured with two or three rows of straight vertical lines, separated by fine horizontal lines after the pattern of a picket fence. The sculpture of the lateral areas is much more branching and composed of fewer riblets than in *I. australis*. Examination of a series of juvenile specimens shows that this sculpture commences in the form of three small rounded tubercles near the exterior margin (fig. 1a). These tubercles are increased by one or more behind the first, which show a tendency to become elongated (fig. 1b). The exterior margin then shows three tubercles, with a succession behind of three or more rows (fig. 1c). The tubercles are then rapidly elongated, gradually extending to and partially fusing with each other, thus forming the widely branching sculpture of the adult shell (fig. 1).

Acanthochiton purpuratus, n.sp.

Plate xxvii., Fig. 2.

Shell large, elevated, carinated, side slopes convex. Colour, ochraceous, flecked with dull red.

Anterior valve densely covered with small oval pustules tending to radiate towards margins; no definite raised ribs.

Median valves; lateral areas not differentiated, having several rows of small rounded or oval pustules arranged more or less vertically; dorsal area very large, V-shaped, vertically striate with faint cross lines, forming at the apex a very strong beak.

Posterior valve with prominent mucro behind the middle, straight behind, covered with pustules except on the dorsal.

Girdle as wide as the exposed portion of the valves, colour dull purple, densely clothed with calcareous spicules and having large spiculose tufts opposite the sutures, which are generally withdrawn and disappear as the girdle dries.

Interior white; anterior valve 5 slits, median valves, 1 slit, the posterior valve in the specimen disarticulated is irregularly slit, there being ten teeth, some doubtless the result of interslitting.

Dimensions: 18 x 11 mm. (dry).

Station: Under stones in rock pools at low tide.

Locality: Betangabe Inlet near Twofold Bay; (type), Port Jackson, Long Reef and Shellharbour, N.S.W.

Remarks: Differs from *A. wilsoni* Sykes in the size, shape and arrangement of the pustules which are oval instead of triangular, and the much larger dorsal area.

When collecting with me on Long Reef, north of Manly, New South Wales, in 1908, my brother W. D. Hull, found two specimens of an *Acanthochiton* having a very wide and spongy girdle which he at first mistook for *Cryptoplax*. Hedley and I (Rec. Aust. Mus., 1909) recorded this discovery as *Acanthochites wilsoni* Sykes, but subsequent examination of typical examples of this shell from Port Phillip led me to doubt the accuracy of our identification. I then sent the two shells to Iredale, who considered that they represented a new species. Roy Bell subsequently collected two similar shells at Betangabe Inlet, south of Eden, New South Wales. In 1922 G. McAndrew took two smaller shells of the

same species near Point Bass, Shellharbour, New South Wales, and during the present year (1923) two specimens have been discovered at the famous collecting ground, Bottle and Glass, Vaucluse, Port Jackson, one by W. Barnes and the other by A. E. J. Thackway.

Lorica paucipustulosa, n.sp.

Plate xxvii. Fig. 3.

Shell large, elevated, carinated, side slopes convex. Colour, deep reddish-brown.

Differs from *L. volvox* Reeve and *L. cimolia* Reeve in the small number and scattered nature of the pustules on all valves, and in the ribs of the central areas, which are only three extending across the area with one or two short ribs near the dorsal area.

Girdle covered with large and small polished scales, and with scattered spiculose tufts not related to the sutures.

Interior white. Anterior valve with 10 slits, median valves with 1 slit. All teeth, and posterior valve callus, pectinated.

Dimensions: 50 x 28 mm.

Station: Under stones at low tide.

Locality: Rabbit Island, King George Sound, Western Australia.

Remarks: This shell is striking in the simplicity of its sculpture, contrasting strongly in this respect with the South Australian and New South Wales species. Specimens larger than the type were collected, but they were much eroded. Traces of a secondary sculpture could be seen, the central areas becoming more wrinkled towards the margin. These examples measured up to 70 x 35 mm.

Genus Liolophura.

Pilsbry (The Nautilus, 1893, vi., p. 105) established the genus *Liolophura*, taking *Chiton japonicus* Lischke as the type, with the following definition:—"Valves exposed, dull and somewhat roughened, generally eroded outside, with minute eyes irregularly scattered over the lateral areas, the head-valve and the sides of the central areas. Interior dark coloured, having anterior and side insertion-plates slit into teeth and sharply pectinated outside; posterior valve with posterior terminal mucro, lacking the insertion-plate, which is represented by a flat callous ledge. Sinus wide, deep, smooth. Girdle covered with stout calcareous spines or obtuse club-shaped processes."

He listed *L. gaimardi* Blainville and *L. georgiana* Quoy & Gaimard as the Australian representatives of the genus, but provisionally noted *Chiton curtisianus* Smith, which he was disposed to believe was a member of the genus. This shell, however, is now definitely placed in the genus Squamopleura, the posterior valve having teeth.

Pilsbry noted that the valves of *L. gaimardi* are "always considerably eroded," but he observed that they were "concentrically wrinkled toward their bases." The girdle he described as "densely clothed with intermingled, minute, larger and large calcareous spines." Quoy and Gaimard described the valves of *L. georgiana* as "having concentric striae, the anterior and lateral most marked." The girdle was "very thick, little dilated at the sides, covered with very small rounded tubercles."

Blainville, however, published (1826) *Chiton hirtosus* Péron, from "Seas of the Island of King," which he compared with the preceding species (*L. gaimardi*) as being "less long and broader," and with a girdle "covered with a multitude of little squamo-spinous tubercles." In publishing this (translated) description Pilsbry, in his Appendix of "Insufficiently described Chitons, and species of un-

known generic position" (Man. Conch, 1892, xiv., p. 106) says "This may be an *Onithochiton* or a *Liolophura*." W. L. May and I both collected at many stations on King Island in 1922, including the locality visited by Péron and Lesueur in 1802, but we failed to discover any trace of a *Liolophura* or any shell that could be made to fit the description of *C. hirtosus*. Péron, however, also collected at King George Sound, Western Australia, in 1802 (the type locality of Quoy and Gaimard's *L. georgiana*) and his collection passed through many vicissitudes before it was ultimately examined by Blainville. A confusion of locality probably occurred, such as undoubtedly took place in the case of *Chiton* (*Stenochiton*) *longicymba* Blainville, which was attributed to "Seas of the Island of King" (where I failed to find it) whereas it is very plentiful in the harbour at Albany, King George Sound. I collected large numbers at the Quarantine Ground, Albany.

In 1894 Pilsbry published (Proc. Acad. Nat. Sci. Philad., p. 87) a revised synonymy of *L. gaimardi* Blainville, and described a shell from Bundaberg, Queensland, as variety *L. Gaimardi queenslandica*, distinguishing it by the larger size, the more slender girdle spines, and the uniform black colour of the girdle.

I have collected a very large series of each of the three foregoing species, my field extending over 300 miles of South Western Australia (King George Sound to the Recherche Archipelago), the whole New South Wales coast; and the coast of Queensland from Southport to Townsville. My collections include perfect examples of the Western Australian and Queensland species, so that I am enabled to present figures approaching that degree of perfection that is the goal of all students of this fascinating group of mollusks, together with fairly good examples of the New South Wales shell. The result of my work, I think, justifies the following revision of the genus.

Liolophura gaimardi.

Plate xxviii. Figs. 1-4.

Chiton gaimardi Blainville, Dict. Sci. Nat., 1825, xxxvi., p. 546.
Chiton incanus Gould, Proc. Bost. Soc. Nat. Hist., 1846, ii., p. 145.
Maugeria incanus Gould, Otia, p. 248.
Acanthopleura incana E. A. Smith, 1884, Zool. Coll. H.M.S. Alert, p. 81.
Liolophura gaimardi Pilsbry, Man. Conch., 1893, xiv., p. 240.
Liolophura gaimardi Hedley, Proc. Roy. Soc. N.S.W., 1918, li., (supp.).

Shell the smallest of the genus. Lateral areas not very clearly differentiated; sculpture of all valves consisting of concentric lines; in very young examples the areas between the lines are slightly pustulose. Girdle scales of three distinct forms: (a) small, pebbly, rounded, irregular scales, (b) larger conical truncated spines, (c) long, pointed, slightly curved spines.

Interior: Dull purple, sutural laminae white.

Dimensions: 45 x 25 mm.

Station: On the upper surface of rocks, in crevices, and on the dead shells of rock oysters, between high water and median tide mark.

Locality: New South Wales, from Port Hacking to Broken Bay (about 49 miles of coast line from point to point, not including indentations of the four harbours opening on to the coast).

Remarks: Very common in Port Jackson and Broken Bay, but rare on the ocean front. Valves nearly always eroded, even in very young examples. Although I have failed to discover this species outside of the very limited range above indicated, it is quite possible that it may yet be found to extend further along the New South Wales coast.

Liolophura queenslandica.

Plate xxviii. Figs. 5-8.

Liolophura gaimardi queenslandica Pilsbry, Proc. Acad. Nat. Sci. Philad., 1894, p. 87.
Liolophura gaimardi, var. *queenslandica* Hedley, A.A.A.S., 1909, p. 352.
Liolophura gaimardi Iredale, Proc. Mal. Soc., 1910, ix., p. 157.

Shell larger than the preceding; anterior valve covered with oval tubercles not arranged in any distinctly radial lines. Lateral areas of median valves clearly differentiated, sculptured with seven or more radiating rows of oval tubercles; central areas horizontally lined. Posterior valve with mucro nearly terminal; ante-mucronal area horizontally lined, post-mucronal area tuberculate. Girdle scales somewhat similar to those of *L. gaimardi*, but smaller, the conical type predominating.

Interior: Dark purple-brown, sutural laminae lighter, but not white.

Dimensions: 55 x 35 mm.

Locality: Queensland, from Caloundra (Bribie Island) to Townsville, about 800 miles of coast line.

Station: Similar to that of *L. gaimardi*, and under stones in rock pools.

Remarks: Very common on the ocean coast, even in the most exposed positions, where the valves are greatly eroded; when found under stones in rock pools the sculpture is less affected, examples being occasionally found with the sculpture intact. In this station the girdle is distended to such an extent that the scales and spines are widely separated, showing the white surface of the integument to which they are attached. Upon removing the shell from the stones, however, the girdle rapidly contracts, and the covering scales and spines become crowded together, as seen in all dried specimens. I here suggest that in this and other genera having wide fleshy or spongy girdles (e.g., *Plaxiphora* and *Onithochiton*) and which occupy similar stations, uncovered by water for a great part of the day, the girdle is utilised as a reservoir, sufficient water being absorbed during high tides to keep the gills supplied when the tide has receded, leaving the shells exposed to the air.

Clavarizona, *new genus.*

Similar to *Liolophura*, excepting the girdle covering, which consists of short, obtuse, striated scales, resembling the heads of aboriginal clubs or nulla nullas. Type, *Chiton hirtosus* Blainville.

Clavarizona hirtosa.

Plate xxviii. Figs. 9-12.

Chiton hirtosus Blainville, Dict. Sci. Nat., 1826, xxxvi., p. 546.
Chiton georgianus Quoy & Gaimard, Voy. de l'Astrolabe, Zool., iii., p. 379, t. 75, f. 25-30.
Liolophura georgiana Pilsbry, Man. Conch., 1892, xiv., p. 241.
Chiton georgianus Iredale, Proc. Mal. Soc., 1910, ix., p. 154 and 1916, xii., p. 105.
Acanthopleura (*Liolophura*) *georgiana* Thiele, Fauna Sud-West. Aust., 1911, p. 399.
Liolophura georgianus } Torr, Trans. Roy. Soc. S. Aust., 1911, xxxv.,
Plaxiphora pustulosa. } p. 100 and 107.
Acanthopleura (*Liolophura*) *hirtosa* Dupuis, Bull. Mus. d'Hist. Nat., 1917, xxiii., p. 533.
Liolophura georgiana Ashby, Trans. Roy. Soc. S. Aust., 1921, xlv., p. 45, Proc. Roy. Soc. W. Aust., 1921-2, viii., p. 32.
Liolophura (*Chiton*) *hirtosus* Ashby, Trans. Roy. Soc. S. Aust., 1922, xlvi., p. 579.
Chiton hirtosus Lamy, Bull. Mus. d'Hist. Nat., 1923, p. 263.

Shell large, broadly oval, moderately carinated, side slopes convex. Colour, olive-green, brown, or black, the two former generally having the dorsal area darker in a series of V-shaped markings, the black shells occasionally exhibiting on one or more of the median valves white patches which extend to the adjacent part of the girdle.

Anterior valve crowded with oval tubercles, irregularly radiating towards the margin; several concentric growth lines causing undulation of the surface.

Median valves with lateral areas strongly differentiated, sculptured with eight or more radiating rows of elongated polished tubercles; central areas with numerous wavy concentric lines over the dorsal area, and breaking up into large oblong tubercles becoming more pronounced towards the margins. Valve ii. also shows three or more vertical lines on the dorsal area, crossing the wavy lines and converging posteriorly.

Posterior valve with projecting terminal mucro, the large ante-mucronal area sculptured similarly to the central areas of the median valves; the post-mucronal area almost recurved, and sculptured with a few elongate tubercles.

All valves with numerous ocelli, scattered on valve i., and chiefly along the diagonal in two or more rows on valves ii. to viii.

Girdle densely clothed with short, obtuse or conical striated scales; colour generally in bands of white and black alternating, the portions in front of the anterior and behind the posterior valves being white.

Interior purple-brown, sutural laminae whitish. Anterior valve with 10 slits, median valves 1 slit, all insertion plates deeply pectinated; posterior valve with broad, rough callus.

Dimensions: The largest example collected by myself measures, dry, 60 x 35 mm.

Station: On the outside, or in crevices of the rocks between high spring and mean tide marks. Juveniles are sometimes found under stones or occupying the interstices between the convolutions of *Galeolaria caespitosa*.

Locality: South Western and Western Australia, extending from Eyre Patch (Great Australian Bight) near the South Australian border to Point Cloates, North Western Australia. Further search may extend the range, both east and north.

Remarks: This is the commonest shell of the Western Australian littoral, being found both on the exposed ocean coasts and along the shores of the most sheltered inlets. The valves are generally eroded or covered with algal or calcareous growths. Specimens showing the sculpture intact are rare, but well worth seeking for.

Reference to the authorities quoted above will show that this shell has enjoyed a good deal of discussion, both as to its generic position and nomenclature. Undoubtedly Péron was the first to collect it, and Blainville the first to publish Péron's manuscript name, with a concise description that is not applicable to any shell which could have been taken at "L'Ile King," the locality assigned to it by the collector. The fact, referred to by Thiele, Dupuis, Ashby and Lamy in their various contributions, that the collection of the Paris Museum contains three specimens assigned to this species, one of which is an *Acanthopleura*, perhaps accounts for the name *hirtosus* (*hirtus* = prickly), the name being more appropriate to the spiny girdle of the northern species. Although Thiele was the first to suggest the identity of Quoy and Gaimard's *C. georgianus* with Blainville's *C. hirtosus* he did not use the latter name. Dupuis was the first to adopt Thiele's suggestion.

The figures shown on Plate xxviii. are particularly interesting when comparison is made between the sculpture of *L. queenslandica* and *C. hirtosa,* which are almost identical in that respect, while the girdle scales are so markedly different. Further, the scales of *L. gaimardi* and *L. queenslandica* are very similar, while the sculpture is entirely different.

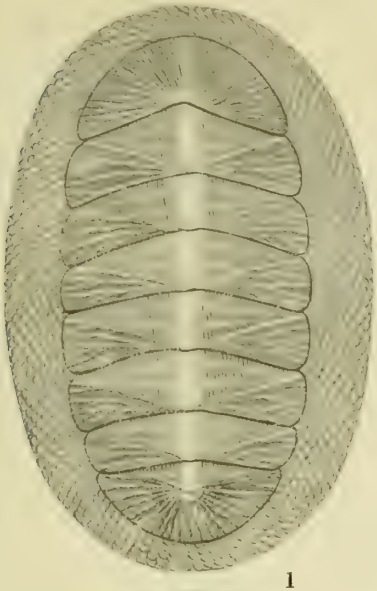
These three shells appear to be degenerate Acanthopleurids, having lost the teeth of the posterior valve. In pushing out from their tropical centre of origin they have proceeded southwards by two distinct routes of migration, west and east; in the former case pushing round the Leeuwin and along the shores of the Great Australian Bight, meeting with no serious bar in the shape of cold waters. This branch, while degenerating internally like the eastern branch, also went through a modification of the girdle covering quite distinct from the other migrants. The eastern species suggest two separate waves of migration, the first extending down the coast of New South Wales, developing an altered form of sculpture, and degenerating in the posterior valve. This primary wave seems to have been cut off, its remnants being confined to a comparatively limited portion of the New South Wales coast line and it never rounded the south of Tasmania, even if it reached so far prior to the separation of Tasmania from the mainland. It was followed by another wave, which has retained much of the sculpture and the dark internal colouration of its ancestors, while again degenerating in the loss of teeth in the posterior valve, and the modification of the girdle covering. This wave has reached only to the northern shores of Moreton Bay.

EXPLANATION OF PLATES.

Plate xxvii. Fig. 1. *Ischnoradsia australis divaricata,* n.subsp.
„ 1. (a, b. and c.) „ „ juvenile.
„ 2. *Acanthochiton purpuratus,* n.sp.
„ 3. *Lorica paucipustulosa,* n.sp.

Plate xxviii. Figures show anterior and posterior valves, one-half of a median valve, and a section of the girdle of:—

Figs. 1-4. *Liolophura gaimardi* Blainville.
„ 5-8. *Liolophura queenslandica* Pilsbry.
„ 9-12. *Clavarizona hirtosa* Blainville.



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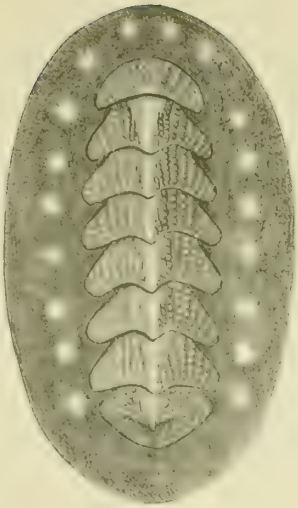

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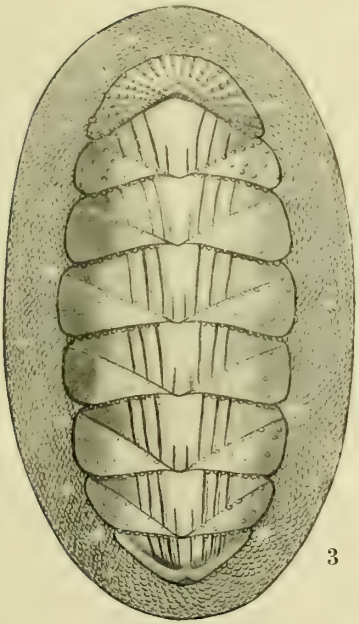

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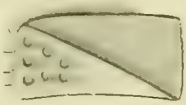

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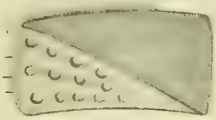
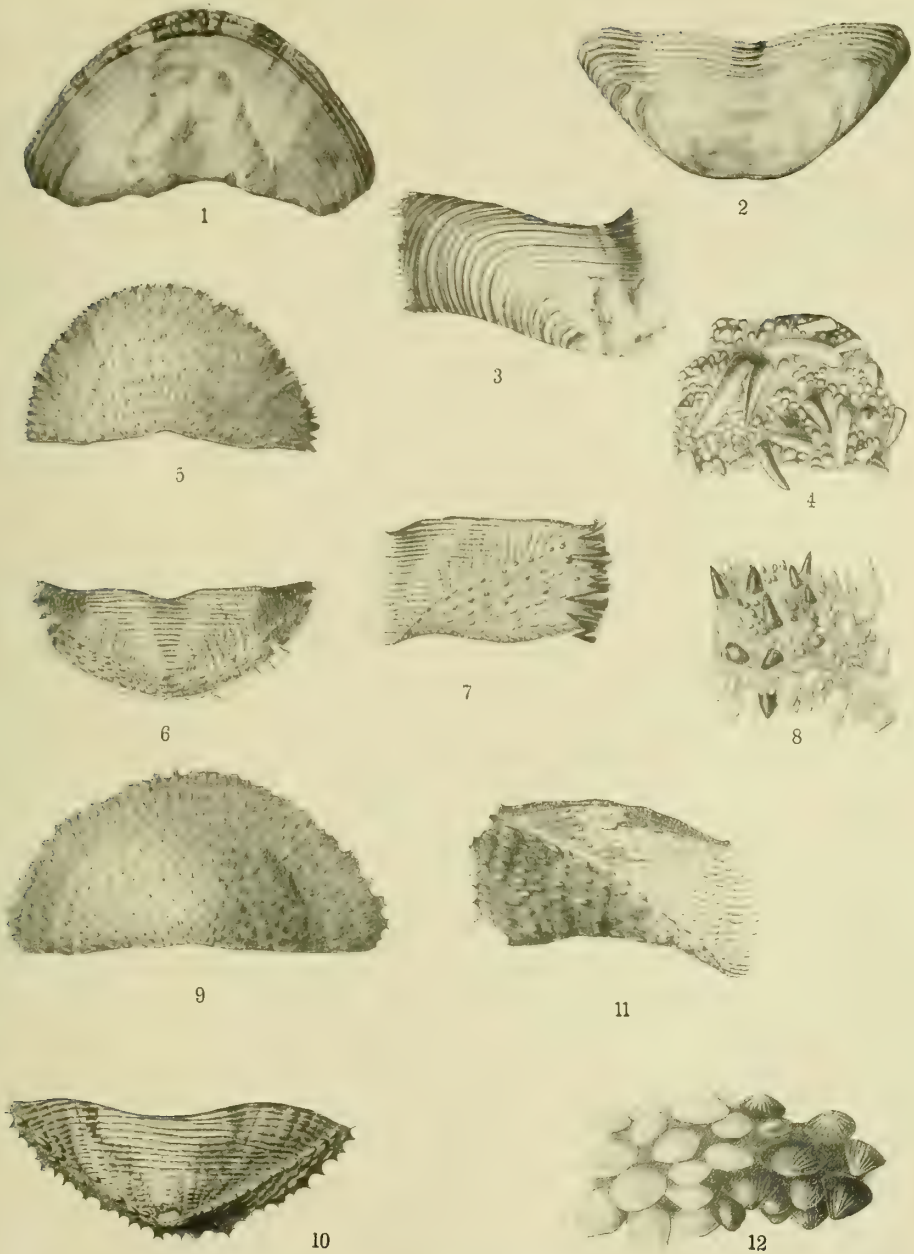


1c

Fig. 1. *Ischnoradsia australis divaricata,* n.subsp.
„ 1. (a, b. and c.) „ „ juvenile.
„ 2. *Acanthochiton purpuratus,* n.sp.
„ 3. *Lorica paucipustulosa,* n.sp.

Drawn by L. M. Iredale.



Figs. 1-4. *Liolophura gaimardi* Blainville.
„ 5-8. *Liolophura queenslandica* Pilsbry.
„ 9-12. *Clavarizona hirtosa* Blainville.

Drawn by Phyllis Clarke.

Royal Zoological Society of New South Wales.

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Royal Zoological Society of New South Wales

NEW MEMBERS.

The following new members have been elected since the publication of the last list (18th December, 1923):—

Ordinary members:—Frank Farnell, F. S. Perry, F. W. Syer.

Associate members:—E. C. Berry, H. Blakeney, C. Coles, A. R. Reid, Sir Joseph Verco (Life Member), Professor F. Wood-Jones.

ANNUAL MEETING.

It has been decided to hold the Annual Meeting of the Society at the University on Wednesday, 23rd July. There will be a dinner at the Refectory, and members will be at liberty to take tickets for their friends. Full particulars will be given in the usual notice, which will be addressed to each member before the end of June.

HONOURS TO MEMBERS.

Mr. Charles Hedley has resigned his position as Principal Keeper of Collections, Australian Museum, after thirty-three years' service, during which he has contributed over 150 valuable papers to Australian scientific research. He has been appointed Scientific Director of the Great Barrier Reef Committee, a body formed under the auspices of the Royal Geographical Society of Australasia, Queensland branch, to engage upon research problems in relation to that great natural feature of the Queensland Coast. Mr. Hedley has also been recently elected an Honorary Fellow of the New Zealand Institute.

Professor Launcelot Harrison has been appointed a member of the Board of Trustees of the Australian Museum, vice Professor W. A. Haswell, resigned.

Mr. W. W. Froggatt has been appointed Forest Entomologist to the Minister for Lands and Forests; his work will be in relation to the timber boring pests.

Mr. W. B. Gurney has been appointed Government Entomologist, Department of Agriculture, N.S.W.

ACTING OFFICERS.

Mr. E. F. Pollock has been appointed to act as Honorary Secretary during the absence of Mr. Hull, who is investigating the birds and certain marine invertebrates at different points in north Queensland, under the direction of the Great Barrier Reef Investigation Committee.

Mr. Donald H. Scott has been appointed Assistant Honorary Treasurer.

EXHIBITION OF BIRD STUDIES.

Mr. Neville W. Cayley proposes exhibiting a number of his water-colour studies of Australian birds in Tyrrell's Gallery, Castlereagh Street, on the 12th June. The exhibition will be under the auspices of this Society, and all members are cordially invited to attend and bring their friends.

AUSTRALIA—THE LAND OF LIVING FOSSILS.

That one needs to go from home for appreciation is a truism that strongly applies to Australia and its fauna. We have recently received "Natural History" for January-February, 1924, the journal of the American Museum of Natural History, the greater part of which is devoted to a series of articles on Australian fauna. Dr. William K. Gregory, who visited Australia a few years ago, writes in appreciation of "Australia, the Land of Living Fossils," as exemplified in the proposed Australian exhibition in the American Museum. The leading features of our marsupials, recent and extinct, are to be strikingly illustrated by "groups" depicting the animals in a carefully reproduced natural environment. "By means of colored maps and relief models the visitor will be able to see graphically" the connection between Australia and New Guinea. All this effort is directed towards procuring representative group exhibits of the Australian fauna *before it is too late!* Dr. Gregory shows that the marsupials never had a serious enemy until "late in the eighteenth century there arrived in Australia by far the most destructive placental mammal the world has ever seen, namely *Homo sapiens,* variety *europaeus,* who has devastated the continent and is now completing the work of destruction."

What are we in Australia doing to preserve examples of our native fauna for the information of our own people and their descendants? The Australian Museum has commenced the "group exhibit" plan with (1) Antarctic Birds and Seals, (2) Lord Howe Island Birds, and (3) A Coral Pool. Not one of these represents any item of the disappearing marsupial fauna, and none is peculiarly Australian in character!

A gift of a collection of Australian animals has recently been made to the Commonwealth Government, and accepted to form the nucleus of a more comprehensive one to be located at Canberra. Now is the time for a serious attempt to make a national collection as complete as possible, before our own settlers and collectors for foreign museums have finished the work of extinction of the rarer species.

"Natural History" also contains a chatty article on "Mammalian Life in Australia and Tasmania," by Harry C. Raven, who collected here in 1921-2 for the American Museum; a brightly illustrated paper on "Bird Personalities of the Australian Bush," by R. T. Littlejohns (of Victoria), an illustrated sketch of "Reptile Life," compiled by Charles Barrett (of Melbourne), and a digest of A. S. Le Souef's article on the "Vanishing Wild Life of Australia," which appeared in "The Australian Zoologist," Part 3, of this volume.

Incidentally the Editor expresses the opinion that different students of the Australian fauna will assign a different order of precedence to the agencies of destruction as set out by Mr. Le Souef. There can be no doubt, however, that man is the most destructive agent of all.

A NEW BOMBYLIID FLY FROM NEW SOUTH WALES.

By J. R. Malloch.

(*Communicated by E. W. Ferguson*).

Recently I received from Dr. C. F. Baker, Los Banos, Philippine Islands, a box containing material consisting of parts of flowers of various plants and many hundreds of insects belonging to several different orders which had been collected at Como, N.S.W., by Mr. H. Peterson. From this lot Dr. Baker had taken the Homoptera, the remainder being sent to me rather than thrown away.

A careful scrutiny of the material revealed the presence of many interesting Diptera, some of them new to science, and amongst them one specimen of a minute bombyliid fly belonging to the genus *Pachyneres* Greene, the description of which genus appeared in print the day I received the Australian species.*

The new species is undoubtedly congeneric with the North American one, there being very few outstanding characters by means of which they may be distinguished even specifically. The genotype, *crassicornis* Greene, was reared from the wood of a decaying *Quercus velutina* at Washington, D.C., and, it is probable that the Australian species will be found in the larval and pupal stages in similar situations.

The genus is characterised by the peculiar wing venation as shown in the accompanying figure, the discal and basal cells being without a separating crossvein, and the second vein connecting with first about middle of wing, forming a small subtriangular closed cell.

In the genotype there is a small thimble-like process at tip of the apical antennal segment, but I can detect no such process in the Australian species with the highest power of my binocular, though it may be possible to do so in cleared specimens with a compound microscope.

Pachyneres australis sp. n.

Female.—Black, shining, but not glossy. Head entirely black. Thorax black, yellow on lower margin of humeral angle, along mesonotal-pleural suture, on a small spot on each side behind the transverse suture, and a large spot between base of wing and scutellum on each side, the margins of pleural sclerites, and both spiracles. Abdomen with a yellowish mark on each side of hind margin of apical three tergites. Legs black, apices of femora and bases of tibiae narrowly yellowish, bases of tarsi more broadly and more obscurely pale. Wings hyaline. Halteres brown, upper side of knobs pale yellow. Hairs on mesonotum pale.

Frons at hind angles of eyes fully one-third of the head width, narrowing towards antennae; posterior ocelli separated from eye by a little more than the width of an ocellus, and from each other by about five times that width, anterior ocellus a little larger than the others and situated less than its own length in front of these; third antennal segment about 1.5 as long as its basal width, more tapered at apex than in *crassicornis;* face below antennae about half as wide as frons at vertex; proboscis small, hardly exserted. Thorax and legs without bristles, former, including disc of scutellum, with very short hairs. Abdomen short and stout. Wings as in figure.

Length: 1.5 mm.

Type: Como, N.S.W., December, 1923 (H. Peterson).

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*Proc. Ent. Soc. Washington, vol. 26, No. 3, March, 1924, p. 62.

THE PRINCIPAL FAUNA OF KATOOMBA AND DISTRICT, COUNTY OF COOK, N.S. WALES.

E. C. Chisholm, M.B., Ch.M., R.A.O.U.

Katoomba is situated in the County of Cook, at an elevation of 3,336 feet above sea level. A mile south of the township are the rugged precipitous rocky cliffs overlooking the Jamieson Valley, varying from 1,000 to 2,000 feet below.

The fauna differs considerably in the upper and lower country. Many forms of life below are never seen on top, and vice versa. Hence, I consider this an interesting locality to record the fauna in the two regions. The vegetation on top is of the usual hard wood type, and the trees mostly Eucalypts with a sprinkling of Acacias, Casuarinas, and a few other forms. Immediately below the escarpment and following the course of the creeks, especially the latter, are found many soft woods as Coachwood, Myrtles (*Eugenia*) Sassafras, tree ferns and others. The birds and butterflies inhabiting this latter situation conform more to the type found on the immediate coast line, as the vegetation is similar, whereas the Mountain fauna proper is found on the top of the range which extends west to the Great Dividing Range, on the other side of which one begins to see a change in the fauna again as the undulating country of the west opens out. The area from which the fauna is recorded is roughly that of the Blue Mountains generally, but particularly that part bounded by Blackheath on the west to Wentworth Falls on the east with Katoomba the centre. The observations extend from November, 1922, to April, 1923.

INVERTEBRATA—INSECTA.

LEPIDOPTERA—RHOPALOCERA.

Hypocysta euphemia. Only seen once, about cliffs under escarpment.

Heteronympha merope. The Common Brown Butterfly. Common in the open forest country, mostly seen on top. The males appearing a few weeks ahead of the females, and disappearing first. I have never been able to find the larvae of this species, nor to identify its food plant.

Heteronympha mirifica. Only seen in the Jamieson Valley, where I came across it occasionally. It prefers the denser growth of the gullies to the more open country of the top of the range.

Heteronympha banksi. The Barred Brown. Only seen once, on the top in the latter end of March or early in April. Also met with it at Mount Wilson.

Xenica acantha. Ringed Xenica. Common amongst bracken and in moist situations, especially near running water. Fairly common in these situations, and only seen on the top. At night time I have found many resting together under an overhanging bank, and often in the company of *Tisiphone abeona.*

Xenica kluggi. Klugg's Xenica. About the commonest butterfly on the Mountains, seen everywhere in the open forest country on top. Appearing early in November, and dying off about the middle of April.

Tisiphone abeona. Large Wood Brown. A handsome butterfly, common all over the Mountains, where its food plant *Gahnia* abounds. I found it more numerous on top. Appearing from November to March.

Precis (junonia) villida. Meadow Argus. Fairly common in open grass lands on top. Appearing early in spring, and disappearing as late as June. Food plants *Plantago erythraea.*

Pyrameis kershawi. The Painted Lady. Fairly common in much the same situations as the preceding species. The larvae feeding on *Helichrysum apiculatum* and *Gnaphalium japonicum.* Mostly to be seen on top.

Pyrameis itea. The Admiral. This species I found decidedly rare, and only saw it once. Food plant, The Common Nettle (*Urtica incisa*).

Candalides hyacinthina. Dusky-Blue. Not common; only seen a few times, and always on top, in the first months of the year.

Candalides acasta. Not common; only seen once or twice. This species appears early, being one of the first. I have recorded it for Marrangaroo as early as August 25th.

Nacaduba biocellata. Only saw this once in a flower garden.

Zizina labradus. Common Blue. Fairly well distributed, especially in grass lands where its food plant—clover—abounds. This species lasts well into the cold months of winter.

Delias aganippe. The Wood White. I only saw this species once, and that was on top, though one would have expected to find it more numerous, as its food plant *Loranthus* is fairly in evidence.

Delias nigrina. The Dusky White. I only found this species in the Jamieson Valley, amongst the denser vegetation bordering the creeks, and only a few times. It lasts well into the winter months.

Anaphaeis teutonia (Belenois Java). Caper White. Only seen once. It is a curious fact that the flights of this species are always in one direction, and one wonders where they originally come from, and where they finally go.

Papilio aegeus. The Orchard Swallow-tail. Only seen twice; once at Mount Victoria, and once at Katoomba, and both times on top. I have found this species feeding on an indigenous plant of the genus *Zieria,* of the same family as the orange, viz.: *Rutaceae.*

Papilio macleayanus. The Green Fanny. A beautiful butterfly, seen mostly in the valley along the course of creeks where its food plant *Doryphora sassafras* is plentiful. Fairly numerous in these situations. *Papilio choredon* is not found so far west.

Trapezites phigalia. Fairly common amongst the stunted growth on top where *Patersonia,* its food plant, grows.

Taractrocera papyria. Once only I thought I saw it. These two skippers were the only representatives of the family I met with.

HETEROCERA.

Synemon sophia. I met with this species several times on the top of exposed tablelands amongst stunted growth on stony ground. A day-flying species.

Phalaenoides tristifica. One of the Agaristid moths, and a day-flyer. The larva feeds on *Epilobium glabellum.* Not common.

Eutrichopidia latina. Another Agaristid day-flying species, not common, and met with in open forest country.

Entometa ignobilis. The only form of case moth met with, and not very numerous.

Antheraea helena. A silkworm moth, of which I only found one in larval stage. The larva feeds on various Eucalypts, and is very subject to a parasitic fly.

Agrotis infusa. The Bugong Moth. Fairly common, and frequently found in the house.

VERTEBRATA.

LACERTILIA.

Ablepharus lineo-ocellatus. Little Garden Lizard. Fairly common, especially in the neighbourhood of fallen logs, and very common in gardens, probably from the fact that insect food is very plentiful there. It is an active, graceful little lizard, and very beneficial, consuming a great quantity of small insects.

Lygosoma (hinulia) quoyi. A Water Lizard. Commonly seen about water in rocky situations. It dives and swims with great agility, and seems perfectly at home there. It is very trustful, and allows a close approach. I have amused myself in an idle hour feeding it on flies, which it has taken from the end of a pointed stick. I have seen it take as many as 50 within about half an hour. It will also take bread crumbs thrown to it. Also seen about fallen timber.

Lygosoma (hinulia) taeniolatum. Copper-tailed Lizard. In contradistinction to the last species, this is very wild, and most difficult to approach. It is a pretty species, with a long, slender copper coloured tail, and many light coloured longitudinal bands along its back and sides. Generally seen about rocky situations or amongst fallen timber. Not commonly seen here.

Tiliqua nigrolutea. Blue-tongued Lizard. This is a much larger species than the preceding. Very sluggish in its movements, and beautifully coloured in orange and dark grey. Only seen in open forest country on top. I only came across it once thus. Probably it is fairly plentiful, as it lies hidden in the low growth, and is not easily seen unless on the move.

Egernia whitei. Spotted Rock Lizard. A pretty species, marked with bars of cream-coloured spots down the back and sides. Very timid in disposition, and difficult to approach. Seen in rocky situations or about fallen timber, living in crevices and holes in these situations. Only seen once or twice on top in well timbered country.

Physignathus lesueurii. Eastern Water Dragon. Only seen in the Jameison Valley on the creeks. Commonly seen on a log or rock above water, into which it dives for food or when disturbed. I only came across it once or twice. Rather shy and more often heard as it splashes into the water than seen.

Amphibolurus muricatus. Common Dragon. A much smaller species than the last, and found in the open country, mostly on top of the range. Fairly common here. This is a good example of protective mimicry, for it is usual to find it lying on dead timber almost exactly the colour of itself. It is very active when feeding. I have seen it run underneath a flying grasshopper for some distance, and then with a leap secure it on the wing.

Pygopus lepidopus. The Common Glow-worm. I found this species once on top. It is almost invariably taken by the uninitiated for a snake, and is killed, though it is a very useful species, living on ground insects. If handled, it almost always breaks close to the junction of the tail with the body.

OPHIDIA.

Pseudechis porphyriacus. Black Snake. I only saw one in the Jamieson Valley just after it had been killed. Statistics show that the number of deaths from the bite of this snake is very small, yet the venom itself is very potent, and the snake can be very vicious. The true explanation of this apparent contra-

diction lies in the fact that its fangs are comparatively small, and, being of the Colubrine type, are grooved, and not channelled as in the Vipers; hence a remarkably small amount of venom penetrates below the epidermis, and when the bite is through clothes less still penetrates as the material absorbs it. There is another element seldom taken into consideration, and this applies to all the venomous snakes. A snake invariably injects its food in the process of capture, and this empties its poison sac, which does not fill again completely for many, possibly 24, hours. If a snake therefore bites a human being immediately after it has fed there is practically no poison to be injected. This fact is taken advantage of by men who claim to have an antidote. The snake which has had no food for some time and whose poison gland in consequence is full of venom is made before spectators to bite a bird to show the virulence of the poison, with the result that the victim dies in a few minutes. Then the snake is allowed to bite the man, but practically no poison is injected.

Diemenia textilis. Brown Snake. More deaths are recorded from the bite of this snake than from the preceding; but this snake grows to a larger size, and has proportionally longer fangs. The only example I found was a dead one measuring over 6 feet, in the Jamieson Valley.

Denisonia superba. Copper Head. The only one I saw I killed on top of the range. It seems to prefer partially cleared land where fallen timber exists. I know of no statistics giving the mortality from bites of this species. I have never found it vicious; and it is always anxious to get away.

Aves.

Uroaetus audax. Wedge-tailed Eagle. Fairly plentiful at times at the edge of the escarpment. I have seen quite a number at one time on the "Narrow Neck."

Falco peregrinus. Black-cheeked Falcon. Seen only once; apparently a rare bird here.

Ieracidea berigora. Brown Hawk. Only seen occasionally, especially about recently burnt bush.

Cerchneis cenchroides. Nankeen Kestrel. Not very plentiful. Generally seen from above flying over valley below.

Corvus coronoides. Raven. Both hazel-eyed and white-eyed birds seen, especially about slaughter yards. I think it is fairly generally recognised now that the white-eyed bird is the older, having attained the white eye with age.

Strepera graculina. Pied Bell Magpie. Very common, feeding down mountain sides on native fruit and berries, coming into orchards on top for the fruit. It generally congregates in numbers.

Strepera versicolor. Grey Bell Magpie. Not common, only met with a few times, and then generally singly or in pairs.

Oriolus sagittatus. Olive-backed Oriole. Only seen once. This bird feeds on berries largely, which it swallows whole as the pigeons do.

Grallina cyanoleuca. Magpie Lark (Peewit). A common bird about low lying, swampy land and stagnant water, where it feeds largely on the pond snail which is a host of the Liver Fluke (*Fasciola hepatica*) and therefore a bird of great value to the pastoralist. One sees these birds sometimes in the evenings flying in large numbers from their feeding grounds to their roosting places.

Collyriocincla harmonica. Harmonious Thrush. Found in all sorts of country, fairly well distributed in pairs. No pair overlapping another's territory. One of our best songsters, especially in the spring and early summer, but changing its notes in autumn and winter to a short double one.

Graucalus novae-hollandiae. Blue Jay. A migrant arriving in September and leaving again in April. A peculiar characteristic about it is its way of folding first one wing and then the other over the opposite one two or three times on alighting. It has a low rippling call. It associates in flocks and feeds amongst the leaves of the trees on Orthopterous and Coleopterous insects, taking its food off the leaves without alighting. I have watched a flock taking blackberries in the same way.

Lalage tricolor. Peewit Lark. (White-shouldered caterpillar-eater). A migrant arriving in November, when its pretty prattling song is heard and often while on the wing. It leaves again late in April. Not a common bird on the mountains, seeming to prefer more open level forest country.

Petroica multicolor. Scarlet-breasted Robin. This is the Common Robin of the Mountains, but only seen on the top.

Petroica phoenicea. Flame-breasted Robin. Seen more in the open country, especially in the winter months, but breeding in the thick timber of the mountains. Both this and the preceding species are ground feeders.

Erythrodryas rosea. Rose-breasted Wood Robin. Found mostly in the denser vegetation of the gullies, especially in the Jamieson Valley. Coming only rarely to the top. It feeds amongst the foliage of the trees, taking insects off on the wing. Not by any means common.

Gerygone olivacea. Native Canary. Not seen at Katoomba, but further east at Blaxland I came across it. A migrant.

Gerygone fusca. Brown Fly-eater. Common in the Jamieson Valley, rarely seen on top. A stationary bird. Both this and the preceding species build pretty hanging nests with a tail suspended from the bottom, and with domed side entrance.

Rhipidura flabellifera. White-shafted Fantail. A migrant, arriving in September. Fairly common on top, more so than in the Jamieson Valley.

Rhipidura rufifrons. Rufous Fantail. Takes the place of the preceding species in the denser growth of the gullies. This is also a migrant. Fairly common in the Jamieson Valley.

Rhipidura leucophrys. Wagtail. Quite a rare bird here; I only saw it after several months, and then only once or twice.

Myiagra rubecula. Leaden Fly-catcher. Only seen once or twice. Easily recognised from the perpendicular quivering movement of the tail. A migrant.

Monarcha melanopsis. Black-faced Flycatcher. Another migrant, preferring the denser growth of the Jamieson Valley, especially about the creeks, where it is fairly common. It has a pretty note, two or three times repeated with variations.

Oreocincla lunulata. Mountain Thrush. Seen only once or twice, and that in the dense gullies in the valleys. It is a very quiet bird, and feeds amongst the fallen leaves on the ground. Tame in disposition, many have probably fallen victims to the pea rifle, as it is quite a rare bird now.

Ptilonorhynchus violaceus. Satin Bower Bird. Quite common, both on top and below in the valley. Mostly the females and males in immature plumage seen. A black bird rarely seen.

Origma solitaria. Rock Warbler. Not as common as one would expect in such rocky country.

Acanthiza pusilla. Brown Tit. Pretty common everywhere, feeding equally in the trees and near the ground. Often in the company of others of the genus. This bird has mimicking powers, and I have heard the same bird imitate the note of the male scarlet-breasted robin to perfection repeatedly.

Acanthiza lineata. Green Tit. Seen in companies feeding amongst the foliage of the trees. One of their characteristic attitudes is that of hanging back downwards on to a curled leaf while getting an insect or spider out.

Geobasileus chrysorrhous. Yellow-tailed Tit. Fairly common, seeming to prefer the neighbourhood of gardens and ornamental trees. A very common host of both Bronze Cuckoos.

Geobasileus reguloides. Buff-rumped Tit. Although rather like the preceding species in general appearance, its habits are totally dissimilar. It is not plentiful, and is found away from the haunts of man, feeding in open forest land or the sides of mountain ranges in small companies, and nearly always in association with other birds. Both these species are ground feeders.

Sericornis lathami. Yellow-throated Scrub Wren. Only seen in the Jamieson Valley, and very difficult to get a good view of owing to inaccessibility and dense undergrowth. This is quite an uncommon bird, and very shy. By waiting near water in the shade of the gullies I was rewarded by seeing many more birds than I would have done by moving about.

Sericornis frontalis. White-browed Scrub Wren. Much more in evidence than the last; frequently seen while walking along the paths in the valley.

Cinclosoma punctatum. Spotted Ground Bird. Seen only on the ridges on top, mostly in exposed and stony situations; never more than a pair of adults together. It is shy, and difficult of approach, and arises from the ground with a loud whir of its wings.

Pycnoptilus floccosus. Pilot Bird. Seen occasionally in the Jamieson Valley, but by no means common.

Hylacola pyrrhopygia. Chestnut-rumped Ground Wren. Rare and very shy. Seen amongst thick, low scrub.

Psophodes olivaceus. Coach-whip. This bird was only heard in the valley along the course of creeks, and not very plentiful.

Gymnorhina tibicen. Black-backed Magpie. Only seen on top, and not very numerous.

Cracticus torquatus. Grey Butcher Bird. Only occasionally seen; one by itself or a pair together. This bird begins to move about a bit during the autumn months after rearing its young.

Eopsaltria australis. Yellow Robin. One of the commonest birds in the valley, and on the sides of the mountains, preferring the denser growth of the gullies. It is fearless, allowing a close approach.

Pachycephala pectoralis. Golden-breasted Whistler. Like the preceding species, mostly to be found below the escarpment. Fairly generally distributed.

Pachycephala rufiventris. Rufous-breasted Whistler. This is a migrant, arriving in September, and leaving again in April. It prefers the open forests. Both whistlers feed amongst the foliage of the trees, taking their food from above them, and mostly by pecking it from the leaves without alighting. Orthopterous insects and Lepidopterous larvae amongst the leaves seem to be their main food.

Climacteris leucophoea. White-fronted Tree Creeper. Fairly common, both on top and below in the valley, where its sharp ringing notes are often heard.

Neositta chrysoptera. Orange-winged Tree-runner. The nearest place on the Mountains that I have seen this bird was at Clarence, where I saw a small number.

Acanthorynchus tenuirostris. Spinebill. Fairly common, especially feeding amongst the flowers of various Proteaceae such as *Banksia* and *Grevillea* for which its bill seems especially adapted.

Zosterops lateralis. Silvereye. Seen mostly in pairs during breeding,

though even then sometimes breeding in communities, when several nests may be found in close proximity. Always flocking in the winter months when they travel from one locality to another in search of insects, which form their main food. They are often in the company of other *Meliphagidae.* In addition to its insect food which consists largely of *Lepidoptera,* especially the adult moths and larvae of both butterflies and moths and aphides it is a honeyeater feeding on the nectar of various flowers, on berries and fruits which are indigenous, it has taken to eating orchard fruit which has given it a bad name. Nevertheless, I venture to state without fear of contradiction from those who have thoroughly studied its habits and mode of life, that it is one of our most useful birds, and should not be ruthlessly destroyed. This bird, although it takes a toll of the fruit when ripe, feeds almost entirely during the winter months on insects, feeds its young entirely on them in the summer months, and more than half its food even during the fruit season is composed of insects, including the codlin moth, aphides, and many other harmful kinds. I have watched a flock during winter attacking the woolly aphis on apple trees and cleaning up in a marvellous way trees which but for their efforts undoubtedly would have succumbed. I have kept these birds in confinement, and noted the immense quantity of insects they consume.

Melithreptus lunatus. Black Cap. Not very commonly seen, mostly due to the fact that it feeds high up in the Eucalypts, either on the nectar of the flowers or on insects about the bark on the upper limbs.

Meliphaga lewinii. Yellow-eared Honeyeater. Heard and occasionally seen in the dense brush of the gullies in the Jamieson Valley. This is near its western limit for it is essentially a coastal bird.

Meliphaga chrysops. Yellow-faced Honeyeater. Only seen once or twice, and very seldom heard. This bird is a migrant.

Meliphaga leucotis. White-eared Honeyeater. Only found here and there, especially where low scrub abounds on top. It is stationary.

Meliphaga melanops. Yellow-tufted Honeyeater. The only place on the Mountains that I have seen this bird was in the gullies about Lapstone Hill, where they seemed to be in good numbers.

Meliornis novae-hollandiae. White-bearded Honeyeater. Common on the top, feeding on the nectar of *Banksia serrata.*

Meliornis nigra. White-cheeked Honeyeater. Fairly common, feeding in the same situations and on the same food as preceding species.

Meliornis pyrrhoptera. Crescent Honeyeater. Frequently found in company with the two preceding species, and feeding on the nectar of flowering Banksias. All three mostly to be found on top or high up on mountain sides.

Philemon corniculatus. Leather Head. A travelling bird, and seen at the beginning of autumn in flocks on the move. It feeds on fruit and berries, as well as insects of the larger kinds as *Cicadae.*

Pardalotus ornatus. Red-tipped Diamond Bird. Not commonly seen, but probably feeding high up in the Eucalypts. More in evidence in early spring.

Pardalotus punctatus. Spotted Diamond Bird. Only seen rarely. It, like the preceding species, feeds high up in the trees.

Hirundo neoxena. Welcome Swallow. Common about buildings, and also seen about caves, among the rocky walls of the escarpment and flying over water often in the company of the Martins.

Hylochelidon nigricans. Tree Martin. Seen mostly round the edges of the rocky mountain side.

Anthus australis. Pipit. Seen about the cleared flat land on top, but not numerous.

Artamus superciliosus. White-browed Wood Swallow. A few of this species

seen beyond "Narrow Neck" amongst stunted Eucalypts. A migrant.

Artamus cyanopterus. Dusky Wood Swallow. A few seen. This bird is a migrant in certain localities. Unfortunately it has got a bad name for feeding on bees. It certainly does take a bee occasionally, but it is by no means its routine food. One of its staple foods is the grasshopper, which alone should amply justify its protection. Moths of all kinds are also part of its food, and this applies to both wood swallows. I know of an instance in the Goulburn district where flocks of *A. superciliosus* nested in an orchard which was infested with the codlin moth, with the result that the succeeding crop of fruit was clean. I met a farmer years ago near Junee who had come to the hasty conclusion that because a flock of *A. superciliosus* had taken up their abode in his orchard that they were fruit eaters, and shot them nearly all. When spoken to later about their value he said that he recognised their value too late, and bitterly regretted his action. I have seen *A. superciliosus* taking the nectar from the flowering silky oak (*Grevillea robusta*).

Zonaeginthus bellus. Firetail. I was fortunate in seeing a pair of these in the Jamieson Valley. I consider this a very rare bird in New South Wales, where I have only met with it three times before, though in Tasmania, where I lived for some years, it was a common bird, especially in the north, and the only native finch on the island. It is a very quiet bird, and unobtrusive, inhabiting the denser growth of the gullies. Mostly seen in pairs. On the other occasions when I met this bird it was off the main Southern Road between Picton and Mittagong.

Aegintha temporalis. Redhead, or Red-browed Finch. Common about tea-tree scrubs, especially along the course of creeks, and mostly on top. Generally seen in flocks, particularly in the winter months. This bird is frequently erroneously (with the Diamond Sparrow) called the Firetail. I have found the egg of *Chalcites basalis* in the nest of this species, which was rather a surprise till one remembers that all the finches feed their young mostly, if not entirely, on insects at first.

Menura novae-hollandiae. Lyre Bird. Seen several times in the Jamieson Valley, but not often heard, although I recall listening for half an hour to a fine performance of vocal music in which a variety of notes of different birds were mimicked. On account of numerous fires at this time in the Valley, many birds were seen at the top.

Chaetura caudacuta. Spine-tailed Swift. Occasionally seen, and generally before a thunderstorm.

Podargus strigoides. Frogmouth or Morepork. I have heard this bird occasionally uttering its "Morepork" note, a long drawn-out and quite distinct note from the call of the Boobook Owl, which more resembles the sound of the word "Mopoke," being uttered more quickly and repeated several times at short intervals, often becoming almost continuous.

Aegotheles cristata. Owlet Nightjar. I found the partly-eaten dead body of this bird at Wentworth Falls, evidently the work of a cat. Roosting in holes of trees by day, it is rarely seen.

Dacelo gigas. Laughing Jackass. Common everywhere, and seeming at home in almost any kind of country.

Halcyon sanctus. Sacred Kingfisher. A migrant, arriving in October, and leaving again in late February. Not very common. One of its favourite foods is composed of the larger kinds of Cockchafer beetles (*Anaplognathus porosus* and *A. viridaeneus*) which it takes from the leaves on the wing without alighting, to bang it to a pulp on a branch before swallowing.

Cuculus pallidus. Pallid Cuckoo. I have not recorded this from Katoomba, but from lower down the Mountains, at Blaxland, where it was not often seen. This is a migrant, and very constant in times of arrival, although some years much more in evidence than in others. I have found the smaller honeyeater the most frequent hosts of this bird, the open cup-shaped nests appealing to it most.

Cacomantis flabelliformis. Fantailed Cuckoo. This is a migrant, although I have known it remain the year through in one locality. Especially is this so about Sydney. At Marrangaroo I recorded it as a migrant. Not very common, and mostly to be found in the valley.

Chalcites basalis. Narrow-billed Bronze Cuckoo. *Chalcites plagosus.* Green Bronze Cuckoo. One or other of these seen, but they were not numerous.

Trichoglossus moluccanus. Blue Mountain Parrot. Seen years ago at the bottom of Leura Falls in the Valley, but not seen later. Like the other honey-eating lorikeets this species is a wanderer, mostly on the move after flowering Eucalypts and berries.

Glossopsitta concinna. Musk Lorikeet. One solitary bird seen feeding on the nectar of flowering *Banksia serrata.*

Calyptorhynchus funereus. Yellow-tailed Black Cockatoo. I only saw one specimen of this bird on top. It was probably nesting.

Callocephalon fimbriatus. Gang Gang. A small company of these was seen several times in the Jamieson Valley.

Aprosmictus scapularis. King Parrot. Only one pair seen several times on or near the edge of the escarpment.

Platycercus elegans. Lowry. This is the commonest parrot on the Mountains, and fairly numerous; generally in small companies. It is very fond of the seeds of the Scotch thistle.

INTRODUCED BIRDS.

Passer domesticus. House Sparrow. Common all over the Mountains, keeping close to the haunts of man.

Carduelis elegans. Goldfinch. Only seen a few times.

Sturnus vulgaris. Starling. Fairly common and well distributed. I saw no large flocks.

MAMMALIA.

Macropus ualabatus. Black-tailed Wallaby. The only wallaby I have seen here. I saw it several times in the Jamieson Valley, and only one or two together. This with the other species have been thinned out tremendously in the last 30 years. The fox and the dingo must be responsible for many deaths, although the gun has been responsible for most.

Cheiroptera. Bats. Unidentified, but fairly plentiful.

Introduced.

Lepus cuniculus. Rabbit. Beginning to get numerous where the land is being cleared, though it probably will never become a great pest here as the country is not suitable.

SOME NOTES ON AUSTRALIAN LAND SHELLS.

By Charles Hedley.

Plates xxix.-xxxii.

Plans had been made by the writer to prepare for local students an illustrated monograph of the land mollusca of Eastern Australia. Literature had been assembled and analysed; many drawings had been finished; a large collection of shells laid out for close examination and certain groups had been reviewed, when the undertaking came to a sudden unexpected end. Now, with much reluctance the project is relinquished. As much of this work as is sufficiently complete for publication is now presented as follows:—

Gyrocochlea, gen. nov.

Shell with three rounded adult whorls, usually wound in an ascending plane so as to form a biconcave disk with the umbilicus deeper than the spire. Protoconch smooth, flat, a whorl and a half. First sculpture consisting of spaced, elevated riblets, descrepant to the protoconch lip, older sculpture crowded, vertical riblets, spiral sculpture absent. Aperture simple, lip sharp, insinuate at the insertion; no internal lamellae. Type; *Helix vinitincta* Cox.

Members of this genus inhabit the rain forests of New South Wales and Queensland. Probably *Helix antialba* represents it in the rain forest of North-West Tasmania. Ancey has assigned my type to his New Caledonian genus *Monomphalus*, but the type of that, *M. heckelianus*, differs by a spirally striated protoconch. *Allodiscus* from New Zealand, according to the type, *A. dimorphus*, has a rather larger protoconch without spiral striae, but followed by consonant fine and crowded ribbing.

Gyrocochlea concinna, sp. nov.

(Plate xxix., figs. 1-3.)

Shell minute, globose-discoid. Colour; adult shell with alternate segments of buff and cinnamon, protoconch dark purple with a pearly lustre. Whorls four closely wound, each rising above its predecessor. Sculpture; last whorl with eighty-two fine, spaced, regular riblets. Spire a deep basin with evenly descending sides. Umbilicus cup-shaped exposing all the previous whorls. Maj. diam. 2.7, min. diam. 2.3, height 1.5 mm.

This account is based on a single, probably immature, specimen. It is the most northern of the genus yet reported. The combination of colour rays and a vertex projecting above the spire distinguishes the species.

Hab.—Queensland: "Cardwell scrubs, North Queensland, 1871" (Ex Brazier, probably "28 miles inland from Cardwell, at an elevation of 3,500 ft., Beddome," vide under *H. macgillivrayi*, Journ. of Conch. i., 1877, p. 269).

Gyrocochlea conferta, sp. nov.

(Plate xxix., figs. 4-6.)

Shell small discoidal. Colour uniform ochraceous tawny. Whorls four, gradually rising till the third whorl and then commencing a slight descent. Sculpture; on the first fifty-five, on the last whorl a hundred and twenty-five lamellate riblets, the last being closely packed. Spire shallow. Umbilicus wide and deep. Maj. diam. 4.1, min. diam. 3.4, height 2.3 mm.

This has a general resemblance to *G. omicron*, from which *G. conferta* is easily distinguished by smaller size, flatter spire, more excavate umbilicus, denser riblets and uniform colour. It occurs south of the territory occupied by *G. omicron*.

Hab.—N.S. Wales: Port Stephens (type, Rev. R. L. King), Coolongolook (C. Laseron), Ellerslie, Wallis Lake (C. Hedley).

Gyrocochlea convoluta, sp. nov.
(Plate xxix., figs. 7-9.)

Related to *G. vinitincta* but differing by being smaller, darker, namely auburn, having the whorls more closely rolled together, the spire more deeply sunk, the riblets more membranous and further apart, namely seventy-seven on the last whorl, with several fine radial hair lines in their interstices. Maj. diam. 6.5, min. diam. 5, alt. 4 mm.

Hab.—Queensland: Beaudesert (type, Dr. R. Pulleine), Camerunga (S. W. Jackson).

Gyrocochlea eurythma, sp. nov.
(Plate xxix., figs. 10-12.)

Shell small and discoidal. Colour uniform cinnamon. Whorls four, wound almost in the same plane; the two first lie in a small hollow formed by the elevation of the third while the last whorl descends slightly. Sculpture, the first whorl carries fifty-four and the last one hundred and ten, close fine radial riblets. Umbilicus wide, exposing all previous whorls. Maj. diam. 3, min. diam. 2.5, height 1.5 mm.

Hab.—N.S. Wales: "Northern Rivers, N.S.W., Petterd" (Cox Coll., type), E. Macleay River (Cox Coll.), Port Stephens (Rev. R. L. King).

Gyrocochlea impressa, sp. nov.
(Plate xxx., figs. 13-15.)

Shell small, compressed. Colour uniform cinnamon-buff. Whorls four and a half, rounded, closely wound, ascending for the entire coil. Sculpture fine, dense and even riblets, one hundred and thirty-two on the last whorl. Spire a deep cup. Umbilicus moderately wide. Maj. diam. 4, min. diam. 3.25, height 2.5 mm.

This species is distinguished by small size, greater height in proportion to breadth and the continual rise of the whorls, by which the vertex of the aperture overtops the preceding whorl. It is a southern outlier of the genus.

Hab.—N.S. Wales: Kurrajong (C. T. Musson, a single specimen).

Gyrocochlea omicron, Pfeiffer.
(Plate xxx., figs. 16-18.)

Helix omicron Pfeiffer, Zeit. f. Malak. viii., Oct., 1851, p. 128; *Id.*, Pfeiffer, Mon. Hel. Viv., iii., 1853, p. 109, vii., 1876, p. 186; *Id.*, Pfeiffer, Conch. Cab., ii., 1854, p. 457, Pl. 155, figs. 13-17; *Id.*, Cox, Monogr. Austr. Land Shells, 1868, p. 18, Pl. 10, fig. 1; *Id.*, Petterd, Journ. de Conch. xxv., 1877, p. 359; *Diplomphalus omicron* Tryon, Man. Conch., i., 1885, p. 115, Pl. 24, fig. 79; *Monomphalus omicron* Ancey, Bull. Soc. Malac. France, v., 1888, p. 359; *Charopa omicron* Hedley and Musson, Proc. Linn. Soc. N.S.W., (2), vi., 1891, p. 553; *Helix ammonitoides* Reeve, Conch. Icon., vii., June, 1854, Pl. 181, fig. 1246; *Id.*, Cox, Cat. Austr. Land

Shells, 1864, p. 14. Not *Helix ammonitoides* Brazier, Proc. Zool. Soc., 1870, p. 661.

This species is much smaller than *G. vinitincta,* not so high in proportion to the breadth, the spire is not so deeply sunk and the different colour is a ready recognition mark.

Shell small discoidal. Colour pale buff painted with about fifteen jagged, radial stripes of terra cotta, as wide as their interstices. The first whorl carries thirty-seven riblets, which growing more crowded increase on the last whorl to one hundred and twenty-five. Maj. diam. 6, min. diam. 5.5, alt. 3 mm.

Hab.—Pfeiffer originally described this from Australia, but in 1876 he erroneously substituted the habitat New Zealand, where most of the alphabet series live. N.S. Wales: Richmond and Clarence Rivers (Macgillivray), Brunswick and Tweed Rivers (Petterd). Queensland: Macpherson Range (Lower), Eagle Scrub, Brisbane (Brazier), Canungera (Jackson), Stanley River (Petterd), Miriam Vale, Warro, Cania, Gympie, and North Pine River (Musson).

Gyrocochlea planorbis, sp. nov.

(Plate xxx., figs. 19-21.)

Shell small, discoidal. Colour uniform cinnamon. Whorls four, wound horizontally. Sculpture; first whorl with forty, last with one hundred and eight narrow thread-like riblets. Spire flat, except that the protoconch is a little sunken. Umbilicus wide, basin shaped, with sloping whorls. Maj. diam. 3.3, min. diam. 2.7, height 1.5 mm.

Hab.—N.S. Wales: Port Stephens (type, Rev. R. L. King), Hastings River (A. R. McCulloch), Macleay River and Nambucca Rivers (Cox. Coll.).

Gyrocochlea prava, sp. nov.

(Plate xxx, figs. 22-24.)

Shell small, compact. Colour uniform ochraceous-tawny. Whorls four and a half, rounded, the earlier gradually ascending, the entire last whorl slowly and evenly descending, leaving the antipenultimate projecting above it. Sculpture; on the first whorl are thirty-eight spaced riblets which increase with growth till they amount to one hundred and thirty-five on the final whorl. Spire a shallow depression. Umbilicus moderately wide. Aperture vertical, lip curved at base and vertex, recurved at the sutures and periphery. The step down from penultimate to final whorl is a useful recognition mark for this species. Maj. diam. 4.3, min. diam. 3.5, height 2.5 mm.

Hab.—N.S. Wales: Upper Tweed River (Petterd).

Gyrocochlea recava, Hedley.

Endodonta recava Hedley, Proc. Linn. Soc. N.S.W., xxxvii., 1912, p. 267, Pl. 10, figs. 58-60.

Hab.—Queensland: Finch Hatton (type, S. W. Jackson).

Gyrocochlea stroudensis, Cox.

(Plate xxxi., figs. 25-27.)

Helix stroudensis Cox, Cat. Austr. L. Shells, 1864, p. 20; *Id.,* Cox, Ann. Mag. Nat. Hist., Sept. 1864, p. 182; *Id.,* Pfeiffer, Mon. Hel. Viv., v., 1868, p. 182; *Id.,* Cox, Monogr. Austr. L. Shells, 1868, p. 20, Pl. 11, fig. 1; *Id.,* Tryon,

Man. Conch., iii., 1887, p. 25, Pl. 4, figs. 28, 29. Not *Endodonta stroudensis* Ancey, Journ. de Conch. xlix., 1901, p. 145.

Shell minute, turbinate, perforate. Colour uniform tawny. Whorls four and a half, each rising above its follower, the last half whorl descending more rapidly than the others. Sculpture; on the first whorl forty-eight, on the last one hundred and five elevated, curved, rather irregularly spaced, lamellate riblets. Spire a low dome. Umbilicus a narrow perforation, partly choked by the overhang of the last whorl, not exposing previous whorls. Maj. diam. 2.5, min. diam. 2.0, height 1.5 mm.

This species differs from typical forms of the genus by the exsert spire. My description is based on the original type presented by the collector, Rev. R. L. King. This enables me to state that there are no spiral striae as figured by Cox and that the description of Ancey refers to a different shell. The species has not been taken again and seems to be rare or local.

Hab.—N.S. Wales: Stroud (type, King).

Gyrocochlea vinitincta, Cox.

(Plate xxxi., figs. 28-31.)

Helix vinitincta Cox, Monogr. Austr. L. Shells, 1868, p. 18, Pl. 1, figs. 6, 6a; *Id.*, Pfeiffer, Mon. Hel. Viv., vii., 1876, p. 186; *Id.*, Petterd, Journ. de Conch., xxv., 1877, p. 360; *Diplomphalus vinitinctus* Tryon, Man. Conch., i., 1885, p. 115, Pl. 24, figs. 88, 89; *Id.*, Hedley Proc. Roy. Soc. Q'land, v., 1888, p. 152, vi. 1889, p. 102; *Monomphalus vinitinctus* Ancey, Bull. Soc. Malac. France, v., 1888, p. 359; *Endodonta vinitincta* Shirley, Q'land Naturalist, iii., 1921, p. 34.

Shell large for the group, thin, contour discoidal. Colour amber brown, either uniform or streaked with ochraceous tawny. Whorls four and a half, of which one and a half compose the protoconch, rounded, rapidly enlarging, coiled in a slightly ascending plane, as far as the fourth whorl, then slightly descending; the shell is thus biconcave but the umbilical hollow is much deeper and narrower than the upper cavity; when full grown the vertex of the aperture has descended to the level of the summit of the body whorl, but at an earlier growth stage the vertex of the aperture projects above the rest, thus giving the shell a different outline. The suture runs in a deep groove. Protoconch is white, smooth and flat, of a whorl and a half, terminating in a slightly everted lip. Sculpture; the earliest sculpture consists of spaced lamellate riblets unconformable with the lip of the protoconch (Pl. C., fig. 31), of these forty four go to the first whorl; gradually, as growth proceeds, these become smaller and closer, the last whorl carries about one hundred and thirty, regular, closely packed thread riblets; springing from the suture the riblets bend obliquely forward, spread and thicken to the vertex, descend vertically, describe a shallow backward curve across the periphery, grow thinner and closer on the base and enter the umbilicus in a forward sweep. The spire lies in a shallow cup, the depth of which is a variable feature. The umbilicus is a quarter of the shell's diameter with vertical sides and exposing all the previous volutions. Aperture vertical, elliptical, lip thin, neither everted nor inverted. Inner lip with an advanced subnacreous callus pad. No internal lamellae. Maj. diam. 8.5, min. diam. 7, height 5.5 mm.

Hab.—N.S. Wales: Upper Richmond River, under logs in the brushes (type, Macgillivray), Lismore, Tintenbar, Brunswick River, very rare (Petterd), Broken Head, Byron Bay (Jackson), Big Scrub, of Murwillumbah, Byangum Scrub (Lower).

Queensland: Little Nerang Creek (Hedley), Queensland National Park (Shirley).

RHOPHODON, gen. nov.

A new genus of the ENDODONTIDAE. Shell minute, radially striped, discoidal, with wide saucer-shaped umbilicus, sculpture dense minute riblets; aperture furnished with a few deeply-seated lamellae on either side. Type: *R. peregrinus* Hedley. Habitat, rain forests of the north coast of New South Wales.

There is a group of small South Pacific snails which resemble *Charopa* but differ by having a series of lamellae variously disposed within the aperture. Until anatomical research has made further progress it will not be decided how the occurrence of these lamellae can be correlated with those structural characters on which a natural classification must depend. For it may be that different groups have independently acquired (or lost) such armature and that a really natural classification may bind together some toothed with other toothless forms. Until further data from the animal is obtained the simplest arrangement is to divide these small snail shells into toothed and toothless forms.

A first step in classifying the toothed snails of the Pacific was taken when Beck in 1837 suggested "*Pitys*" for the reception of *P. oparana* Beck, from Opara = Rapa Island in the Tubuai, Austral or Dangerous Archipelago. Pilsbry points out that Beck's genus must lapse because it depended on an undescribed species; as later writers gave a different meaning to *Pitys* the loss of that name is the less regretted. Probably Beck had in mind a shell described two years later as *Helix opanica* by Anton and figured as *Helix oparica* by Reeve in 1852. This, *H. lamellosa* Ferussac and others were legitimately grouped in 1850 by Albers into his genus *Endodonta.*

Hutton noticed in 1883 (Trans. N.Z. Inst. xv., p. 135) that a New Zealand snail had a fortified aperture and he placed it on that account in the North American genus *Strobila.* Seeing that this southern species was incompatible with *Strobila,* Ancey in 1888 (Bull. Soc. Mal. France, v., p. 372) proposed for it a new genus *Ptychodon;* probably this name should be disqualified on account of *Ptychodus* Agassiz, 1839 (Pois. foss. iii., p. 150). Unaware of action by Ancey, Suter proposed for the same group, first *Huttonella,* already occupied in mollusca by Pfeiffer, and then *Maoriana* (Trans. N.Z. Inst., xxxiii., p. 96). For a group with hooks on the palatal lamellae Pilsbry has erected *Thaumatodon* (Man. Conch., ix., 1893, p. 26), with a subgroup *Nesophila.*

An early but neglected name in this connection is *Plesiopsis,* Ancey (Bull. Soc. Malac. France, v., 1888, p. 372) of which the genotype is a rare New Caledonian shell, *Helix lombardeaui* Montrouzier, radially striped, imperforate, 10 mm. in diameter, with one or two strong palatal lamellae. The last to be proposed is *Norfolcioconcha* Preston (Ann. Mag. Nat. Hist., 8 ser. xii., Dec., 1913, p. 535) from Norfolk Island, genotype *Endodonta norfolkensis* Hedley (Rec. Aust. Mus., iii., 1899, p. 152, Pl. 28, figs. 4, 5, 6).

Comparisons between *Rhophodon* and genera beyond Australia are as follows:

The only one smaller is *Norfolcioconcha,* from Norfolk Island, this shell is turbinate with an elevated spire and small perforation; the remarkable feature is the development of the parietal lamellae, the two blades of which plunge deep into the aperture.

Maoriana, from New Zealand, is sculptured by spaced delicate lamellae, the whorls are tightly rolled leaving a small perforation, the aperture has a larger diameter and is furnished with palatal plicae set even and close like the teeth of a comb.

Thaumatodon, from Rarotonga, has a general resemblance in form and colour, but the aperture has more lamellae carrying curved processes.

Endodonta, from Raiatea, is of similar contour, but the shell is much larger and has a keeled periphery, the armature of the aperture is simpler.

Libera, from Rarotonga, is about 5 mm. in diameter, has a dome top, sharp keel, flat base coarse radial riblets, umbilicus choked, sharp keel, flat base, coarse radial riblets, umbilicus choked and armature reduced to a few small spaced threads.

Nesophila, from Hawaii, is largest of all attaining a diameter of 12 mm., the contour resembles *Rhophodon,* the mouth armature is reduced to a minimum, consisting of a series of fine thread-like parietal lamellae.

Plesiopsis, from New Caledonia, is a bulky form, 10 mm. in diameter, imperforate, the armature reduced to two palatal lamellae.

Rhophodon consobrinus, n.sp.

(Plate xxxi., figs. 32-34.)

? *Endodonta stroudensis* Ancey (not Cox), Journ. de Conch., xlix., 1901, p. 145.

This form closely resembles *R. peregrinus,* but is larger, the umbilicus comparatively deeper, the ribbing coarser and the labial lamellae project further, the longest extending outside the lip. Maj. diam. 2.5, min. diam. 2, height 1 mm.

Hab.—N.S. Wales: Richmond and Tweed Rivers (W. F. Petterd in Cox Coll.), Tyagarah (Lower).

Rhophodon contortus, sp. nov.

(Plate xxxii., figs. 35-37.)

Shell minute, discoidal. Colour chestnut, irregularly streaked with raw sienna Whorls four including the protoconch, this is smooth and prominent and consists of a whorl and a quarter; the last whorl slowly and slightly descends and the penultimate rises to correspond; at the maximum height the penultimate partly overlaps its predecessor; the vertex of the last whorl is compressed into a ridge between which and the inner whorl runs a deep sutural furrow, the outer side of this whorl is first flattened and then constricted, causing the periphery to become subcarinate. Sculpture fine close arcuate growth lines, the upper surface being harsh but the lower smooth and glossy. Umbilicus wide and shallow. Aperture subrhomboidal; armature, one prominent exsert, and deeply entering, palatal fold, running along the periphery, and two deep seated, short parietals on the base. Maj. diam. 2.0 mm., min. diam. 1.5 mm., height 0.9 mm.

Hab.—N.S. Wales: Sherwood on the Macleay River (C. Laseron).

Rhophodon peregrinus, sp. nov.

(Plate xxxii., figs. 38-40.)

Shell minute, discoidal. Colour; centre pearl grey, adult whorls buff crossed by about a dozen irregular rays of russet brown. Whorls rounded, slightly ascending as far as the final half whorl which descends a little, protoconch of a whorl and a half, rather inflated, sometimes slightly tilted, adult whorls three. Sculpture; the initial whorl is radially striated, the adult whorls carry fine close regular riblets which amount to about one hundred and fifty on the last whorl. Spire a little concave. Umbilicus very wide and shallow. Aperture; the lamellae on the outer whorl are discernible through the shell, they commence about one-tenth of a whorl behind the aperture and continue backwards for about one-eighth of a whorl, half grown shells have their lamellae in the same position as adults, but as lamellae do not continue deep within the shell it is apparent that they are resorbed; the

series are thus disposed, on the inner lip one minute and deep seated lamella is just beneath the suture, the next is on the periphery, a little lower is the tallest and farthest exsert, closely followed by another not so prominent nor protruding so far, at an equal interval is the lowest, a small deeply seated fold which leaves a small sinus at the base of the columella; the tallest palatal is opposite the lower of the major pair of columella folds, beneath it are three or four small evenly spaced lamellae and finally there is a small one above situated between the suture and the vertex. Maj. diam. 1.9, min. diam. 1.5, height 0.75 mm.

Hab.—N.S. Wales: Tweed River (type, Petterd in Cox Coll.), Scrub at Cape Byron (Lower in Cox Coll.).

Suteria, Pilsbry.

Patulopsis, Suter, Trans. N.Z. Inst., xxiv., 1891, p. 270 (not *Patulopsis* Strebel and Pfeffer, Mexik. Land Sussw. Conch., iv., 1879, p. 16) type *Helix ide* Gray; *Suteria* Pilsbry, *nom. mut.* Nautilus, vi., 1892, p. 56; *Id.*, Man. Conch., ix., 1893, p. 17; *Id.*, Suter, Man. N.Z. Moll., 1914, p. 670.

Hitherto *Suteria* has been considered to be peculiar to New Zealand and the following species is referred to it with hesitation. The type, *S. ide*, differs indeed from *S. seticostata* by having two more whorls and is by that much larger; but correspondence in the primary character of the bristly ribs, of the texture, and of the shape, of the shell lends some support to the identification.

Suteria seticostata, sp. nov.

(Plate xxxii., figs. 41-44.)

Shell depressed and widely umbilicate, unusually thin and fragile. Colour buff, on which ground are about a dozen, radially ziczag, chocolate flames. Whorls four and a half, including the protoconch, rounded, the last gradually and slightly descending; protoconch a whorl and a half, smooth and polished. Sculpture; elevated spaced membranous ribs, on the first whorl thirty-two, on the last fifty-seven, in their interstices run four to six, microscopic, radial hair-lines, a faint spiral sculpture is sometimes indicated; on a fresh shell the major ribs carry slender upright bristles (fig. 44), regularly spaced and reaching as high as half a millimetre, but these are fragile and soon lost from worn shells. Spire low, convex. Umbilicus wide, exposing all earlier whorls. Aperture a little oblique. Maj. diam. 3.8, min. diam. 3.0, height 1.8 mm.

Hab.—N.S. Wales: Dorrigo, Nov. 1910, under logs (type, S. W. Jackson); Clarence River (Cox Coll.); Big Scrub, Murwillumbah (C. Laseron); Lismore, Ballina and Byron Bay (Lower in Cox Coll.).

EXPLANATION OF PLATES.

Plate xxix.

Figs. 1-3, *Gyrocochlea concinna,* Hedley, Type.
4-6, „ *conferta,* Hedley, Type.
7-9, „ *convoluta,* Hedley, Type.
10-12, „ *eurythma,* Hedley, Type.

Plate xxx.

Figs. 13-15, *Gyrocochlea impressa,* Hedley, Type.
16-18, „ *omicron,* Pfeiffer.
19-21, „ *planorbis,* Hedley, Type.
22-24, „ *prava,* Hedley, Type.

Plate xxxi.

Figs. 25-27, *Gyrocochlea stroudensis,* Cox.
28-31, „ *vinitincta,* Cox.
32-34, *Rhophodon consobrinus,* Hedley, Type.

Plate xxxii.

Figs. 35-37, *Rhophodon contortus,* Hedley, Type.
38-40, „ *peregrinus,* Hedley, Type.
41-44, *Suteria seticostata,* Hedley, Type.

LHOTSKY'S LAMENT.

By Tom Iredale.

The name of Coxen is well known to the present generation of Australian ornithologists, as he was the brother-in-law of Gould and furnished the latter with many birds, some of which were new, after he settled in Queensland. The early history of Coxen does not seem to be on record, so that any item is of interest. Thus I find in the Mitchell Library, Sydney, in No. II. of the New South Wales "Literary, Political and Commercial Advertiser," which appeared early in 1835 a note entitled "Australian Geography. Private Interior Discovery. We have to inform the Public that Mr. C. Coxen, who arrived in this Colony with orders from the Zoological Garden, London, has finished his first trip to the interior. He started on the 26th of December last from the Hunter, and penetrated on the banks of the Nammoi, so far as 100 miles beyond the last station (one of Sir John Jamison's), situated on this River. . . . As far as collecting is concerned Mr. C. was very successful, having discovered as much as twenty-six very rare species of birds, amongst which twenty at least, are entirely new to science. The greater part are of the parrot and pigeon tribe, the former ones of a very splendid plumage."

This estimate proved extravagant as far as the pigeons and parrots were concerned, as Kuhl and Temminck had named most of these some years previously, and as far as can be traced none were described as new from Coxen's trip.

The New South Wales "Advertiser" abovementioned was published by Dr. John Lhotsky, who appears to have been one of the "characters" of Sydney's early days. Evidently a very well-educated man, a Pole, Lhotsky appears to have come out to Sydney with the idea of entering the public service as a Naturalist of sorts. All his efforts in this direction were repulsed, and he seems to have become very embittered against the authorities, giving vent to his feelings in print.

The New South Wales Magazine appears to have been initiated by him, as, though Barton in his "Literature of New South Wales," published in 1866, on page 71, gives the Rev. Ralph Mansfield as the editor and proprietor, the Natural History Department was conducted by Dr. John Lhotsky, and in the second number, "Australian Zoology" is "By the Editor," and in connection with the occurrence of a seal at Coodjee Bay he sets out what he would have done "had I been appointed colonial zoologist, or keeper of the colonial museum—a situation which has now been unoccupied for the last two years, although a sum for its support has been annually voted by the Legislative Council. It is impossible in the colony to make out what species of *Otaria* it is; probably not the *Otaria jubata* of Peron. Should it prove to be a new species, I would call it *Otaria*. . . *Nulla dies sine linea—recta.*"

In the hope, as we shall see, of impressing the authorities, he made a scientific excursion into the Australian Alps, and again met with no success at the hands of authority, though his results were fine. As a matter of fact, Lhotsky appears to have been an early discoverer of gold in Australia, and claims to have discovered and named the far-famed Snowy River. Upon his return he attempted to publish his results under the title of "A Journey from Sydney to the Australian Alps," issuing it in sheets as printed, but only seven and a half sheets were printed and probably only seven sheets published. I was unable to see this un-

finished tract in England, but found a copy in the Mitchell Library, Sydney, and from this copy I reproduce the zoological notes, few in number, but worthy of republication, as hitherto nothing has been recorded in this connection at all. The title page of this tract reads, "A Journey from Sydney to the Australian Alps, undertaken in the months of January, February and March, 1834. Being an account of the geographical and natural relation of the country traversed, its aborigines, etc., together with some general information respecting the Colony of New South Wales. By Dr. John Lhotsky. Colonist, N.S. Wales, F.R. Bot. S. Bavaria, etc. Sydney: 1835. Sold by J. Innes, Bookseller, Pitt Street. London: By Commission at R. Ackerman's Repository of Arts, Strand." On the inside of the title page is the wording, "Sydney:—Printed at the *Australian* and Sydney *Gazette* Offices."

Lhotsky left Sydney on January 10, 1834, proceeding south-west, and his first complaint occurs as a footnote (page 15) in connection with ant's nests, of which he gives some description. "I possess very fine specimens of such cellular work, but although I offered repeatedly to our Colonial Government my collections, composed of all sorts of Australian curiosities, for sale, I could not get even an answer to my applications. These very curious objects are therefore now scattered about over many of the Museums of Europe, when they could in a great part have been united (for a comparatively trifling sum) in our well doted Colonial Museum." On page 21 a note with regard to his geological observations is interesting. "In my present circumstances my time is so taken up by minor business, that it was impossible in my Journey, and so it is now in my study to pay to such geological occurrences the minute attention necessary. My minerals I am about to send to the Geological Society, London, and Wernerian, Edinburgh, where they will, combined with my rhapsodic observations of their localities, contribute at any rate to lay down the *first rudiments* of a radical *Geology of Australia.*" On page 22, January 17, Garner's Station, "secured a good quantity of game which I proceeded to skin, and of which I noted the observations mentioned below, regarding our Colonial Zoology, etc.* * Laughing Jackass (*Dacelo gigantea*, Leach) lingua brevissima, cartilaginea, spatulata, angulis posterioribus serratis. Mutton Bird* (?) oculis rubis, pupilla nigra, Epizois scatet." Page 24. The occupations I was engaged in in this Edenlike valley collecting insects, etc., etc. The whole collection which I now possess from this expedition. . ' . . Besides my extensive collection of minerals and plants there are about 3,000 specimens of insects and above 100 of quadrupeds and birds. The only gentleman who could render me any assistance respecting *insects* (non omnia possumus omnes) who is besides in possession of an incomparable library on Natural History is so entirely engaged in the sphere of high and official life (which under present circumstances seems to be *incompatible* with a scientific one) that it would be out of the question to request his literary assistance and co-operation. However, we will give some *Entymological remarks* in the course of this work, and the Insects will be sent to the Zoological Garden, London, and others, for their radical and final elucidation. . . . . Passing the Pack Inn on our way I was asked by the owner to send one of my servants with his man, after some wild turkeys (the New Holland Vulture, of Dr. Latham) which were seen in the adjacent wood. This was the first time I saw this noble bird of our forests, which, however, gets more common on proceeding towards Menero, but was not observed by me on those downs." Page 27. "Arrived at a second ford of the Wollondilly, the

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*(The Chough, *Corcorax melanorhamphus* Vieillot. Ed.)

waters of which are yet covered with a great variety of ducks." Page 30. "The limestone of Goulburn is rather deficient in petrefactions, however, I am told that Dr. ——————, found in a similar formation at Paramarago, some perfected ones of shells, which he presented to Mr. ——————, the gentleman who with one or two more, claimed till the present time, an exclusive monopoly and dictatorship over all information respecting the Natural History of New South Wales, and the transmission of specimens to the first rate Museums in Great Britain—*Hinc illae lacrimae.* Hence so much crying and sanguinary injustice I have endured in this colony." Page 37. "Like Cain in the time of old stained with fratricide, I was marked with the guilt of two capital offences, which very few in this Colony (spoilt as it is by two bad and corrupted administrations) will ever forgive. I was a man without fortune, and unconnected with Government. But enough of this *Jeremiad* on Breadalbane Plains." January 27. "I heard at daybreak the singing of a little bird, the tones and strains of which were very delicate and tender. This is rather rare in Australia, the feathered tribe here not being very melodious. However, during this season (the summer) in exposed places, scores of Magpies (*Picus*—) are to be seen, which greet the rising sun, with their clamarous, gay, and flute-like tones; flying, playing, and hopping upon the trees near the traveller, in fact so tame are they, that I felt considerable reluctance to shoot any of them. Another characteristic bird of this land is the white Cockatoo (*Psittacus galeritus*), but it is somewhat singular, that there are only certain places where I met with it. For instance, they were very numerous near Captain Rossi's, and I also saw many of them on my return near Lake Bathurst. They are very shy, and perch only upon the highest branches." Page 56. "I remained six days in Limestone cottage, and I brought together a collection of minerals, etc. However, I am rather at a miss to lay its results before the reader, because my time and attention being taken up by selling wood and vegetables, my mind is consequently not quite in that equable state, which a work of this kind requires. . . . . the writer of these lines was not deemed worthy to receive . . . . any official assistance whatever. My offence against the Government was indeed an inexpiable one. I reminded Governor Bourke and Mr. McLeay, nearly two years since of a salary which was and continues to be voted for a dead man, and I petitioned that the vacant situation might be bestowed on me *pro tempore,* etc., etc." A footnote at page 30 reads: "I must observe here once for all that it would be a loss of time and quite out of place in New South Wales to make 'new genera and species.'" For this, the gentlemen connected with the British Museum, etc., are better provided with books, instruments, and the fostering assistance of Government. My province is only to make such observations, as are necessary to be made on the spot, and for which the learned in Europe will be thankful enough, as it is out of their sphere to make them." Page 61, Limestone River. "Among the reeds of this river the Platipus (*Ornitorynchus*) is rather plentiful, but they are so extremely shy, that even the flash in the pan makes them dive under with amazing celerity, so that the shot often has no time to reach them. Walker wounded a very large one with my percussion rifle, and followed it among the reeds, but the spurs of the monster prevented his approaching it. At another part of the river the sand of the banks was interspersed with shells, amongst which a snail (*helix*) was remarkable. The shell is of the very finest description, and resembles an extremely thin coat of dissolved isinglass, its colour is yellow-brown. Three more fresh water shells were found in this river, one of which is of considerable beauty." Page 62. "A number of hawks were so unshy, that they remained for hours there (on the fences) and on the adjacent trees. They are about the size of a fowl in the body, of a brownish plumage, the female variegated upon the breast and neck in a very handsome

manner, the male more of a uniform brownish red, and in the opinion of Mr. Coxen, who has much experience in Australian ornithology, are a new species. I called it *Falco Napoleo* on account of its resemblance to the emblematic arms of that celebrated man." Page 66. "I wandered happy upon the adjacent hills and gulleys, with the confident anticipation that so extensive a collection as I was able to make, would gain after my return, the approbation of the two persons who command our Colonial Museum; an expectation which, however, was altogether frustrated by reason of the old (but in this instance greatly misapplied) principle: 'Amor incipit ab ego.'" Page 104. "Menero Downs, Kuma hut. "Some curious birds, which were swimming in the waterhole and of which we soon shot a couple. There was no native name given to them, but they belong to the family of Pygopodes, perhaps some genus about Uria or Colymbus. The body like a small pigeon, with an entirely elliptical form, having no tail. The wings very small, the webs consisting of lobes, the head not at all like that of a duck, but with a straight pointed bill. Their eyes shortly after they were killed were very curious, and glittering like diamonds. Colymbus ? oculis bruneis, punctis alboluteis micantibus, pupilla externe circulo albicanti, micanti-nigra."

As above stated, this publication stopped at page 110, and we do not know what else was noted on the trip. After this he drifted to Tasmania, and there published a weekly tract entitled "Information for the People." No. 1, consisting of 8 pages, was occupied by "Sketches of Tasman's Peninsula" (to be continued) but no zoology occurs in this part. Nos. 2 and 3, each of 8 pages, dealt with other topics such as the Tasmanian Literary Institution, the Orphan School, the Public Garden of Hobart Town, etc., etc., and on page 23 is a note: "We under, stand, that next week one of the large presses, containing the collection made by Dr. Lhotsky in this island, will be ready for public inspection. Facts, and far more objects, are stubborn things. The last item on page 24 reads: "This weekly periodical has now reached the third number, and several parties have advised us that it would be expedient, if besides the ready money sale every Saturday evening . . . a regular system of subscription should be established" and details of such are offered. As, however, this is all of this periodical there is in the Mitchell Library, the only place I have seen it, I cannot say what happened. In his "Journey" he suggests that as the Colonial Museum has not even answered his letters offering his collections, he must send them to England and have them worked out there. It would appear that even this satisfaction was denied him, as the last note I have of Lhotsky is the offer by public auction by the Berlin Museum authorities of the duplicates of his collections made on that journey and at Sydney. The sale was to be on April 6, 1837, the catalogue being dated end of December, 1836.

From the data here provided more information may be forthcoming from some local student, but especially more information is needed with regard to Lhotsky's Tasmanian collection, as I have very little note of any local workers in Tasmania at this early date.

A MONOGRAPH OF THE AUSTRALIAN LORICATES.

(Phylum MOLLUSCA—Order LORICATA).

By TOM IREDALE and A. F. BASSET HULL.

II. Family ISCHNOCHITONIDAE.

The Family Ischnochitonidae embraces nine genera, about thirty-seven species, with some seven subspecies and a few of doubtful status. The members of this family are generally found below median tide mark down to depths of twenty-five fathoms, but mainly within one fathom below that mark. With the exception of one genus—*Stenochiton,* which inhabits the roots and blades of sea-grasses—all species are found on the under sides or at the edges of insertion in the sand of movable stones, or on the rock surface under such stones. The animals are the most alert and active of the whole Order, some species dropping off the stones when they are raised to the surface, while others move rapidly on the stones to gain the under side and escape the light. They are largely mobile, moving up or down the littoral zones with the decrease or increase in the surface temperature of the water. They are also very sensitive to the encroachment of sand in the pools they inhabit, moving out as the loose stones become covered with the sand, and returning when the changing currents have removed the sand.

No satisfactory grouping of the genera can be achieved from the study of the external characters alone. It is true that the sculpture falls into three easily recognisable variations—bold, moderate, and weak—and the girdle scales may be separated into dull and polished, striated, deeply grooved and smooth, uniform and irregular in size, but the sculpture and scale characters do not fall into any natural arrangement such as is possible when the median valves are separated and the slitting examined. This provides a differential character which, used with those of sculpture and scales, furnishes all the requirements of a satisfactory key to the genera.

The differential characters of the genera may be epitomised as follows:—

Insertion plates of median valves with one slit.
- Girdle-scales oval, moderately convex, not highly polished, horizontally grooved.
  - Scales large or medium .. .. *Ischnochiton.*
  - Scales very small .. .. *Autochiton.**
  - Scales of varying sizes.
    - Not deeply grooved .. .. *Heterozona.*
    - Deeply grooved .. .. *Strigichiton.*
- Girdle-scales rounded, highly polished .. .. *Haploplax.*

Insertion plates of median valves with more than one slit.
- Girdle-scales small, flat, lozenge-shaped, smooth and highly polished. .. .. *Stenochiton.*
- Girdle-scales highly convex, horizontally striate
  - Scales small, regularly oval .. .. *Anisoradsia.*
  - Scales large, rounded, uniform in shape .. .. *Ischnoradsia.*

Insertion plates of median valves unslit .. .. *Subterenochiton.*†

**Autochiton* gen. nov. Type: *Ischnochiton torri* Iredale and May.

†*Subterenochiton* gen. nov. Type: *Ischnochiton gabrieli* Hull.

Genus Ischnochiton.

Ischnochiton Gray, P.Z.S., 1847, 126. Type by subsequent designation (id., ib., 168), *Chiton textilis* Gray.

Shells of medium size for the family, of varied colouration, elongate ovals, sculpture of pustules in quincunx pattern, sometimes confluent into irregular lines, divaricating on end valves and lateral areas of median valves, rarely on central areas; scales on girdle large or small but always more or less striated and oval. Insertion plates sharp, not pectinated or thickened, more than eight slits in end valves, the normal slitting probably being twelve, but always variable from nine to fourteen, slits being most numerous in young examples. Sutural laminae large, separated; only one slit each side in median valves.

While it would be difficult to prepare a Key to the species, the distinctive features can be indicated as follows:—

Girdle scales large:
- Sculpture on end valves strong radials .. .. *versicolor.*

Girdle scales smaller:
- Sculpture on end valves moderate radials:
  - Median areas with very strong ridges .. .. *falcatus.*
  - Median areas with heavy nodulose ribs .. .. *pilsbryi.*
- Sculpture on end valves weak radials .. .. *elongatus.*
  - Lateral area with toothed edge .. .. *tateanus.*
  - Median areas with zigzag wrinkles .. .. *ptychius.*
- Sculpture on end valves strong semi-nodulose radials .. .. .. *variegatus.*
  - Median areas with zigzag lines .. .. *lineolatus.*
- Sculpture on end valves separated pustules .. .. *contractus.*

Girdle scales very small:
- Sculpture on end valves weakly radiate .. .. *examinandus.*
- Sculpture minutely pustulose throughout .. .. *luticolens.*
- Sculpture strongly pustulose throughout .. .. *atkinsoni.*

In pattern the sculpture of the lateral areas of the median valves closely resembles that of the end valves.

Ischnochiton elongatus.

(a) Ischnochiton elongatus elongatus.

Plate xxxiii., figs. 1-1a.

Chiton elongatus Blainville, Dict. Sci. Nat., xxxvi., 1825, 542. New Holland (Peron and Lesueur). (We select Kangaroo Island). Type in Paris Museum.

Chiton ustulatus Reeve, Conch. Icon., iv., 1847, pl. xvii., sp. and f., 102. Australia (Jukes). Type in Brit. Mus. Iredale and May, Proc. Mal. Soc., xii., 1916, 110, pl. xii., f. 3a'. Not *Ischnochiton ustulatus* of Bednall and recent writers.

Ischnochiton crispus var. *decorata* Sykes, Proc. Mal. Soc., ii., 1896, 87. Port Phillip, Victoria (Bracebridge Wilson). Type in Melbourne Museum.

Ischnochiton decoratus Sykes, Iredale and May, Proc. Mal. Soc., xii., 1916, 110, pl. iv., f. 3a'''.

Ischnochiton lineolatus Blainville, Dupuis, Bull. Mus. Paris, 1918, 526. Ashby, Trans. Roy. Soc. S. Aust., xliv., 1920, 272, pl. xi., f. 3 (review). May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 12. Not *Chiton lineolatus* Blainville, 1825.

Shell medium, rather elongately ovate; moderately elevated; sub-carinated; side slopes rounded. Sculpture weak in juvenile, well expressed in adult examples. Colour extremely variable:—(a) Olive-green, thickly painted with dots of a darker colour. (b) With broad dorsal stripe in white, extending from the centre of the anterior valve to behind the mucro of the posterior valve, sometimes relieved by V-shaped markings on valves ii. to vii., with an inverted V. on the posterior valve, the apex of which touches the mucro; the rest of the shell uniformly coloured in black, grey, red, blue, brown or green, or with curved lines in colour tending towards the jugum. (c) Uniformly coloured or stippled in black, dull purple, red, blue, brown or green. (d) Uniformly white, with girdle brown, maculated, or bright yellow. (e) Ground colour white or yellowish, the colour pattern formed by dots on the jugum and curved narrow to broad short lines increasing in width towards the margin, in black, grey, brown, purple or rose. (Sykes's *decoratus*).*

Anterior valve having 40-50 radiating rows of elongated pustules, becoming obsolete on the apex.

Median valves; lateral areas strongly raised, having 8-20 radiating rows of elongated pustules; central areas finely sculptured with lirae curving inwards towards the jugum.

Posterior valve large, the mucro prominent, slightly in front of the middle; ante-mucronal area similar to central areas of median valves, post-mucronal area similar to anterior valve, but the pustules generally larger, more prominent, and less continuous.

Girdle scales medium, uniform, rounded ovals, horizontally deeply grooved, about six to a scale.

Interior white. Slits 11-1-13. Sinus very broad.

Dimensions: Average adult 25 x 13 mm. Maximum 32 x 15 mm.

Station: Under stones between median and lowest spring tide marks; occasionally found in root-sheaths of *Zostera*.

Habitat: Victoria from Wilson's Promontory on the east coast to South Australia, and Tasmania.

Remarks: This is one of the commonest Loricates, being found in practically every sheltered pool or in smooth water inlets and harbours.

Though Dupuis, Ashby and Lamy have recorded that the "types" of *lineolatus* Blainville in the Paris Museum were shells of *crispus* auct., none searched for the "types" of *elongatus*, based on many examples also in that Museum. The description of *elongatus* is clearly applicable to the present species, and the shells described by Blainville probably came from Kangaroo Island, where Peron and Lesueur made a very large collection which was never reported on, and examples from that locality loaned us by Mr. E. H. Matthews agree in detail with the original description.

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* Note.—The descriptions have in all cases been written by us from normal examples, the original author's description being in some cases (as in the early authors) totally inadequate, and in later instances unnecessarily diffuse for the purposes of a work such as this monograph.

The size "small," "medium," or "large" is based upon an arbitrary standard established for each genus. The standard for the genus Ischnochiton is:—Small, under 15 m.m. for average adult; medium, over 15 and under 30 m.m. do.; large, over 30 m.m. do.

(b) Ischnochiton elongatus crispus.

Plate xxxiii., fig. 1b.

Chiton crispus Reeve, Conch. Icon., iv., 1847, pl. xix., sp. and f. 120. Australia = Port Jackson, N.S.W. Type in Brit. Mus.

Chiton mesoleucus Lichtenstein, Verz. Samml. neuholl. Nat., 1837, 9. New South Wales, *nom. nud.*

Chiton longicymba Sowerby, Conch. Illus., 1840, f. 67, and of many other authors until Pilsbry, but not *Chiton longicymba* Blainville, 1825.

Ischnochiton haddoni Pilsbry, Man. Conch., xiv., 1892, 88, pl. xxii., f. 67-73. Port Jackson, N.S.W. Type in Acad. Nat. Sci. Philadelphia.

Ischnochiton crispus Reeve, Pilsbry, Nautilus, viii., 1895, 129. Ashby, Trans. Roy. Soc. S. Aust., xliv., 1920, 272, pl. xi., f. 4.

Shell similar in sculpture and variable colour to the preceding species. Differs only in the girdle scales, which are rather smaller, and the grooving is weaker.

Habitat: Mallacoota Inlet, Victoria, and New South Wales from Twofold Bay to Broughton Island; probably extending much further north, but not reaching Queensland.

Ischnochiton variegatus.

Plate xxxiii., fig. 2.

Lepidopleurus variegatus H. Adams and Angas, P. Z. S., 1864, 192. Yorke's Peninsula, South Australia.

Ischnochiton atkinsoni lincolnensis Ashby, Trans. Roy. Soc., S. Aust., xliv., 1920, 275, pl. xii., f. 5a, 5b. San Remo, Victoria, etc.

Shell medium, elongate oval, moderately elevated, semi-carinated, side slopes convex. Colour distinctive, whitish mottled with brown and black, the mottlings generally forming a continuous dark line down each side, leaving a broad white dorsal stripe, with a few indistinct splashes on the jugum.

Anterior valve rayed with numerous fine low ribs, divaricating anteriorly and becoming semi-nodulose through concentric growth lines cutting them; missing towards the apex.

Median valves with the central areas finely decussated in quincunx, laterally developing irregular fine linear ridges; lateral areas ribbed more boldly than the anterior valve, the nodulose sculpture becoming more notable through the concentric growth lines being more pronounced.

Posterior valve with the mucro ante-median; ante-mucronal area as median central areas; post-mucronal area showing similar sculpture to anterior valve, but much more nodulose.

Girdle scales small, less than those of *I. elongatus crispus* Reeve, elongate ovals, closely packed and finely grooved with six to eight ridges.

Interior white. Slits 12-1-12.

Dimensions: 20 x 10.5 mm.

Station: Between tide marks.

Habitat: South Australia.

Remarks: This species was well described but not figured, and was recognised by Pilsbry, Bednall (who adapted the original description), Matthews and Torr, but Ashby, through an oversight, neglected it and redescribed the species as a form of *I. atkinsoni* Iredale and May, naming it *I. a. lincolnensis.* While showing a little variation it appears to be fairly constant and restricted to South Australia and western Victoria, though the confusion with *I. atkinsoni* has some-

what complicated the records. The type of *I. variegatus* is at present missing, but we figure a neotype, collected for us by Mr. E. H. Matthews, at Minlacowie, Hardwicke Bay, South Australia, the exact locality whence Angas described it.

Ischnochiton examinandus.

(a) Ischnochiton examinandus examinandus.

Plate xxxiii., figs. 3a, b, c, d.

Ischnochiton examinandus Hull, Aust. Zool., iii., 1923, 160, pl. xxv., f. 1-4. Long Reef, near Manly, N.S.W. Type in Australian Museum.

Shell small, a little depressed, semi-carinate, side slopes slightly convex. Colour: the whole shell is covered with a reticulated pattern in dull pink, having darker brownish pink mottlings. Scattered irregularly over the anterior valve, in the central areas and, in some valves, on the jugum are blotches of yellowish maculated with dark greenish; the whole presenting a distinctive marbled scheme of pink and green. (Type). Other examples are wholly pink, pink with black markings on some valves, and yellowish.

Anterior valve superficially almost smooth, but having a quincuncial punctation developing into ribbing only at the edges, the pustules close and flattened.

Median valves with central areas finely quincuncially punctate, lateral areas raised and similarly sculptured, ribbing developing only slightly towards the girdle.

Posterior valve with mucro ante-median; ante-mucronal area as preceding, post-mucronal area similar to anterior valve in sculpture, no ribbing noticeable.

Girdle broad; scales small, closely packed, beautifully regular, and carved with about eight even grooves.

Interior pinkish-white. Slits 10-1-10.

Dimensions: 14 x 8 mm.

Station: Under stones and on dead shells below low water mark; rather solitary; also dredged in 6-8 fathoms.

Habitat: New South Wales (central and southern coast).

Remarks: This shell can be distinguished from *I. elongatus crispus* by its generally broader dimensions, wider girdle, and smaller girdle scales, as well as the absence of distinctive sculpture. Juvenile shells show no radials, and senile ones only a little.

(b) Ischnochiton examinandus laetior.

Plate xxxiii., figs. 3, 3e, f, g, h.

Ischnochiton examinandus laetior Hull, Aust. Zool., iii., 1923, 160, pl. xxiv., f. 14-17. Caloundra, Queensland. Type in Australian Museum.

Shell very like the preceding in detail, but with much more varied colouration, some being typical pink and green marbled examples, while others range from ochraceous to deep pink; some are decorated with a broad white dorsal stripe varying in breadth, disposed somewhat after the manner of the common colour pattern of *I. versicolor* Sowerby.

The sculpture throughout is stronger; the radial ribbing more pronounced on the anterior valve, the lateral areas of the median valves and on the posterior valve.

Dimensions: 15 x 9 mm.

Station: Under and on pebbles and small stones between tide marks; generally in shallower water than the southern species.

Habitat: Caloundra and Point Cartwright, south Queensland.

Ischnochiton lineolatus.

Plate xxxiv., figs. 2, 2a.

Chiton lineolatus Blainville, Dict. Sci. Nat., xxxvi., 1825, 541. Ile King (Peron and Lesueur). Type, Paris Mus.

Chiton contractus Pilsbry, Nautilus, viii., 1895, 129, and all subsequent writers to 1916, but not of Reeve.

Ischnochiton lineolatus Iredale and May, Proc. Mal. Soc., xii., 1916, 108, pl. iv., f. 1, 1a. Flinders Group, Bass Strait.

Ischnochiton iredalei Dupuis, Bull. Mus. Nat. Paris, 1918, 526. New name for *contractus* auct. *non* Reeve = Flinders Group. Ashby, Trans. Roy. Soc. S. Aust., xliv., 1920, 272. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 11.

Chiton pallidus Sykes, Proc. Mal. Soc., ii., 1896, 82, in synonymy. Not *C. pallidus* Reeve, Conch. Icon., iv., 1847, pl. xvi., sp. and f. 92. Loc. unknown, prob. Africa. Type Mus. Cuming in Brit. Mus.

Ischnochiton iredalei kingensis Ashby and Hull, Aust. Zool., iii., 1923, 81, pl. viii., f. 1-4. Fraser Bay, King Island, Bass Strait.

Shell large, elongately oval, the ends rounded, not contracted; semi-carinated, slightly elevated, side slopes straight.

Colour distinctive, white or yellowish with brown or blackish longitudinal splashes down the middle, generally on each side of the jugum, fewer spots towards edges; sometimes the splashes are repeated on the outer margins of the lateral areas.

Anterior valve rayed with very closely packed irregular linear ridges, semi-jugum, coarser and nearly straight towards the girdle: lateral areas irregularly nodulose at edges through cutting by concentric growth lines, but nodules elongate and *not* separated and rounded: lateral edges semi-nodulose.

Median valves with the central areas showing zigzag ridges, fine on the rayed and concentrically cut, the rays consisting of massed pustules irregularly arranged.

Posterior valve with the mucro ante-median, the ante-mucronal area sculptured as median central areas, but sculpture finer; the post-mucronal area showing a sculpture consisting of separated pustules irregular in shape and massing towards margin, where they become confluent but are cut by concentric growth lines.

Girdle scales regular, rather rounded, fairly large, evenly grooved with Interior white. Slits 11—12-1-12—14.

Dimensions: Maximum 50 x 25 mm.

Station: On the underside of stones below median tide mark.

Habitat: Southern Australia, from King George Sound to Western Port, Victoria; Islands of Bass Strait and Tasmania.

Remarks: Iredale and May revived the Blainvillean name *lineolatus* for this species, the description exactly conforming and the locality cited agreeing. Dupuis, from an examination of the specimens in the Paris Museum, concluded that Blainville's "types" of *lineolatus* were not the present species, but were the shell known as *"crispus"* and he therefore renamed this species *iredalei*. Ashby has recently acquiesced in this view as has also Lamy, but none of these viewed the matter judicially. Blainville compared this species with his own *"elongatus"* founded upon *many examples* in the Paris Museum. None of the workers cited attempted to trace in that Institution this species (*elongatus*) which we have recognised as the southern form of *crispus* (ante). Consequently Blainville's *lineolatus* which was contrasted with *elongatus* would easily apply to this present species as Iredale

and May showed. The conclusion is that neither Dupuis, Ashby nor Lamy saw the original shells described by Blainville as *"lineolatus,"* but saw specimens of *"elongatus"* which had been wrongly labelled. Rochebrune was probably responsible for this, and his errors are well known. Blainville cited King Island as locality, and in this case this appears to be correct as May and Hull have recently collected this species there, it being very common on the eastern coast. Ashby and Hull named the King I. form *I. iredalei kingensis,* the variation they regarded as geographical, having been since determined as individual only. When Dupuis proposed *I. iredalei* as a new name for *I. contractus,* he cited no definite locality, so we designate Flinders Island as the type locality, citing the specimen figured by Iredale and May from that locality as typical.

ISCHNOCHITON CONTRACTUS.

Plate xxxiii., fig. 5.

Chiton contractus Reeve, Conch. Icon., iv., 1847, pl. xv., sp. and f., 78. New Zealand (error = South Australia). Type Mus. Cuming in Brit. Mus.

Chiton sulcatus Quoy and Gaimard, Voy. Astrolabe, iii., 1835, 385, pl. 75, f. 31-36. King George Sound, South-west Australia. Type in Paris Mus. Not *Chiton sulcatus* Wood, Gen. Conch., Pt. 1, 1814, 15.

Chiton decussatus Reeve, Conch. Icon., iv., 1847, pl. xviii., sp. and f. 107. Australia (Jukes). Type Mus. Cuming in Brit. Mus.

Chiton castus Reeve, Conch. Icon., iv., 1847, pl. xxii., sp. and f., 145. Loc. unknown. Type in Brit. Mus.

Lepidopleurus speciosus H. Adams and Angas, P.Z.S., 1864, 192. Port Lincoln, South Australia.

Gymnoplax urvillei Rochbrune, Bull. Soc. Philom. Paris, 7th Ser., v., 1881, 121. Based on type specimen of *C. sulcatus* Q. and G.

Ischnochiton intergranosus Carpenter M. S. Pilsbry, Man. Conch., xiv., 1892, 93, in synonymy.

Ischnochiton decussatus Pilsbry, Nautilus viii., 1895, 129, and subsequent writers to 1916.

Ischnochiton contractus Iredale and May, Proc. Mal. Soc., xii., 1916, 107. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 9.

Shell large, elongate oval, a little contracted at the ends, semicarinated, side slopes straight, moderately elevated.

Colour distinctive, white or yellowish with flame marks of brown or greenish along the dorsal area; girdle dark brown.

Anterior valve closely covered with small rounded separated pustules, finer towards the apex.

Median valves with central areas sculptured with sloping linear ridges, about thirty on each side of the jugal ridge, which is finely decussately striate, the lines sloping from the jugal area towards the girdle: lateral areas sculptured as anterior valve, the pustules rarely tending to amalgamate towards the edges.

Posterior valve with the mucro ante-median: ante-mucronal area sculptured as median central areas, the post-mucronal area as anterior valve.

Girdle scales rather large, rounded, regular with about six to eight deep even grooves.

Interior white, under jugum dark. Slits, 12-1-12.

Dimensions: 38 x 21 mm.

Station: Under stones below median tide mark.

Habitat: Western Australia from Fremantle south and east to South Australia, Victoria, and Furneaux Group, Bass Strait.

Ischnochiton versicolor.

(a) Ischnochiton versicolor versicolor.

Plate xxxiv., fig. 1b.

Chiton versicolor Sowerby, Mag. Nat. Hist. (Charlesworth), iv., 1840, 292. (Conch. Illus. fig. 75; and fig. 122 = var. alb.). Loc. unknown; collected by Dr. Stanger.

Chiton proteus Reeve, Conch. Icon. iv., 1847, pl. xviii., sp. and f. 111. Newcastle, N.S.W. Type Mus. Cuming in Brit. Mus.

Ischnochiton divergens Pilsbry, Man. Conch., xiv., 1892, 90, pl. 22, f. 74-77. Port Jackson, Australia. Not *Chiton divergens* Reeve. (Port Jackson).

Ischnochiton intricatus and *intricandus* id. ib. ex Cpr. M.S. in synonymy.

Ischnochiton proteus Iredale and May, Proc. Mal. Soc. (Lond.), xii., 1916, 109, pl. v., fig. 2a'''

Shell large, elongate oval, head valve small, tail valve large, median valves deep, a little flattened, semi-carinated, side slopes convex.

Colour very variable, the most frequent being sage green, with a lighter dorsal stripe, but uniform white, rose, blue or brown are not uncommon, while the same ground colours are often maculated or splashed with black or brown.

Anterior valve small, rayed closely with numerous ridges, towards the edge intercalating riblets appearing.

Median valves: Central areas sculptured toward the edges with fine wavy linear ridges, finer towards the jugum where they show a fine zigzag character; lateral areas with three or four primary ribs divaricating towards the girdle, the interstices finely punctate.

Posterior valve with mucro ante-median, the ante-mucronal area sculptured as median central area, the post-mucronal area with irregular elongate pustules which amalgamate into ribs and show divarication.

Girdle scales large rounded ovals, evenly placed all over the girdle, very regularly deeply grooved, with six to eight ridges.

Interior pinkish or bluish white, according to external coloration, red horseshoe in tail valve, slits 10-1-10.

Dimensions: 60 x 30 mm. (maximum observed).

Station: Under stones below median tide mark.

Habitat: New South Wales and Mallacoota Inlet, Victoria.

(b) Ischnochiton versicolor milligani.

Plate xxxiv., figs. 1, 1a.

Ischnochiton milligani Iredale and May, Proc. Mal. Soc., xii., 1916, 109, pl. v., f. 2, 2a'. Port Arthur, S. Tas. Type in Tas. Mus. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 14.

Differs in its generally larger size, more complicated sculpture on lateral areas, and coarser sculpture on central areas of median valves; more numerous ridges on head and tail valves and comparatively smaller scales.

Slitting in young shells 13-1-13, senile 9-1-11.

Habitat: Tasmania, South Australia, Victoria.

Remarks: A very common shell in most localities, and especially notable for its brilliant coloring. A long series collected by Roy Bell at Twofold Bay, N.S.W., Mallacoota and Port Fairy, Victoria has proved that the variation can only be regarded as subspecific, though the extremes are abundantly distinct.

This species was undoubtedly described by Sowerby in 1840 as *Chiton versicolor,* the figures and description being unmistakeable.

ISCHNOCHITON FALCATUS.
Plate xxxiv., figs. 6, 6a, b, c, d.

Ischnochiton falcatus Hull, Proc. Roy. Soc. Vict., xxv., 1912, 121, pl. viii. Western Port, Victoria, dredged 6-8 fath. Type in Coll. Gabriel. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 10.

Ischnochiton sculptus Gatliff and Gabriel, Proc. Roy. Soc. Vict., xxi., 1908, 383. Not *Chiton sculptus* Sowerby, 1840.

Ischnochiton tateanus Sykes, Proc. Mal. Soc. (Lond.), ii., 1896, 87. Tate and May, Proc. Linn. Soc. N.S.W., 1901, 413.

Shell small, oval, elevated, carinated, side slopes straight.

Colour: Yellowish-brown.

Anterior valve rayed with twenty-five ridges tending to divaricate towards edge of girdle: lateral edges strongly toothed.

Median valves: Central areas punctate on jugum, curved ridges developing laterally with wider interspaces, widely spaced towards girdle: lateral areas elevated with two prominent ribs either divaricating towards girdle, lower rib massive and broken into a dozen separated saw teeth.

Posterior valve with the mucro median: ante-mucronal area sculptured with curved lines as median central area; post-mucronal area simply punctate behind mucro, developing concentric rows of tubercles towards edge.

Girdle scales small regular flattened ovals with about ten shallow ridges.

Interior: Pinkish-white. Slits 11-1-13.

Dimensions: 15 x 9 mm.

Station: Dredged in 6-15 fathoms.

Habitat: Victoria and Tasmania.

ISCHNOCHITON PTYCHIUS.
Plate xxxiv., fig. 5.

II. Family *Ischnochitonidae.*

Ischnochiton ptychius Pilsbry, Nautilus, viii., 1894, 53. Gulf St. Vincent, South Australia. Type in Brit. Mus.

Shell small, elongate oval, semi-carinated, side slopes straight.

Colour distinctive, pinkish mottled with whitish, rarely.

Anterior valve quincuncially punctate, obsoletely rayed.

Median valves: Central areas quincuncially punctate, but with zigzag striae developing at sides. Lateral areas obsoletely three or four ribbed, ribs flattened, suggesting towards edge confluent pustules, lateral edges thickened not toothed.

Posterior valve: Mucro ante-median, ante-mucronal area as median central areas: post-mucronal area obsoletely rayed with seminodulose flattened ribs.

Girdle scales comparatively large, regular flattened ovals, finely grooved with about ten ridges.

Interior: Pinkish-white. Regular Ischnoid slitting.

Dimensions: 11.5 x 7 mm.

Station: Below low water mark.

Habitat: South Australia (Gulf St. Vincent).

Remarks: A rare shell, the above description may be modified a little when series are collected: a magnificent example collected by Mr. E. H. Matthews, 21 x 12 mm., shows the zigzag sculpture of the central areas of the median valves very prominently; and the lateral edge semi-nodulose, but still not toothed.

ISCHNOCHITON TATEANUS.
Plate xxxiv., fig. 4.

Ischnochiton tateanus Bednall, Proc. Mal. Soc., ii., 1897, 147, pl. xii., f. 3 and text-fig. Sultana Bay, Yorke's Peninsula, South Australia. Dredged. Type in coll. Matthews ex Bednall.

Shell small, broad oval, flattened, semi-carinated, sides slopes convex. Colour French grey, flecked with white; uniform rose pink, or yellowish.

Anterior valve rayed with about 35 undulating flat ribs with connecting concentric waved riblets, lateral edge strongly serrated.

Median valves: Central areas rather coarsely quincuncially punctate, the pustules massing into wavy lines towards the girdle; the lateral areas with three to five flat ribs, the outsides regularly toothed so as to show a rounded saw edge.

Posterior valve with the mucro median; ante-mucronal area sculptured as central area; post-mucronal area sculptured as anterior valve, but sculpture less definitely marked.

Girdle scales small regular flattened ovals, evenly grooved, with eight low ridges.

Interior white or pinkish. Slits 12-1-12.

Dimensions: 13 x 9 mm. (grey), 20 x 13 (rose pink).

Station: Dredged on shells in 5-30 fathoms.

Habitat: South Australia, Victoria, Tasmania, and southern New South Wales.

Remarks: The typical form (from South Australia) is characterised by strongly marked sculpture, especially the serrations on the posterior margins of valves i.-vii.

Specimens dredged by Roy Bell in Disaster Bay 12-20 fathoms and Twofold Bay 20 fathoms, in New South Wales are smaller, more elongate, much more elevated, and less marked in sculpture. The rose and yellowish colours predominate in these localities. For the New South Wales shell we propose the subspecific name *I. t. paradisiacus.*

Ischnochiton pilsbryi.

Plate xxxiii., fig. 4.

Ischnochiton pilsbryi Bednall, Proc. Mal. Soc., ii., 1897, 143, pl. xii. Sultana Bay, Yorke's Peninsula, South Australia. Type in coll. Matthews ex Bednall.

Shell medium, regular elongate oval, wide girdle, round back, moderately elevated, the posterior edges of anterior and median valves raised and strongly callused. Colour: uniform yellowish buff.

Anterior valve with apex sinused, a little recurved, posterior edge thickened and raised; sculptured with regular rays of nodules about forty in number at edge, obsolescent at apex where pustules are coarse, but much smaller.

Median valves: Central areas showing irregular ridges of massed pustules rather separated and comparatively few, about fifteen being counted, the jugum showing coarse pustules only; lateral areas showing two to four ribs of separated large tubercles, the interstices between being minutely granulose.

Posterior valve with the mucro low and median, the ante-mucronal area as median central area, post-mucronal area minutely granulose, pustules forming towards girdle and becoming concentrically arranged.

Girdle very broad; scales long ovals comparatively large and flattened, laid down in order, not imbricating; glossy, showing twelve shallow grooves.

Interior white. Slits 11-1-11.

Dimensions: 24.5 x 15 mm. Maximum: 28 x 16.

Station: Under large blocks of limestone at low tide.

Habitat: Yorke's Peninsula, South Australia.

Remarks: The fine series loaned us by Mr. E. H. Matthews enables us to give some details of the growth stages of this rare shell. The youngest one 10 x 6 mm. shows a coarsely pustulose surface, the pustules running into lines at the edges of the median central areas and a few large tubercles appear at the edge of the lateral areas. In the second stage the linear and confluent arrangement on the central areas becomes more pronounced, while tubercles appear round the

edges of the end valves; sometimes the tubercles increase in size without massing, in other cases forming irregular lines before becoming very large.

ISCHNOCHITON ATKINSONI.
Plate xxxiv., figs. 3, 3a, 3b.

Ischnochiton atkinsoni Iredale and May, Proc. Mal. Soc., xii., 1916, 110, pl. iv., f. 3. Sulphur Creek, N.W. Tas. Type in Tas. Mus. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 8.

Shell small, elongate oval, elevated, roundbacked, not carinated. Colour, uniform buff.

Anterior valve quincuncially punctate, obsoletely rayed towards girdle edge, rays about thirty in number.

Median valves: Central areas coarsely quincuncially granulose, granules round and flat-topped, a little finer on jugum and a little coarser towards girdle edge; lateral areas elevated, irregularly pustulose, tuberculose towards edge, tubercles longitudinally confluent.

Posterior valve with the mucro ante-median, ante-mucronal areas quincuncially punctate, post-mucronal area coarsely pustulose towards the edge, the pustules concentrically arranged.

Girdle scales very small and regular evenly grooved ovals.

Interior white. Slitting a little weak, 9-1-11.

Dimensions: 8 x 4.5. Maximum: 13 x 7.

Station: At median tide under stones.

Habitat: North Tasmania, King Island, Victoria.

Remarks: In some specimens the radial sculpture on the end valves and lateral areas of the median valves shows more regular raying and little erosion, but the majority are much eroded medially before reaching the senile stage.

ISCHNOCHITON LUTICOLENS.
Plate xxxiv., figs. 7a, b, c, d.

Ischnochiton luticolens Hull, Aust. Zool., iii., 1923, 159, pl. xxiv., f. 10-13. Port Curtis, Queensland. Type in Australian Museum.

Shell small, elongated oval, not carinated. Colour buff or pale brown, sometimes stained with blackish-brown.

Anterior valve densely covered with minute granules, not arranged in any definite pattern.

Median valves with moderately raised, rounded lateral areas, covered with elongated oval granules diverging outwardly; central areas with granules diverging inwardly, rather larger and more clearly defined than those on the lateral areas.

Posterior valve with granules as on the anterior valve, but tending to radiate, central areas similar to the median valves; mucro in front of the middle; the posterior portion concave.

Girdle densely clothed with minute striated scales.

Interior white. Slits 15-1-13.

Dimensions: 11 x 6 mm.

Station: On the under side of small stones embedded in mud, below low water mark.

Habitat: Port Curtis (Barney Point), Queensland.

The following three species are recorded, but are at present indeterminate:—

ISCHNOCHITON ALBINUS.

Ischnochiton albinus Thiele, Die Fauna Sudwest. Austr. iii., 1911, 400, pl. 6, f. 4. Sharks Bay, West Australia.

A minute shell from Surf Point, Outer Bar, Sharks Bay, West Australia,

only 3.5 mm. long and 2 mm. broad, entirely white, the shell arched, scarcely keeled, the mucro post-median. Pustulose throughout, finely reticulate on the jugum. Fourteen slits in the anterior valve, the slits in the posterior valve irregular "but may be the normal eight." Girdle scales small, about 70 μ broad, with numerous grooves (i.e., finely striated). The radula is peculiar.

We are unable to do anything with this minute species, which appears to be the immature of a new species, but the only illustration offered is of a girdle scale. The peculiar radula is well described, but the description is of little assistance until more material is available.

Ischnochiton indifferens.

Ischnochiton indifferens Thiele, Fauna Sud-west Austr., iii., 1911, 401. Sharks Bay, Western Australia.

Thiele's short description of a shell 4 mm. long by 2.5 mm. broad probably from Sharks Bay, West Australia, makes his species indeterminate until a series has been secured, the characters given being those of an immature shell, the coloration white, marbled with red; elongate oval, semi-keeled, mucro median, sculpture simply granulose; slitting 11-1-8, the sutural laminae small and rounded; the girdle scales small, about 70 μ long and with 16-18 fine grooves.

Ischnochiton auratus.

Ischnochiton auratus Ashby, Trans. Roy. Soc. S. Aust., xliv., 1920, 277, pl. xii., f. 6a and b.

The description of two immature specimens leaves this species unrecognisable, and we have been compelled to regard it as based on the very young stage of *Heterozona cariosa* (Pilsbry), as we find this species varies considerably in development, sometimes growing to a considerable size before the typical scale arrangement appears, in others the peculiar character of the girdle being shown in the very young stage. We have been unable to examine the type.

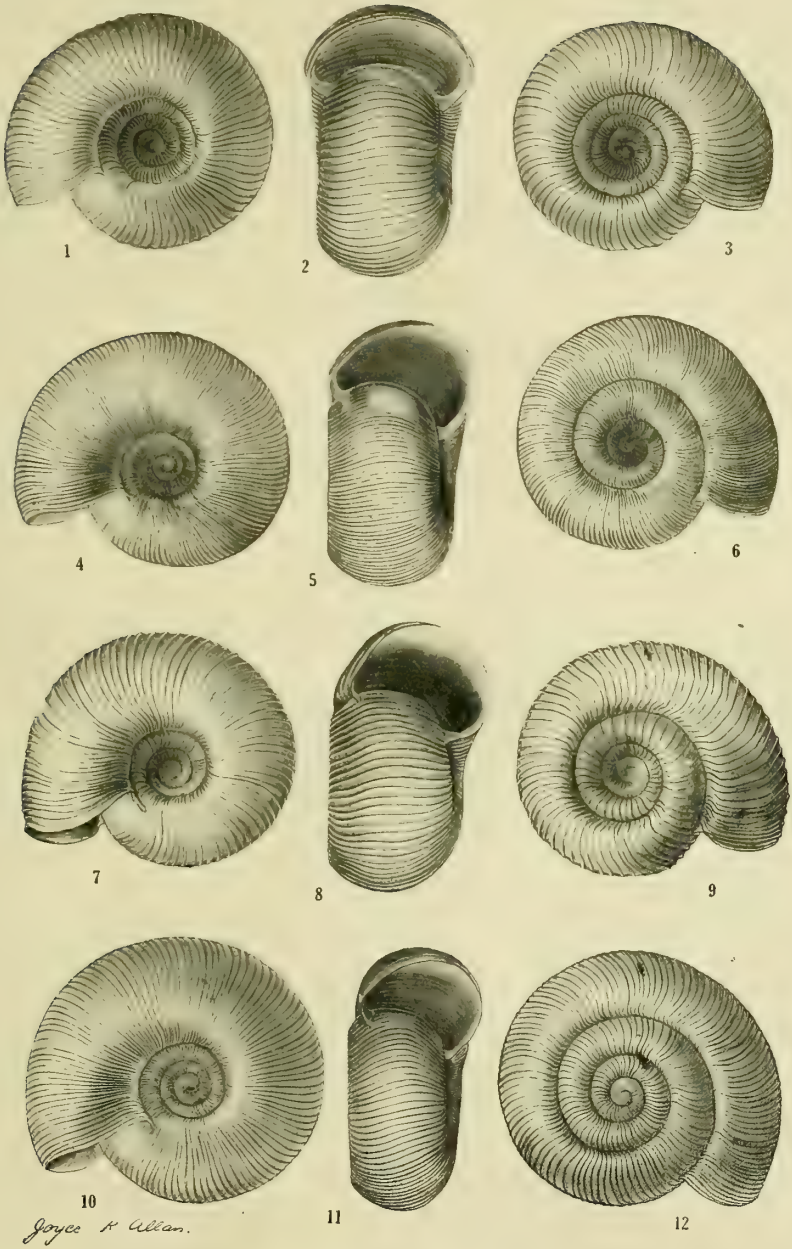
EXPLANATION OF PLATES.

Plate xxxiii.

Fig. 1. Whole shell of *Ischnochiton elongatus* Blainville.
1a. Scales of *Ischnochiton elongatus* (*ustulatus*). } Not to same
1b. Scales of *Ischnochiton elongatus crispus* Reeve. } magnification.
2. Whole shell of *Ischnochiton variegatus* Adams and Angas.
3. Whole shell of *Ischnochiton examinandus laetior* Hull.
3a, b, c, d. Valves and scales of *Ischnochiton examinandus examinandus* Hull.
3e, f, g, h. Valves and scales of *Ischnochiton examinandus laetior* Hull.
4. Whole shell of *Ischnochiton pilsbryi* Bednall.
4a. Side view of *Ischnochiton pilsbryi* Bednall.
5. Whole shell of *Ischnochiton contractus* Reeve.

Plate xxxiv.

Fig. 1. Whole shell of *Ischnochiton versicolor milligani* Ire. and May.
1a. Sculpture of *Ischnochiton versicolor milligani* Ire. and May.
1b. Sculpture of *Ischnochiton versicolor versicolor* Sowerby.
2. Whole shell of *Ischnochiton lineolatus* Blainville.
2a. Sculpture of *Ischnochiton lineolatus* Blainville.
3. Whole shell of *Ischnochiton atkinsoni* Ire. and May.
3a. Sculpture of *Ischnochiton atkinsoni* Ire. and May.
3b. Scales of *Ischnochiton atkinsoni* Ire. and May.
4. Whole shell of *Ischnochiton tateanus* Bednall.
5. Whole shell of *Ischnochiton ptychius* Pilsbry.
6. Whole shell of *Ischnochiton falcatus* Hull.
6a, b, c, d. Valves and scales of *Ischnochiton falcatus* Hull.
7a, b, c, d. Valves and scales of *Ischnochiton luticolens* Hull.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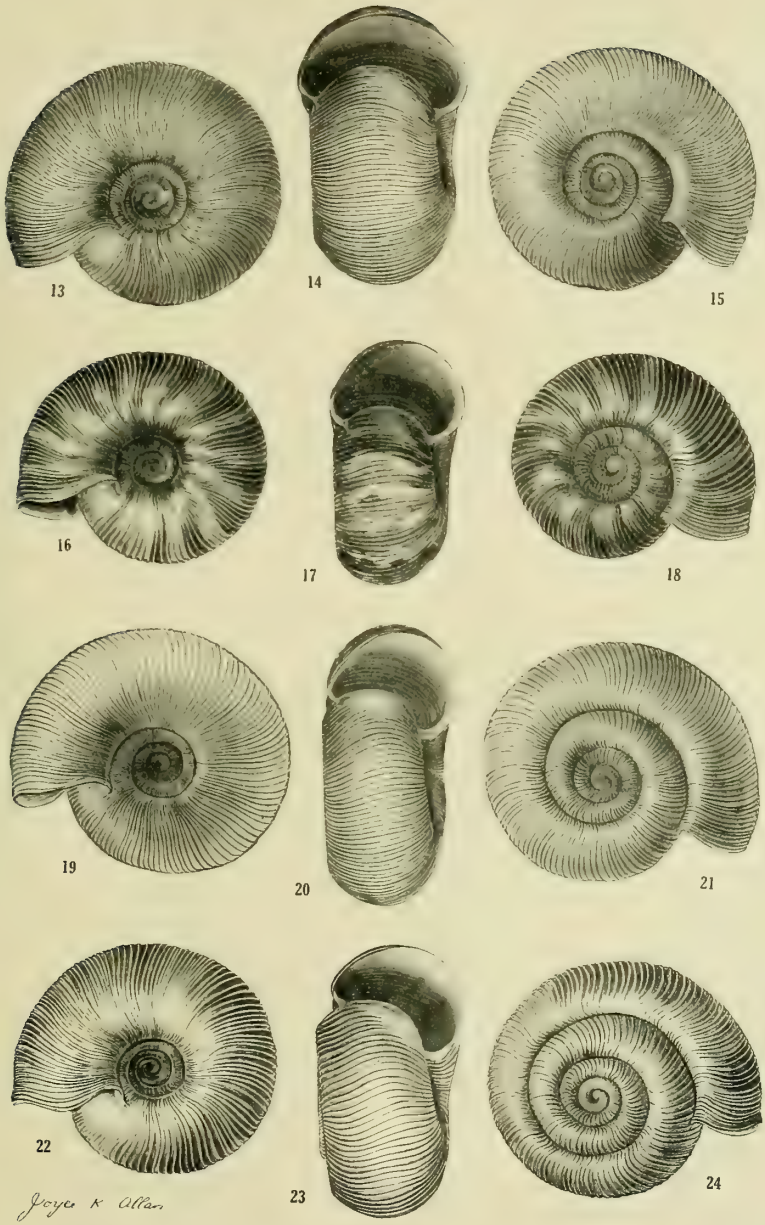
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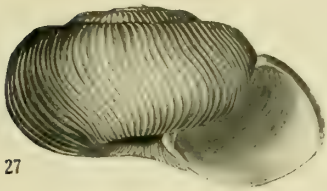

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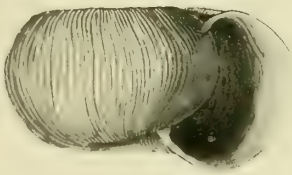

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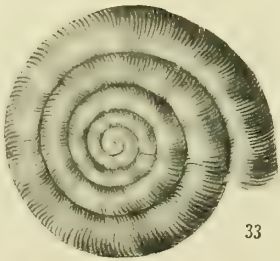

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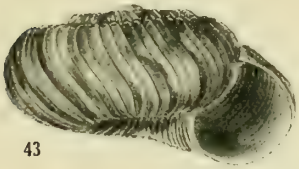

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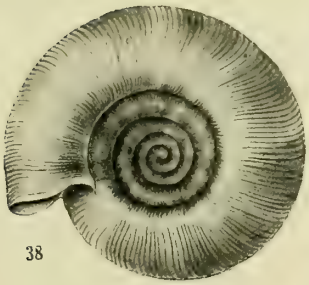

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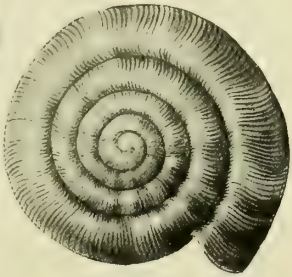

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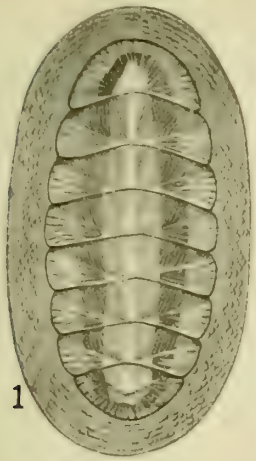
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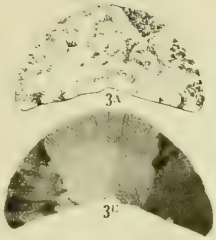
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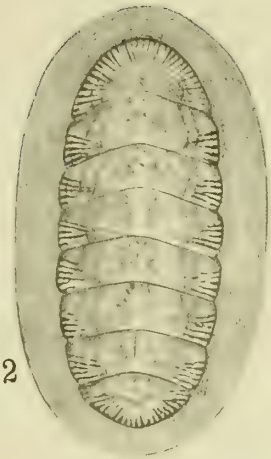
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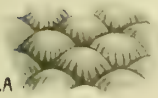
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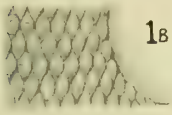
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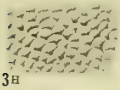
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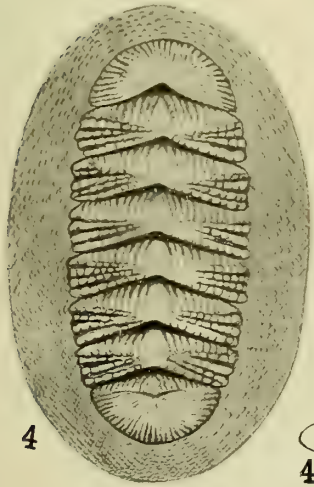
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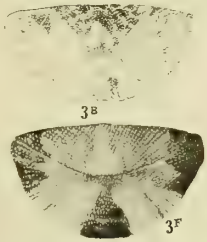
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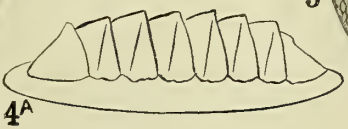
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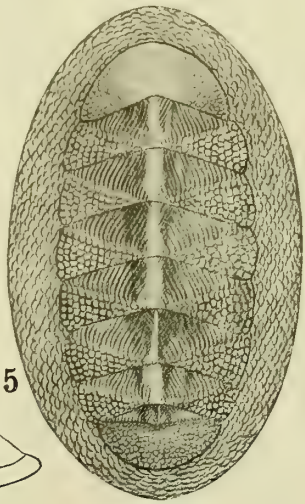
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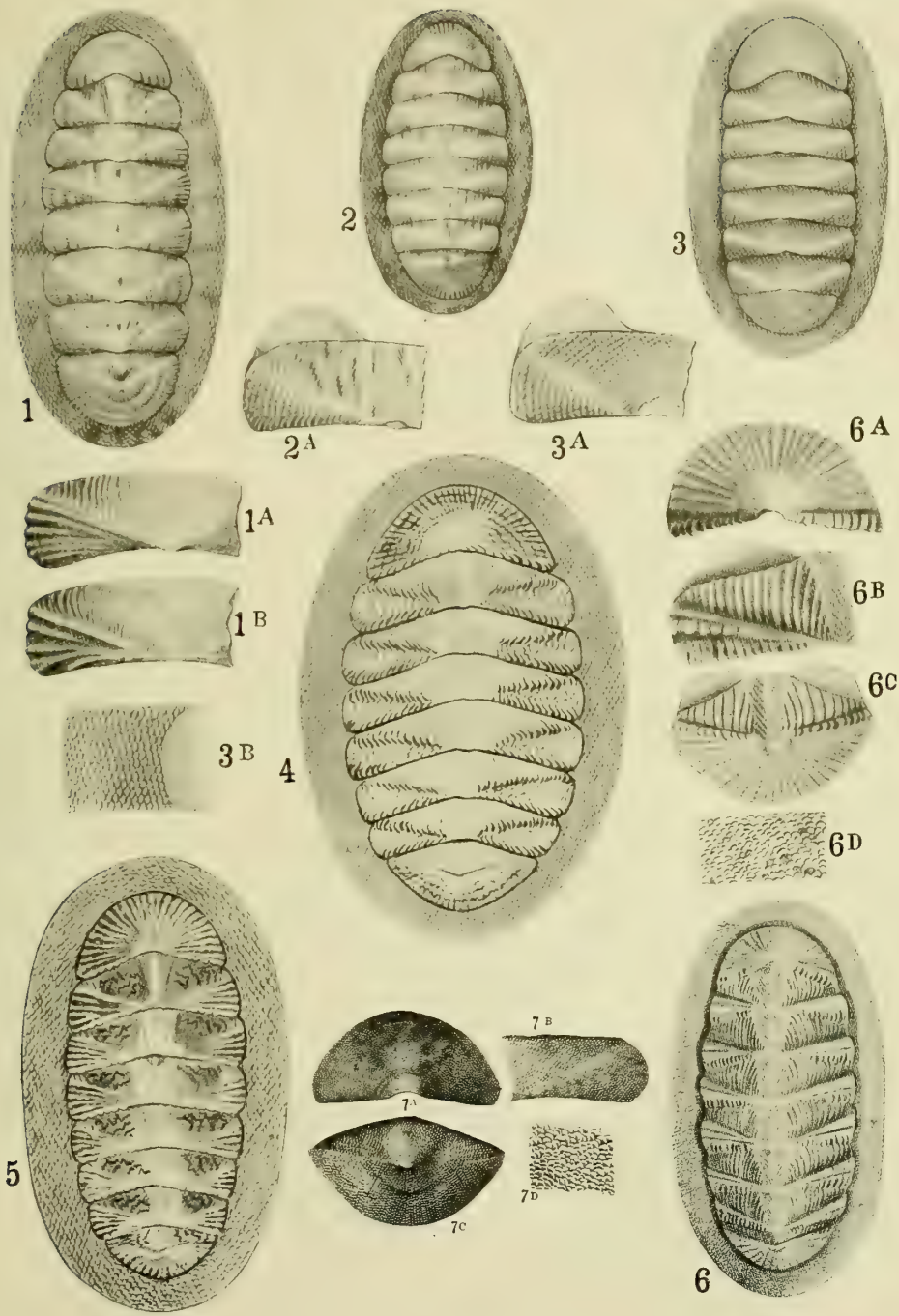
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Royal Zoological Society of New South Wales.

PUBLICATIONS.

"The Australian Zoologist"

A Journal containing reports of the proceedings of the Society, papers relating to the Zoology of Australia, contributed by members, notes and comment upon matters coming within the scope of the Society's aims and objects.

Published at irregular intervals.

VOLUME I. (1914-1920). Parts 1 to 8.
256 pp. with 19 plates and 63 text figures. Unbound. Price £1 net.

VOLUME II. (1921-2). Parts 1 to 4.
172 pp. with 45 plates and 16 text figures. Unbound. Price 12/6 net.

CONTENTS OF VOL. 3, PART 1.
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CONTENTS OF VOL. 3. PART 2.
Published 9 March, 1923. Price 4/6.

CONTENTS OF VOL. 3, PART 3.
Published 7 June, 1923. Price 5/-.

CONTENTS OF VOL. 3, PART 4.

Published 15 August, 1923. Price, 5/-.

CONTENTS OF VOL. 3, PART 5.

Published 18 December, 1923. Price, 5/-.

CONTENTS OF THIS PART.

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Application for Publications should be made to the Honorary Secretary, Box 2399, G.P.O., Sydney.

THE AUSTRALIAN ZOOLOGIST

Issued by the
Royal Zoological Society of New South Wales

Edited by
A. F. BASSET HULL, C.F.A.O.U.

Vol. 3—Part 7
(Price, 4/-.)

Sydney, October 7, 1924.

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Royal Zoological Society of New South Wales.

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SUBSCRIPTION: Ordinary Member, £1 1s. per annum. (Entrance Fee £1/1/.
Associate Member, 7s. 6d. per annum. (No Entrance Fee).

PRIVILEGES:

Ordinary Members—Free admission to Taronga Zoological Park; Additional Tickets admitting 20 Adults or 40 Children each year; Free Copy of "Australian Zoologist."

Associate Members—Free Copy of "Australian Zoologist."

"THE AUSTRALIAN ZOOLOGIST."

Communications intended for "The Australian Zoologist" should preferably be type-written.

Authors should state whether proofs and reprints are desired when submitting MS. Fifty reprints of any article appearing under a separate title will be supplied gratis. If more are required, terms may be ascertained on application to the Editor.

Royal Zoological Society of New South Wales

ANNUAL MEETING.

The Annual General Meeting was held in the Zoology Lecture Theatre, The University, Sydney, on Wednesday, 23rd July, 1924. Thirty members were present.

The President (Professor Launcelot Harrison) read the following report:—

Membership.

The number of members on the Register as at 30th June, 1924, was as follows:—

Honorary members, 5; life members, 31; ordinary members, 253; life associate members, 9; associate members, 99.

Since the beginning of the current month, 11 new ordinary members have been elected, who, together with the life and ordinary members previously on the Register make a total of 295 members enjoying full privileges to-day. The total membership at date is 409.

In addition to the above the Register contains the names of 14 other members who have not paid last year's subscription, and who have not been included in the above summary of members.

The Council.

Your Council held meetings on 9 occasions during the financial year, and the attendances were as follows:—

A. Halloran, 9; Prof. Harrison, A. Musgrave, 8; J. H. Campbell, Dr. D'Ombrain, Dr. Ferguson, A. F. Basset Hull, D. G. Stewart and E. F. Pollock, 7; Dr. Walkom and Dr. Waterhouse, 6; W. W. Froggatt, H. E. Finckh and W. C. Shipway, 5; A. R. McCulloch; 4; C. Hedley, 3 (resigned); G. M. Goldfinch and F. L. Rolin (resigned May, 1924), 2; D. H. Scott and Phillip Shipway (elected May, 1924), 1.

Australian Zoologist.

During the past financial year three parts of the Society's journal were issued, viz., Volume 3, Parts 4, 5 and 6, issued in August and December, 1923, and May, 1924.

Sections.

The meetings of the various sections have been well attended, and the interest of the members is satisfactorily sustained.

Obituary.

During the year the Society has lost by death one of its oldest Life Members, Colonel Sir James Burns, who was also a contributor to the Handbook Publication Fund. His Excellency, Sir Walter E. Davidson, K.C.M.G., late State Governor, was an Associate Member, who took a great interest in the "Australian Zoologist." Mr. W. H. Dudley Le Souef, an honorary member of many years' standing, and one of the best-known practical zoologists of Australia. Other losses by death were Mr. James Brown Campbell (Life Associate), Mr. Harry P. Curtis, and Mr. Frederick Gannon (Life Member).

Finances.

The satisfactory state of the finances is shown by the balance sheet, a copy of which is appended hereto.

Retiring Officer.

After five years' service as Honorary Secretary, Mr. Basset Hull retires from office. The Society owes much to his untiring efforts for its advancement, and it is gratifying to know that he will retain his interest in its welfare by remaining a member of Council and continuing to edit the Society's journal. His nominated successor, Mr. E. F. Pollock, is well known to members, and the routine business of the Society will be well cared for in his hands.

Presidential Address.

This address will be found on page 247.

Officers 1924-5.

At the close of the Annual General Meeting, a meeting of the Council was held, and the following members were elected officers for the year ending 30th June, 1925:—

President, Dr. G. Athol Waterhouse; Vice-Presidents, Professor L. Harrison, Dr. E. W. Ferguson, Dr. E. A. D'Ombrain, J. H. Campbell; Honorary Secretary and Photographer, E. F. Pollock; Honorary Treasurer, Donald H. Scott; Honorary Editor, A. F. Basset Hull; Honorary Librarian, Phillip Shipway; members of Council (to fill statutory vacancies), Dr. E. A. D'Ombrain, D. H. Scott, W. C. Shipway, Phillip Shipway, D. G. Stewart, and Dr. A. B. Walkom.

Annual Dinner.

The Council decided to try the experiment of holding a dinner preceding the Annual General Meeting. This function took place in the new refectory at the Sydney University, and was attended by over sixty members and their friends. The innovation having proved so successful, it is hoped to make it an annual fixture.

New Members.

The following new members have been elected since the publication of the last list (9th May, 1924):—Ordinary members: P. Burrows, Miss V. A. Bartlett, Ralph L. Houston, R. C. Malley, J. C. Murray, Mrs. E. M. Middleton, W. Messer, A. A. Nassoor, Mrs. J. R. Patrick, C. Von Drehnen, Mrs. D. H. Scott. Associate members:—P. E. S. Barnett, E. Cheel.

Personal.

The degree of Doctor of Science (with medal) has been conferred on Mr. G. Athol Waterhouse, B.Sc., B.E., by the Sydney University. Dr. Waterhouse's thesis was "The Biology of *Tisiphone abeona.*"

Mr. Harry Burrell has been elected an honorary member of the American Museum of Natural History (New York), in recognition of his assistance to representatives of the museum when they were in Australia.

Mr. Burrell has gone to Manilla (N.S.W.) to procure a series of moving pictures, illustrating the life-history of *Ornithorhynchus anatinus.*

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES.

BALANCE SHEET AS AT 30th JUNE, 1924.

LIABILITIES.

	£	s.	d.
Capital	691	5	0
Income Account	80	4	8
Handbook Publication Fund Account	225	3	9
	£996	13	5

ASSETS.

	£	s.	d.	£	s.	d.
Investments				691	5	0
Income Account:—						
Commercial Banking Co.	10	7	2			
Government Savings Bank	69	6	4			
Cash on Hand	0	11	2			
				80	4	8
Handbook Publication Fund—						
Government Savings Bank				225	3	9
				£996	13	5

INCOME ACCOUNT FOR YEAR ENDING 30th JUNE, 1924.

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance from 30th June, 1923				78	17	4
Annual Subscriptions—year ending 30th June, 1924				277	16	0
Annual Subscriptions—year ending 30th June, 1925—(paid in advance)				9	10	6
Life Subscriptions				3	15	0
Sales "Zoologist" (including Reprints)				5	11	3
Interest—						
Commonwealth Stock	32	0	0			
N.S. Wales Government Stock	2	15	0			
Government Savings Bank	2	18	6			
				37	13	6
Exchange				0	10	6
				£413	14	1

DISBURSEMENTS.

	£	s.	d.	£	s.	d.
Publication "Australian Zoologist"						
Printing	82	12	0			
Blocks	52	11	0			
				135	3	0
Appropriation to Capital Account				100	0	0
Office Accommodation				39	0	0
Printing and Stationery				14	19	6
Books—(Mathew's Birds)				17	4	0
Petty Cash—						
Postage and Duty Stamps	9	16	4			
Stationery	0	8	6			
Post Office Box	1	0	0			
Exchange	0	13	0			
Sundries	1	11	0			
				13	8	10
Miscellaneous				13	14	1
Balance on 30th June, 1924				80	4	8
				£413	14	1

HANDBOOK PUBLICATION FUND ACCOUNT FOR YEAR ENDING 30th JUNE, 1924.

RECEIPTS.

	£	s.	d.
Balance from 30th June, 1923	164	3	3
Government Grant for year	50	0	0
Donations	1	1	0
Handbook Sales ("Fishes of N.S.W.")	2	10	6
Savings Bank Interest	7	9	0
	£225	3	9

DISBURSEMENTS.

	£	s.	d.
Balance on 30th June, 1924	225	3	9
	£225	3	9

D. G. Stewart, Hon. Treasurer.

We have examined the books and vouchers of the Society for the twelve months ended 30th June, 1924, and certify the above statements of Receipts and Disbursements and Balance Sheet to be in accordance therewith.

Sydney, 8th July, 1924.

(Sgd.) Coates, Cunningham & Co., *Public Accountants.*

SECTIONS.

Entomological Section—Annual Report, 1923-4.

The session just closed has been the most important we have had since the formation of this Section. In addition to the five ordinary meetings, two special meetings have been held, with an average attendance of over ten. At these meetings ten visitors have been present. The ordinary meeting of the Section for August fell during the Sydney session of the second Pan-Pacific Science Congress, and we were able to welcome at this meeting a large number of the oversea delegates, all of whom addressed the meeting. During the Science Congress an outing was arranged to Bulli Pass on Saturday, 25th August, at which about 56 visitors and members attended. The party left Queen's Square at about 9 a.m., and proceeded by motor-cars along the Prince's Highway to above Bulli Pass, where lunch was partaken of, and at about 3.30 p.m. the cars left by various routes on the return journey to Sydney. This outing was considered one of the most enjoyable features of the Pan-Pacific Science Congress. At the special meeting, held in November, to meet Dr. A. J. Turner, of Brisbane, a highly important and interesting discussion on the distribution of the Australian fauna took place. In December, another special meeting was held, at which Mr. G. H. Hardy gave an account of his experiments in connection with the blowfly investigations at Brisbane. At all meetings, many rare and interesting insects were exhibited.

G. M. Goldfinch, Hon. Secretary. G. A. Waterhouse, Chairman.

Ornithological Section.

The Annual Meeting was held on July 25, 1924. Mr. P. A. Gilbert, R.A.O.U., presided.

The following report was submitted:—

The Committee have pleasure in presenting the second annual report of the Section's activities. Eleven ordinary meetings were held. At one meeting twenty members attended, while the average attendance was twelve. The membership has increased from 45 to 51. The lecturettes have proved interesting and instructive. In every instance keen discussion took place.

The first lecturette was delivered on June 15th, 1923, by Mr. A. H. Chisholm, who gave an interesting discourse on Robins. The Australian Robins, he claimed, are easily the most beautiful in the world; all are charming, and some are very remarkable little birds. Mr. Chisholm dealt briefly with the various genera and species, and discussed the seasonal movements of members of the *Petroica* and *Erythrodryas* families. References to the nesting habits of Robins led him to a digression on the Cuckoos, which parasitise these birds. An animated discussion ensued.

At the meeting held on July 20, 1923, Mr. A. F. Basset Hull delivered a short lecture on Sea-Birds, and exhibited specimens and eggs of six species of the genus *Puffinus*, and one of the genus *Pterodroma*. He dealt with the distribution of each species, and his lecture was full of personal observations, extending over many years, amongst this little-known group.

Mr. J. S. P. Ramsay, on August 20, 1923, gave an instructive lecture on Nature Photography, illustrated with lantern slides. He told of the many obstacles to be faced before good results can be obtained, and exhibited many ingenious devices invented by himself to overcome these. The slides illustrated

the actual taking of some of his subjects from the beginning of the operation to the final result, and in many instances showed his inventions in actual use.

On September 21, 1923, Mr. N. W. Cayley delivered a short lecture on Pigeons, illustrated by his water-colour drawings of every known Australian species, including the two species of the genus *Globicera*, recently added to the list by Mr. G. M. Mathews. Mr. Cayley gave his personal experiences with many species, especially the Fruit Pigeons; their food and nidification, and mentioned the economic value of the Wonga and Nutmeg species.

At the meeting held on October 19, 1923, Mr. J. R. Kinghorn read an instructive paper on "The Value of Birds," dealing mainly with their economic value to mankind generally.

Dr. E. A. D'Ombrain, on November 16, 1923, delivered a lecture on Quails, illustrated by water-colour drawings lent by Mr. N. W. Cayley, and a mounted specimen of a Plain Wanderer from his private collection. Brief references were made to the species which the lecturer had not personally observed, and many items of interest given with regard to those he knew. Special mention was made of information recently received by him relating to the Plain Wanderer; the specimen exhibited was procured quite recently from Victoria.

On February 15, 1924, Mr. Tom Iredale delivered a lecture on Australian Migrants, a group of birds of which very little is known, especially in Australia. He dealt at length with their distribution and explained that Australia was the northern limit of the Antarctic breeding species, Petrels, Albatrosses, etc., few of which were only casual visitants. He also described the routes taken by the Arctic breeding Waders on their annual migration to Australia and the Islands of the Pacific. Mr. Iredale exhibited the young of the Kentish Plover, Peewit and Ring Plover, and drew attention to their similarity to the young of the Red-capped Dotterel, Spur-winged Plover and Hooded Dotterel. At this meeting Mr. C. Coles exhibited the eggs of the Magnificent Bird of Paradise, laid in captivity, the first known record of the eggs of this species. He also gave some interesting notes on the habits of the species in captivity.

A collection of photographs, the work of Mr. D. W. Gaukrodger, Alice Downs, Blackall, Queensland, was exhibited at the meeting held on March 21, 1924. They comprised a series of unique photographs of the Emu and Wedge-tail Eagle, and practically illustrated the life-history of these shy birds.

On May 16, 1924, Mr. Norman Chaffer exhibited a collection of his lantern slides. Mr. Chaffer is perhaps the youngest prominent Nature photographer in Australia; and his work compares favourably with that of any of the older photographers. The slides shown were of a high standard. Mr. Chaffer received the congratulations of the members present.

Mr. G. H. Barker, State Secretary for Queensland, was welcomed by the Section at this meeting. He outlined the intentions of the Queensland members regarding the forthcoming Congress of the Royal Australasian Ornithologists' Union.

On June 20, 1924, Mr. Tom Iredale delivered a short lecture on Wrens (Malurus), and exhibited specimens lent by the Australian Museum authorities. Mr. Iredale drew attention to the two distinct groups, the "Blues" and "Reds." He explained that in his opinion *Malurus melanocephalus* was entitled to separate generic rank. He dealt principally with the literature of the group, and gave some interesting theories on the evolution of the various species. A specimen of the White-backed Wren (*Malurus leuconotus*) collected by Mr. E. G. Troughton,

30 miles east of Farina, S.A., which Mr. Iredale considered re-established this species, was exhibited.

Members of the Section have reason to congratulate themselves on the success of their proposal to establish permanent camps in National Park. After protracted delays, at a special meeting convened by the Section, to which members of kindred societies were invited, a scheme was submitted and co-operation enlisted to approach the trustees of the National Park for permission to establish a station and outposts in the Park to be used as observation posts to carry out a biological survey of that area. Mr. Frank Farnell, Chairman of the Trust, attended the meeting, and gave the scheme his support. He offered on behalf of the Trust the use of a six-roomed stone cottage, free of rent, situated at Gundimaiian, as a headquarters, and promised help in the erection of the outposts. This offer was cordially accepted. A Committee, the guests of Mr. Farnall, who proved himself an ideal host, spent a week-end at the Park, and inspected the cottage, and also made a preliminary selection of sites for outposts.

The matter will be completed immediately, and members will be able to avail themselves of the accommodation provided by the trustees of the Park.

Members are invited to help the Committee by influencing their friends to join the Section, and country members are cordially invited to attend the Section's meetings, which are held on the third Friday in each month.

The following officers were elected:—Chairman, Mr. A. H. Chisholm; Vice-Chairman, Mr. A. F. Basset Hull; Hon. Secretary, Mr. N. W. Cayley; Committee, Messrs. P. A. Gilbert (immediate past Chairman), H. Wolstenholme, J. R. Kinghorn, Dr. E. A. D'Ombrain, and E. F. Pollock.

NEVILLE CAYLEY, Hon. Secretary.

Chairman's Address.

As the Secretary's report deals exhaustively with the past activities of the Section, it is unnecessary for me to further touch on our past work. Before vacating the chair, however, there are a few suggestions I would like to make with regard to the future work of this Section. Observation of the well nigh inexhaustible phases of bird-life gives members unlimited scope in the field, and it is field work upon which I now particularly wish to remark.

In a lecturette some time ago, Mr. Tom Iredale commented upon our absolute lack of knowledge as to the migration of Australian birds. I pointed out at that lecturette, and I again mention it to-night, that I put forward a proposal at the last (W.A.) Congress of the R.A.O.U. to grapple with this subject. The proposal involved the co-operation of every field student in Australia. A sub-Committee of three was appointed to put the scheme into operation, and that was the end of the matter.

Migration is essentially a problem that can only be completely solved by the combined efforts of field observers. I now suggest that this Section, rather than waiting any longer, should make an attempt to at least partly answer this great question.

Subsidiary to migration, is the ringing of nestlings with coloured bands. By this means we could ascertain the seasonal movements of birds with greater certainty. I propose that we concentrate on the movements of *Grallina picata* as our forest representative, and a species of Petrel for the Seabirds, or any other species reckoned to be more suitable for our purpose. Here again co-operation is imperative to ensure a complete observation of this extremely interesting phase of bird-movement. Every autumn *Grallina picata* makes its way to the coast

from inland, and congregates in flocks of countless numbers. To exactly determine the regions from whence they come, certain areas could be defined, and designated "colour areas." Rings corresponding in colour with the respective areas should be strictly used in these parts. Thus, if the County of Cumberland be designated yellow, all birds in this County would be ringed with yellow bands, so that, if a bird at any time went north or south it would be known that its original territory was the County of Cumberland. Coloured rings or bands would obviate the necessity of shooting birds, which would be necessary if numbered metal bands were used.

Again several members could with advantage undertake to study the life-history of a common bird. Particular notice could be taken of its behaviour from the commencement of the nest until the time the young left the nest. At the end of the season these members could compare notes, and thus a tolerably certain history of a species would be attained.

Extended excursions to various districts could be undertaken by small parties of the Section, and much useful knowledge would be gained of birds in other parts.

A sequence of lecturettes would enhance our indoor studies, especially if we commenced with embryology and worked through physiology and osteology. I will, therefore, recommend that our Committee secure the services of a competent biologist to detail these branches of bird biology.

I thank members for the assistance they have given me while carrying out my duties as Chairman, and I can assure them that my services are always available to further the interests of this Section.

P. A. Gilbert, Chairman.

Biological Survey Section

As the outcome of the activities of the Ornithological Section, working in conjunction with representatives of other scientific societies, the Trustees of the National Park (Mr. Frank Farnell, chairman), have offered the use of a cottage within the Park to members for the purpose of carrying out a biological survey of the Park area. In consequence of this generous offer, a Section of the Society has been formed to conduct biological surveys, the officers being:—Chairman, Professor Launcelot Harrison; Honorary Secretary, Neville W. Cayley; Honorary Treasurer, Dr. G. Athol Waterhouse; Executive Committee, Professor Griffith Taylor, Professor W. R. Browne, A. J. Nicholson, M.Sc., and E. Cheel.

The Society has voted a sum of £50 towards the cost of furnishing the cottage with "camp" equipment, and several substantial donations for the same purpose have been promised. Any additional donations will be welcome.

The cottage is a substantial stone one, consisting of six rooms, with an out-building, kitchen and laundry. Water is laid on from a dam, constructed across a creek in the vicinity, and, although the supply is not unlimited, sufficient can be obtained for all ordinary purposes, and there are enough tanks to provide rain-water for drinking. At the water front there is a boat-shed, with boat, and also an enclosed bathing place.

The cottage is situated in Gundamaian Park, close to where the Hacking River enters Port Hacking, and is built upon the remains of an old aboriginal kitchen midden. The spot is most suitable for the objects in view; Mangrove Island is a few hundred yards from the shore; very interesting trees are growing close to the cottage, and eucalyptus and casuarina forest and marsh country is close at hand. Quite a large number of subtropical plants are to be found growing in suitable places not far distant.

The cottage is distant about two miles by water from Audley, and it can also be reached from Cronulla by means of the launch service between that place and the Park. By road the distance from Audley is between four and five miles.

Sufficient camp equipment for nine persons has been provided. As the cottage can accommodate nearly twenty, it is hoped that some further donations will be shortly received so as to enable more than nine investigators to visit the cottage at one time.

Several members have already visited the cottage, and have made some important entomological captures. It is hoped that when the organisation is completed, the cottage will be fully occupied.

Views of the Biological Station are shown on Plate xxxviii.

Meetings of Sections.

Entomological Section:—
Wednesday, October 7.

Ornithological Section:—
Friday, October 17.
Friday, November 21.

Meetings are held at the Society's office, at 7.30 p.m., and are open to all ordinary and associate members.

The Biological and Economic Zoology Sections have no fixed dates for meetings during the remainder of the current year.

THE MIGRATION ROUTE OF THE AUSTRALIAN MARSUPIAL FAUNA.

PRESIDENTIAL ADDRESS.

By Professor Launcelot Harrison, B.A., B.Sc.

It may justifiably be said that a majority of Australian zoologists, as well as many botanists, believe that Australia has in past time been connected by land with South America, and that a considerable proportion, both of its plants and animals, has been derived from the latter Continent by land migration. There is a good deal of evidence for the extension of land masses well into the eastern Pacific, which joined up with New Zealand to the south, and with Papua to the north. But there is a vast stretch of deep ocean between the easternmost of those islands and submarine banks, which afford indication of former land extensions, and the coast of South America, and a land bridge in this direction would involve a radical change of level in the floor of the Pacific. Such a change is not acceptable to geologists, though that need not place it outside the bounds of possibility. But Australian opinion favours a connection through former extensions of the Antarctic Continent, linking up with South America, Australia, and Africa, and there is a widespread belief that much of our fauna was received from America along this route.

In recent years, however, several important attacks have been launched against this hypothesis. The first of these which I propose to consider is that of W. D. Matthew (1915), who, in an extremely able and comprehensive survey of the distribution of mammals from the Tertiary onwards, argues for a Holarctic dispersal centre for all the major mammalian groups. Matthew correlates mammalian migration with the migration of climates, adopting the view that climatic change has been of the nature of alternating periods of glaciation followed by aridity and epi-continental flooding accompanied by moist climates and the development of rain forest. This view is that of the American school of geologists, led by Chamberlin. With the broad features of Matthew's thesis one can quite agree, but when he endeavours to lay down one way, and one way only, for mammalian distribution, he becomes involved in difficulties which require measures even more drastic than inter-continental bridges for their solution. Matthew claims a northern derivation for the Australian marsupials, and incidentally considers the distribution of crayfish and frogs, two groups which have been used extensively for the purpose of arguing a southern connection between Australia and South America.

More recently G. K. Noble (1922) and E. R. Dunn (1923) have discussed the distribution of frogs, both claiming a northern origin for the Australian Hylidae and Leptodactylidae. As the distribution of these families in Australia and South America has hitherto been one of the strongest arguments in favour of a former land connection, it is necessary that careful consideration should be given to their views. Maynard M. Metcalf (1923), on the other hand, brings forward very strong additional evidence, of a circumstantial nature, no doubt, but in accordance with the writer's views on the distribution of parasites, of the direct relationship between Australian and South American forms.

Finally H. A. Longman (1924), has advocated a northern origin for the marsupials, basing his belief upon the variety of forms found in the islands to the north of Australia, and upon the past distribution of marsupials in Queensland.

Matthew's views are perhaps of most importance, and it is of interest to examine the general nature of the theses upon which they rest. These must be presented in very summary form, and it is difficult to be entirely fair under such circumstances, but I have at least made an honest endeavour to present them impartially. Matthew states that climatic change is the chief known cause of the distribution of land vertebrates, and that the principal lines of migration were radial from Holarctic centres. The geographic changes required to explain distribution are not extensive, and, for the most part, do not affect the permanence of ocean basins. The idea of alternations of moist and uniform with arid and zonal climates accords with the facts of distribution. Land bridges over the present deep ocean are improbable and unnecessary.

He adopts Chamberlin's views on the alternation of climates between extremes of warm moist tropical climates, resulting from prolonged base-level erosion and overflow of large continental areas by shallow seas; and cold arid zonal climates resulting from re-establishment of isostatic balance, with the expansion of continental areas to the limits of their continental shelves. As regards their geological residues, the former are marked by limestone and coal, the latter by thick barren formations, culminating in a great extension of glaciers from boreal and high mountain areas. He limits the possible emergence of continental land masses to their existing continental shelves, except along those lines of weakness or instability which have been subject to folding, with great changes of level. He indicates the essential distinction between the faunae of these alternating climatic phases. The former phase implies isolated continents, with provincial land fauna, which, owing to abundant food supply and easy conditions of life, would tend to be sluggish in the matter of evolution; while the latter implies, under conditions of cold and aridity, a stimulus to migration and differentiation along the now connected land masses, with cosmopolitan fauna, the more primitive forms being pushed southwards.

As regards the time of dispersal, Matthew writes (*l.c.*, p. 179):—"With a clearer perspective of geologic time and far more exact records, it is clear that most of this deployment and dispersal of the mammalian races has taken place since the Eocene epoch of the Tertiary, although remnants of an older dispersal on the same lines are probably traceable in the present habitat of monotremes, marsupials, and primitive insectivores."

Matthew's interpretation of supposed exceptions to his general rule is not so satisfactory. He writes (*l.c.*, p. 179):—"There has been a disposition in recent years among students of geographical distribution to lay weight upon certain *apparent exceptions* * to this general rule, *where the geological record has not yet afforded evidence to support the northerly origin of certain groups* * now limited to the southern continents or to the tropics and to infer various equatorial or southern continental connections during or previous to the Tertiary, in order to account for these exceptions. To these hypotheses, there are several objections:—

"(1) The evidence for the general permanence of the great ocean basins and their maintenance formerly, as now, by isostatic balance is very strong and direct, and before allowing any exceptions, we should be very sure that no other explanation will serve.

"(2) The instances adduced in favor of former equatorial or southern connections are distinctly exceptional cases in the faunae, which may, in all the cases

* Italics mine.

I have examined, be accounted for by appealing to the imperfection of the geologic record, by parallelism or by the rare accidents of oversea transportation.

"(3) The existence of such land bridges would present the opportunity for migration of other parts or of the whole of certain faunae, which has evidently not occurred. I can see no good reason why the only animals which availed themselves of such continental bridges should be the ones which might be accounted for in other ways, while those which would furnish conclusive proof are invariably absent.

"(4) Many students of geographic distribution proceed on what appear to me to be wholly false premises. They assume that the habitat of the most primitive living member of a race is the original habitat of the race, the most advanced forms inhabiting the limit of its migration. It seems to me that we should assume directly the reverse of this."

The words I have italicised above show how Matthew's argument descends on occasion to dialectic. The facts are that in our present state of knowledge the distribution of certain groups does not conform with Matthew's views. By calling these "apparent exceptions" and introducing the word "yet" into the next clause, Matthew implies that further palaeontological discovery will bring these groups into line with his ideas, an assumption for which there is, at present, no justification whatever.

As regards paragraph (1), we may admit that there is very strong evidence for the permanent nature of the great ocean basins, but many of the land bridges which have from time to time been suggested would not interfere to any extent with that permanency. A glance at the south polar projection shown in Matthew's, Fig. 2 (p. 176) will show that no great degree of elevation of the Antarctic hemisphere would bring Australia, New Zealand, South America, and Africa into connection with an extended Antarctica.

Fig. 1.—The Southern Hemisphere on a south polar projection. After Matthew.

Matthew's argument (p. 189) that—"The permanency of the continental platforms is indicated by the absence of abyssal deposits in their sedimentary succession wherever this has been adequately studied," only holds in so far that geologists are somewhat reluctant to apply their principle of uniformity to such deposits when they are observed. He mentions chalk found in shallow water, which may be possible, but even radiolarian oozes, hardened into cherts, are claimed as shallow water deposits, a claim which is entirely untenable. The radiolarian cherts of north-eastern New South Wales indicate a deposition at 2,000 fathoms or more just as surely as do the radiolarian oozes to-day. Yet these are stated to be of shallow water origin on the ground that similar cherts have had the same claim made for them in other parts of the world. A radiolarian deposit, free from calcareous remains, cannot be formed except in ocean abysses; and such a deposit found on an existing continental platform indicates a very great change of level in past time. There is evidence for a relative permanence of continental platforms and ocean basins, but the claim for absolute permanence cannot be maintained.

Paragraphs (2) and (3) I find difficult to understand. Some of the statements may apply to a fraction of the land bridges which have from time to time been hypothecated, or, possibly, even to a majority of them, but I am here concerned only with the past land connections of Australia, and to these I cannot see that they apply. A great deal of the Australian flora, almost the whole of the mammalian and amphibian faunae, and a long list of genera, families, and even orders of other faunal groups find their nearest relatives in South America, and it cannot be said that these are "exceptional cases in the faunae." The three ways by which Matthew would account for this condition are all of them ways for which no positive and direct evidence can exist. The objection that—"The existence of such land bridges would present the opportunity for migration of other parts or of the whole of certain faunae, which has evidently not occurred" fails entirely, for it is just this that a majority of Australian zoologists holds to have occurred. It is, of course, obvious that only co-existent groups could make use of any given land bridge, unless it persisted through a very long period, a consideration that would appear to have evaded Matthew. or been evaded by him, in some of his detailed arguments.

The last sentence of paragraph (3) has no meaning for me. When a certain proportion of the members of every animal Phylum found in Australia shows South American affinities, which, however, I do not concede that Matthew has accounted for in other ways, it would be interesting to learn just what other groups of South American animals, if discovered in Australia by some happy chance, would afford evidence more convincing than that already provided, or less easily "accounted for in other ways."

With the broader features of Matthew's principles of dispersal one may agree, but he himself has had to admit exceptions, and the single Holarctic dispersal centre which apparently holds good for most mammalian migrations during the Tertiary will not hold for all. The outstanding feature of his masterly analysis of these migrations from the viewpoint of the present enquiry lies in the emphatic re-statement of the isolation of Australia from the northern land masses. We know quite well that the placental mammals failed to reach Australia, but the fact seems to take on a greater significance as we find it restated in the analysis of each successive group. This isolation Matthew admits (p. 232) to have extended through the whole of the Tertiary.

Matthew's views on the dispersal of marsupials (pp. 262-269) may be summarised as follows:—The present distribution is almost limited to the Australian and Austromalayan region. A single unspecialised group, the opossums, close to

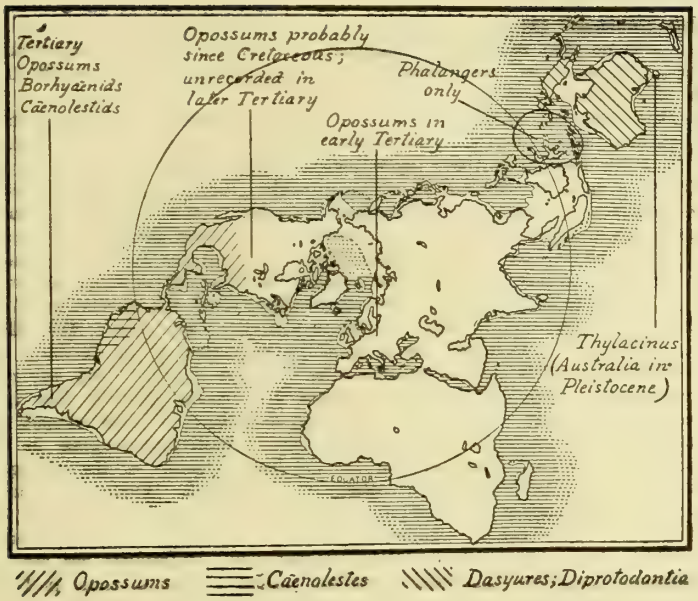

Fig. 2.—The distribution of marsupials. After Matthew.

the primitive type from which all marsupials have developed, survives in the Neotropical and ranges northwards into the Sonoran sub-region of North America. *Caenolestes* is not a diprotodont, but an American radiation from the polyprotodonta. The first remains which seem definitely those of marsupials occur in the uppermost Cretaceous of Wyoming. No marsupials have been recognised in the Holarctic basal Eocene. Polyprotodonts definitely occur in the Lower and Middle Eocene of Wyoming, in the Oligocene of Colorado and in the Upper Eocene to lower Miocene of France and Germany. In the southern continents, they assumed a much more important position. The adaptive radiation in South America was not so marked as in Australia, owing to the fact that the former was invaded by certain primitive placental groups before it was cut off from North America. The South American Borhyaenids show homoplastic resemblance to, and not relationship with, *Thylacinus*, so that this evidence for Antarctic connection fails. *Caenolestes* and the Epanorthids are modified polyprotodonts, not, as was at first supposed, primitive diprotodonts.

P. 267—"In view of the great amount of adaptive divergence seen in the various Pleistocene and modern genera of Australian Diprotodonta, the origin of the suborder in Australasia or its earliest invasion of that zoological region, must be dated far back in the Tertiary. On our present evidence it may well be regarded as wholly autochthonic, derived from early Tertiary or possibly from late Mesozoic polyprotodonts. Nevertheless, in view of the defectiveness of the Mesozoic record, where we should chiefly expect to find this group, if anywhere in the North, and the presumable rarity of Tertiary survivors, *there is nothing unlikely in the view that they originated primarily in the North like their polyprotodont and allotherian relatives and were driven southward with the former group and somewhat more thoroughly extinguished in the north, while in Aus-*

tralia they blossomed out into a great adaptive expansion paralleling the absent ungulate mammals" (1).

There is no clear record of Didelphids in the Miocene or Pliocene of North America, none after the Lower Miocene in Western Europe, nor in the later Tertiaries of India or China.

Such is the body of fact upon which Matthew bases the opinions I have italicised, and that opinion goes no further than to claim that there is nothing unlikely in the view of northern derivation. It seems to me, however, that this conclusion is open to criticism on sound grounds. Admitting the imperfection of the geological record, the actual evidence derivable from it is that the earliest Holarctic marsupials occur in the late Cretaceous; that none are known from the Palaearctic after the Lower Miocene; and that none at all are known from south-eastern Asia. It is possible to argue upon this basis that North America formed the centre of dispersal, though, despite disagreements about the correlation of the South American horizons, it seems certain enough that there was a well differentiated marsupial fauna in that continent at the beginning of the Tertiary, and more probable that this evolved *in situ* from Mesozoic ancestors. At any rate, more marsupials, fossil and recent, are known from South America than from any other part of the world outside Australia, and there is little evidence for any considerable development of even the most primitive marsupials in the Palaearctic land mass. Any argument for the incompleteness of the geological record in Asia applies with equal cogency to Antarctica. What we do know about the latter continent palaeontologically may be quoted from David and Priestley (1914, pp. 313-314), who, after pointing out that the five plant genera *Sagenopteris, Thinnfeldia, Cladophlebis, Pterophyllum, Otozamites* are common to Antarctica, and Indo-Australia, while the second and third occur in South Africa, and the second and fourth in the Argentine, write:—

"The close affinity of the flora to that of Australia and of India, shown on this list, implies a land connection between Antarctica and Australia in Jurassic or Trias-Jura time.

"At Snow Hill Island abundance of Cretaceous fossils, including numerous Ammonites, were collected by Dr. Nordenskjöld's Expedition. These fossils imply the existence of a mild climate, with comparatively warm ocean currents in the neighbourhood of Snow Hill Island in Cretaceous time. The fossil plants Araucaria, Fagus, etc., near to *A. braziliensis,* unearthed by the Nordenskjöld Expedition at Seymour Island, adjoining Snow Hill Island on the north-east, prove that these mild weather conditions were further prolonged into some part of Tertiary time, probably Oligocene or Lower Miocene. In marine strata, also of Tertiary age, and considered by Wilckens to belong to Upper Oligocene or Lower Miocene, this expedition found numerous bird bones, since referred to five new genera of penguins, besides two vertebrae of a big mammal referred to the genus Zeuglodon. It is very interesting to note that remains of a large penguin have been obtained in New Zealand in the Oamaru beds, which are considered to be of Eocene age."

Matthew dismisses Gondwana Land as being outside the scope of his discussion, but to leave this question of Antarctic connections without discussing the Mesozoic floral distribution is to offer Hamlet without the prince. In the first place, we have evidence that Antarctica possessed a mild climate and a rain forest flora throughout the Mesozoic and into the Tertiary as far, perhaps, as Lower Miocene. Secondly, there is demonstrated the existence of at least two distinct florae, a Mesozoic Gondwana flora, and a Tertiary flora with South American affinities, including *Araucarias* and small-leaved beeches. This latter

(1) Italics mine.

flora occurs in both New Zealand and Australia. Cheeseman (1909) has discussed the floral relationships of Fuegia with the ring of circum-polar sub-antarctic islands and with New Zealand, Australia, and South Africa. While he is dubious about actual land connections, he considers that these probably were extensions of the existing land masses, which brought them in closer proximity to one another, and he can explain the existence of a proportion of the sub-antarctic flora only on the ground that it has been derived from the Antarctic continent.

If Antarctica possessed a rain forest flora through the length of time indicated, from the Jurassic into the Tertiary, it seems equally certain that it must have possessed a fauna. Some happy chance may in the future throw some palaeontological light upon the nature of this fauna, but it seems most likely that the mantle of ice and snow which covers the continent will keep the matter a mystery for us. But when we know quite definitely that certain kinds of plants occurred there, which are still found in South America, in New Zealand, and in Australia, and when we see that many kinds of animals are common to these three regions, and afford no evidence whatever of northern origin, despite the fact that we have not found them fossil in Antarctica, it seems to me that we are well justified in assuming their existence there in times past. I have not time to traverse the large body of evidence relating to the invertebrates, but in almost every group there are members which can most plausibly be accounted for by a southern origin. Benham (1909) has put forward a particularly good case for the Oligochaetes, which also holds to some extent for groups like the land planarians and land nemerteans, all creatures for which it is difficult to imagine a drift transportation. Australian systematic zoology teems with forms exhibiting South American affinities. Curiously enough, many of these forms find their nearest relatives in Chili, but this is probably due to the similar nature of the physical environment, and does not necessarily argue for a direct trans-Pacific connection. Men who have been most intimately acquainted with the invertebrate fauna, Hutton and Benham in New Zealand, Haswell and Hedley in Australia, have all agreed upon the necessity of Antarctic connections.

It is obvious that these could not have been contemporaneous. Marsupials did not reach New Zealand, and it is still a somewhat doubtful question whether any reached Africa. Benham's evidence (*loc. cit.*) from earthworms would indicate that connection with New Zealand post-dated that with Australia, and may have occurred after our supposed Antarctic marsupials had been killed off by increasing cold. But the data available at present are not sufficient to allow of putting a period to any of these hypothetical land connections. All we can say is that Africa and Australia, common possessors of a Proteacean flora, would seem at some time to have been connected, probably through the south; that there is some evidence for a separate connection with Madagascar; and also that Australia, New Zealand, and South America would appear to have had connections with Antarctica, though not contemporaneously. Matthew would consider the related faunae and florae upon which these hypotheses are based as residuals of a once cosmopolitan distribution, driven southward along the three great peninsulas. I would reply that there is no actual evidence for this view, and that the weight of probability is against it. Apart from the mere matter of probability, there is evidence of a kind which may not be generally acceptable, but which I believe to be absolutely reliable, to the discussion of which we shall presently come.

One argument for actual land connections as against the mere narrowing of intervening seas, may be drawn from Australia itself. Australia has been isolated from the north since the beginning of the Tertiary, or, possibly, since late Mesozoic time. To the north lies a group of islands which have suffered geographical

vicissitudes not yet fully worked out. The lines of Wallace and Weber may not be absolute faunistic boundaries, but it seems likely that they have a significance, and that Wallace's line does, in a general way, mark the line of separation of Austro-Malaya from Asia, a separation that most probably took place in the Mesozoic. The only indication that any of the most primitive mammals reached Australia lies in the fact that the existing monotremes are still found there, and these are certainly derivatives of a very primitive mammalian stock. Unfortunately we know nothing about the history of the monotremes. Various fossil remains, particularly in South America, have been attributed to the group, but none has been proved definitely to belong to it. The genus *Ornithorhynchus* has existed unchanged in Australia since the Pliocene, and its specialisation from a primitive stock must have been a long business. It seems probable that the ancestors of the existing monotremes entered Australia from the north during the Mesozoic, possibly in the Jurassic, and that soon after their arrival the land way was cut. Had this not been the case, other primitive mammalian stocks would surely have entered. No evidence for such invasion has been found, but little weight can be attached to this, for there is equally no evidence for the invasion of the ancestral monotremes, which must have occurred.

In any case, it seems clear that from the beginning of the Tertiary no mammals reached Australia from the north. The point I want to make is that, although Australia is almost connected by a chain of islands, with Malaysia, there has been comparatively little accidental transportation of fauna. The stocking of the East Indian islands appears, according to the latest work of the Dutch geologists, to have been accomplished through alternate joining up and severance of land masses. In this sub-region, which offers conditions peculiarly favourable to accidental transportation, there is very little evidence for its occurrence, except that afforded by a few rodents, other than which no terrestrial placental has been able to reach Australia. Now if porcupines can be rafted from South America to Africa as Matthew suggests (certainly with some diffidence, but without any suggestion as to how the raft was provisioned for the voyage) and if this sort of thing happens generally, even though rarely, why has it not happened to Australia? Since it has not happened here, although conditions are most favourable, we are surely justified in concluding that it does not happen elsewhere, and that land mammals require land bridges for their migrations.

The question remains—Was the land bridge by which the marsupials reached Australia to the north, or to the south? In America, marsupials reach to about the fortieth parallel of north latitude. In Austro-Malaya, no marsupial reaches the equator. Accepting Matthew's view that the northern phalangers are a radiation from a Papuan centre of dispersal, they have been prevented by a hitherto impassable barrier from passing to the north and west of Celebes. But the polyprotodonts have an even more restricted range, extending only as far as Ceram. This is not what one would expect if their primitive ancestors came by way of the Moluccas. It is a simple matter to assume that these have become extinct throughout south-eastern Asia and the greater number of the East Indian islands. But why should they have become extinct? The physical environment is in every way suitable, and small cryptozoic marsupials are not in the least likely to have been killed out. It seems much more probable that they were never there, a probability that is much strengthened by the similarity of distribution in frogs of the families Hylidae and Leptodactylidae which are discussed below. Accepting all the facts that Matthew has so carefully put together, I can still see no reason for the deductions he makes from them. It is true that certain pieces of evidence that were formerly used to support the Antarctic connection have to be resigned. *Caenolestes* is not a primitive diprotodont, *Borhyaena* is not a Thylacinid, *Galaxias* breeds in the sea. But these things do not appreciably

lessen the evidence derived from so many groups of affinities most easily explained by Antarctic connections.

Longman (1924) analyses the present distribution of Australian marsupials and points to the considerable number of species of Peramelidae and Dasyuridae, known now to occur in North Queensland and Papua, as evidence of northern derivation. According to Matthew's views, however, which hold good so generally for Holarctic dispersal centres, it is just precisely this kind of distribution that we should expect if these admittedly primitive marsupials had become dispersed from a southern centre. In fact, Matthew, admitting the dispersal of the Diprotodonts from an Australian centre, writes (1915, p. 263):—"The Phalangers of the Austromalayan islands are regarded as marginal types from an Australian dispersal centre." Of the Polyprotodonts, however, Matthew (*l.c.*, p. 295) states that they have not—"entirely disappeared from the East Indian islands." Since the Phalangers and the more primitive Polyprotodonts have, in general, the same total marginal distribution, it is surely not reasonable to interpret this distribution as evidence of Australian dispersal in one instance, and of northern dispersal in the other. The primitive Polyprotodonts are generally assumed to have been derived from primitive Didelphids, and may have had either a Holarctic or a Neotropical derivation. But there is no evidence at present derivable from marsupials themselves, whether fossil or recent, as to the actual source of origin.

The nature of the Papuan sub-region introduces a further factor which has not been considered by Longman, but which must have been of great importance in stimulating the formation of species. Throughout this sub-region we have high mountains and dense rain-forests, and a considerable amount of geological change. That a number of arboricolons and small terrestrial species should have become differentiated is not at all remarkable. The evidence from other sources makes it clear that Papua has served as a dispersal centre for a number of local groups, and it is quite probable that a limited dispersal of Phalangers may have taken place in this way. Nevertheless it seems equally probable that there was an earlier dispersal from an Australian centre.

Much of Longman's argument is directed against the existence of the diprotodont condition in South American marsupials. But before the supposed American diprotodonts were discovered it was considered that this condition originated in Australia. We have lost nothing through the discovery of the correct affinities of these American forms. Syndactyly is an adaptation to arboreal life, and may as Lönnberg (1921, p. 96) suggests, have occurred independently in Australian polyprotodonts and diprotodonts.

Longman writes (*loc. cit.*, p. 12):—"The assumption of a continent in the Antarctic in early Tertiary times"—as if this itself were hypothetical. But the continent was there from the Palaeozoic, had a Mesozoic rain-forest flora, and a Tertiary flora also. Moreover, it is still there to-day, although its flora has been reduced to a single phanerogam and a few cryptogams, owing to intensive glaciation.

Longman's conclusions are:—

1. The "fundamental consideration" that marsupials were once widely distributed in Holarctic regions. This, of itself, proves nothing.

2. The diversity of marsupial genera in North Australia and Papua. This is only natural, but has no bearing on the question of origin.

3. The evolution of the Australian marsupials has taken place in Australia. I am not aware that this has ever been disputed.

4. *Wynyardia* is not akin to the Caenolestids. This is immaterial. What is of importance is that *Wynyardia* seems to be in some respects intermediate between the polyprotodonts and the diprotodonts.

5. The diprotodonts have nothing in common with South American forms.

Since they are presumed to have been derived from polyprotodonts in Australia, there is no reason why they should.

6. All living families of marsupials were well differentiated early in the Tertiary. This only makes a Cretaceous migration to Australia the more probable.

7. The rich development of Peramelidae in the Austro-Malayan region. This development is almost entirely Papuan, and it is well-established that Papua has been joined to Australia.

8. The primitive nature of syndactylism. Whether the view suggested above be correct or not, syndactylism has arisen in Australia, and does not affect the general question of origin.

Matthew (*l.c.*, pp. 294-296) discusses the dispersal of Amphibia, and the following quotations are pertinent to our discussion:—

"Among the modern families the Cystignathidae (1) are chiefly Australasian and Neotropical, but a few are *still* (2) found in North America. This distribution parallels that of the polyprotodont marsupials, except that the latter have not reached New Zealand or the Antilles, or *entirely disappeared from* (2) the East Indian islands.

"The genus *Bufo* has failed to reach Australasia, Madagascar or New Zealand, but is replaced in Australia by a (more primitive ?) member of the family. The Hylidae are to-day chiefly South American and Australian, but a few members *still* (2) inhabit North America. They are not found in Africa or the Oriental region, where it seems reasonable to suppose that they have been displaced by the true frogs (Ranidae), peculiarly varied and abundant in these regions. The Ranidae, like the Bufonidae, represent a less ancient dispersal, probably from a southern Palaeartic or Oriental centre, since they have reached northern Australia on one side and north-western South America on the other, and, while they have reached Madagascar and the Solomon Islands, they have failed to reach the Antilles."

The words italicised exhibit again the partisan twist which Matthew gives to much of his argument. In each case there is an inference or implication added to the statement of fact. There is no evidence whatever that any greater number of Hylids or Leptodactylids ever inhabited North America, and the implication that they are residuals of a larger fauna when it seems much more probable that they are fairly recently derived from the south, and have never greatly extended further northwards and westwards, is unjustifiable. The same holds for the statement that the polyprotodont marsupials have not entirely disappeared from the East Indian islands. There is not one jot of positive evidence to indicate that any polyprotodont marsupial has ever disappeared from any East Indian island. Had they ever existed in the islands not at present tenanted by them, all the probabilities are that they would have persisted to the present, for these islands afford an environment similar to that provided by neighbouring islands in which they contrive to flourish and even undergo adaptive radiation.

Noble (1922) has adopted and expanded Matthew's views. He writes (*l.c.*, p. 63):—

"If the recent herpetological literature is critically examined, it will appear that to-day there is no need for the antarctic continents or mid-Atlantic land bridges which have been revived from time to time to account for the distribution of the Salientia. Perhaps the most recent of these revivals is that of Metcalf (1921a) who has brought some additional evidence derived from a study

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(1) Cystignathidae = Leptodactylidae.

(2) Italics mine.

of the Opalinid parasites of the Salientia. There seems to me to be little need for the land bridges Metcalf has revived. Hylids and 'leptodactylids' occur in the Ethiopian region. We have merged the 'leptodactylids' into the Bufonidae, while the hylids have almost certainly evolved from this bufonid stock.' Noble assumes a polar origin for the Hylidae, and Leptodactylidae, on the ground that the Brevicipitidae, Ranidae, and Bufonidae, 'have almost certainly gained access to Africa from the north.' He writes further (p. 69):—

"The genus *Hyla* possesses nearly a world-wide distribution, except for a great gap in the Indo-Oriental region. Formerly considerable emphasis was placed on this gap in its present distribution. This, together with the abundance of the genus in the South American and Australian regions, seemed to lend some support to the Gondwana land hypothesis. But to-day we know of one true *Hyla* from the Ethiopian region and three toothed bufonids. The latter are all referable to the single genus *Heleophryne*. It thus seems most likely that the genus *Hyla* originated in the north and pushed southward into Africa and the Oriental region. Finally, when the genus gained access to Australia, it died out in most of the more northern regions except in Papua and some of the East Indian islands where it is still abundant."

Noble has united the Bufonidae and Leptodactylidae, calling them all Bufonids. This action has not had time to draw upon itself the requisite criticism which will decide whether it be well founded or no. It does, however, enable Noble to claim a continuity of Bufonidae from Asia into Australia which, on closer analysis, does not exist. Typical northern Bufonids of the genus Bufo have not been able to penetrate to the east or south of Celebes. The Australian Leptodactylids, the essential characters of which are not in any way altered by calling them Bufonids, have not succeeded in penetrating to the north or west of Papua, in which island they are represented by one or two species only; and their closest affinities would still seem to lie with South American forms. The occurrence of *Heleophryne* in Africa would not be inconsistent with Antarctic derivation, probably after Australia was cut off from its Antarctic connection. There is evidence for this African connection shown by the Proteaceae among plants. Moreover, *Heleophryne* and the reported *Pseudophryne* of Africa may be wrongly determined as Bufonids. I am not, however, concerned about Africa at present, and prefer to consider the Hylidae only, since they do not raise any question of African relationships. Before proceeding to this, however, a few more passages from Noble's paper must be added, though they merely reiterate the same arguments.

He writes (p. 70):—"The fact that numerous toothed bufonids occur in Australia and in South America has for many years lent some support to the Antarctic continent theory. We have already stated above that this recent discovery of toothed bufonids in Africa together with a recognition of the close affinity of toothed and toothless forms removes much of the argument in favor of this view. For years the distribution of hylids has been used as supplementary evidence in favor of a former South American-Australian land connection. . . . The distribution of the genus *Hyla* is very difficult to explain. We have already remarked on the discovery of a *Hyla* in Abyssinia. The genus is now known from all the major zoological regions except for a remarkable hiatus, extending from the Philippines, Borneo, Celebes, Siam, and the Malay Archipelago through India. Several of the Asiatic Hylas encroach upon the border of this region (as in Burma), but these are readily recognisable as ectogenetic forms. Why this Indo-Oriental region should be a closed territory to *Hyla* is not known, but I do not believe there is good reason to assume that it has always been a closed territory, that the genus has never existed in any of this region. If we overlook for a moment the great gap in an almost world-wide distribution for the genus *Hyla*

. . . . it is much simpler to account for the present distributions . . . . by assuming a northern origin and later migration southward by three routes, the first leading into South America, the second into Africa, and the third into the East Indies and Australia, than to assume land connections between South America and Australia when we would have still to account for the *Hylas* in Africa and northern Asia."

I would suggest that the reader of Noble's argument who was totally unacquainted with Anuran distribution would get a hopelessly wrong idea of it from the selection of facts which he sets out. The alleged world-wide distribution of Hylidae is perhaps verbally true, but the distribution in the Oriental, Palaearctic, and Ethiopian regions, much more than half the world, is limited to two species, one of which is divided into half a dozen varieties, while the other appears to be only doubtfully known. These two species, according to Metcalf and Noble, are closely related to American forms. In the case of *Hyla arborea* and its races it seems certain that it migrated from America via Alaska. About *H. wachei* so little is known that it is difficult to base any conclusion upon it. If Noble's suggestion (*l.c.*, p. 65) be well founded, it is most closely related to the *maxima* group of northern South America, and may have followed the same route as *H. arborea.*

Dunn (1923) does little more than reiterate Noble's conclusions. Noble quotes Metcalf (1923), but appears to allow little weight to the evidence the latter adduces from the distribution of Opalinid parasites of frogs. Metcalf finds that *Hyla arborea* and its subspecies harbour Opalinids belonging to a modern group, which he believes to have originated in North America. The Australian Hylas are tenanted by the primitive genus *Protoopalina,* while the "narrow Opalinas" found in American and Holarctic Hylas are thought by Metcalf to have been brought about through the reactions of these hosts upon the "broad Opalinas" of *Rana* and *Bufo.*

Metcalf concludes (1923, p. 394):—"No multinucleated Opalinids are known from Australasia. If the Australian Hylas had entered from Asia they should have brought multinucleated Cepedeas or Opalinas, such as are found in Nearctic Hylids, unless they left Asia before the evolution and presence there of these multinucleated genera. All the indications seem distinctly against the hypothesis of the Australasian Hylids having entered Australasia from the north."

The evidence is not conclusive, as Metcalf admits, but it is strongly supported by that derived from the parasites of the Leptodactylids. The Opalinid genus *Zelleriella* is found only in Australia and southern America. As Metcalf points out, if the Australian and South American Leptodactylids were of northern origin, then, on the basis of what happens with other Opalinids, *Zelleriella* would still occur in some Anuran hosts in Holarctica, which it does not. The distribution of Opalinid parasites seems to me conclusive for southern derivation of the host groups.

There may of course be objection taken to this host-parasite method of arriving at conclusions of such far reaching importance. But I believe it to be well justified. I first proposed in 1911 that the Mallophagan parasites of birds might settle some vexed questions in bird phylogeny, and have used them to this end in several subsequent papers. In 1915, I put forward the general thesis "that in the case of total obligate parasites, closely related parasites will be found to occur upon phyletically connected hosts, without regard to other ecologic conditions. As the state of evolution of the parasite will be less advanced than that of the host, it follows as a corollary: That a study of such parasites may give valuable indications as to host phylogeny." My predecessor in the chair I now occupy. S. J. Johnston, tested my proposition for Trematoda and Cestoda (Johnston, 1913, 1914) and found that it held good. Metcalf quite independently found the

value of the method with Opalinids. I shall make a further new application of it before I conclude this address.

Since it is with the marsupial fauna that we are mainly concerned, what of the parasites of the marsupials themselves? S. J. Johnston (1913, p. 278), writes:—"The trematode parasites from Australian marsupials are very interesting in this connexion. Two species of Harmostomum from Dasyurus and Perameles are very closely related to H. opisthotrias Lutz from an American Didelphys, so closely related that I am convinced that they must be considered as being derived from common ancestors. They thus afford some pretty convincing circumstantial evidence of the phylogenetic relationship of the Australian and South American marsupials.

"No less interesting are two new species of flukes, one from Dasyurus and the other from the platypus, which have been described in Part 4 of the Proceedings of the Linn. Soc. N.S.W. for 1912, as representatives of a subfamily intermediate in position between the Fasciolinae, flukes typically parasitic in the higher mammals and the Psilostominae parasitic in reptiles and birds."

Certain evidence from Cestodes (S. J. Johnston, 1914, p. 4) points also to the genetic affinity of Australian and American marsupials, but neither they nor the Trematodes help us in the matter of migration routes. The Mallophagan ectoparasites, however, may afford assistance. I wrote (1922, p. 154) apropos of a Mallophagan parasite of an American marsupial, *Peramys*:—"Mallophaga from Australian marsupials are contained in a family, the Boopidae, which finds its closest relations in the Gyropidae, a family found upon certain South American rodents. Certain South American rodents also harbour the two contained species of a third family, the Trimenoponidae. With the exception of these three small groups, all mammalian Mallophaga belong to the widely different family Trichodectidae, which is placed in a distinct super-family.

"Believing as I do that Mallophagan parasites afford valuable indications as to the genetic relationships of their hosts, I have always been puzzled by this distribution. That the marsupials of Australia should not carry the same kinds of parasites as the Eutherian mammals is reasonable enough. But, apart from marsupials, I should have expected all other mammalian Mallophaga to belong to the Trichodectidae. Hence the occurrence of two small, but distinct, families, not upon rodents in general, nor even upon American rodents in general, but on a limited number of South American rodent species, families which showed, moreover, some relationship with the Boopidae, but differed from all other Mallophaga, was difficult to reconcile with my ideas.

"The explanation would appear to be that such Ambyceran Mallophaga as occur on South American rodents have been migrants in the past from the marsupial stock. The new genus which I describe from a South American marsupial must be placed in the Trimenoponidae, but shows some marked features of resemblance to the Boopidae, and some points of contact with the Gyropidae. It is, of course, no use trying to base definite conclusions on a single marsupial-infesting species, but it seems likely that, when more information is available concerning the Mallophagan parasites of American rodents and marsupials, the suggestion thrown out here may be upheld. It is also possible that the discovery of further connecting forms will make it advisable to unite these three anomalous groups under one family name."

Curiously enough, further information was soon forthcoming, for my paper was anticipated by just a fortnight by G. F. Ferris (1922) whose communication not only bore the same title as my own, but described my species, so that my *Acanthomenopon horridum* falls to Ferris' *Cummingsia peramydis*. Ferris described also a genus *Harrisonia* from an Octodont rodent, and a second species

of *Cummingsia* from *Caenolestes*, and the new forms which he has brought to light show obvious affinities with the Boopidae of Australian marsupials.

So we find that the Boopidae, Gyropidae, and Trimenoponidae occur upon marsupials, and upon South American Hystricomorph rodents, a group of which Matthew writes (p. 232):—"No hypothesis satisfactorily explains the accepted relationship and distribution." There is no evidence that these parasites have ever existed on other mammals in more northerly lands, and it seems most probable that they would have left residuals here and there if such had been the case. So here again the greater probability lies with Antarctic connection between South America and Australia. It may be that at a later stage Australia was cut off from Antarctica, and Africa joined, allowing of a migration of Hystricomorphs, but this raises a very complex question, bristling with difficulties, with which we are not here concerned.

The last instance I wish to bring forward is that of the distribution of crayfishes, also treated by Matthew (*loc. cit.*, pp. 301-303). Matthew discusses the views of Ortmann (1902), and, after pointing out that the Holarctic crayfishes form a family distinct from the southern forms, which have a curious distribution in South America, New Zealand, Australia, and Madagascar, writes:—

"The Australian and South American crayfish I should regard as derived from the north, by way of the existing or slightly submerged land bridges, at a time when the northern crayfish were much more primitive than now and when, for reasons which I do not venture to suggest, the tropics were a more favourable environment than now. The northern crayfish have since evolved into *Potamobius* and *Cambarus*, the southern specialized into the more divergent *Parastacus* of South America, *Cheraps* and *Engaeus* and *Astacopsis* of Australia and Tasmania, *Paranephrops* of New Zealand . . . . and *Astacoides* of Madagascar.

"Of these southern genera, *Astacoides* is the nearest to the northern types. This is to be expected, if the southern genera are remnants of a cosmopolitan distribution derived by dispersal from the north; for the Malagasy genus would be a derivative from Ethiopian crayfish, which would be less remote from the north, and would be correspondingly more advanced than in South America and Australia."

Geoffrey Smith (1909, p. 214) refers to the distribution of crayfishes as follows:—

"It seems reasonable to suppose that the two families of crayfishes characteristic respectively of the northern and southern hemispheres have been independently derived from marine ancestors, which have subsequently become extinct. Their complete absence in the tropics is striking, and Huxley drew attention to the fact that it is exactly in those regions where the crayfishes are absent that the other large fresh-water Malacostraca are particularly well developed, and *vice versa*. Thus the large fresh-water prawns are typically circumtropical in distribution, while the South African rivers abound with River-crabs, which, in general, are found wherever crayfishes do not occur."

Later (*loc. cit.*, p. 217) he writes of the general distribution of fresh-water Crustacea that it—"in the temperate southern hemisphere affords strong evidence in favour of the view that the chief land-masses of this hemisphere, which are at present separated by such vast stretches of deep ocean, were at no very remote epoch connected in such a way as to permit of an intermixture of the temperate fauna of New Zealand, Australia, and South America. While this connexion existed, a certain number of forms characteristic of the northern hemisphere, which had worked through the tropics by means of the Andes, were enabled to reach temperate Australia and New Zealand. The existence of a coast-line connecting the various isolated parts of the southern hemisphere would, of course, also account for the community which exists between their littoral marine fauna.

It is impossible to enter here into the nature of this land-connexion which is becoming more and more a necessary hypothesis for the student of geographical distribution, whatever group of animals he may choose, but it may be remarked that the connexion was probably by means of rays of land passing up from an Antarctic continent to join the southernmost projections of Tierra del Fuego, Tasmania, and New Zealand."

He summarises these arguments again in his study of the Australian crayfishes (1912, p. 148):—

"The Astacidae (= Potamobiidae) and Parastacidae, the one family occurring in the northern Hemisphere, the other in the Southern, are therefore separated by important characters, and it is very probable that they have been independently evolved from marine lobster-like ancestors which already differed in these characters before they took to a freshwater life.

"The occurrence of Parastacidae in Australia, New Zealand, and South America, with an aberrant genus (*Astacoides*) in Madagascar—that is to say, in countries which are now separated by wide stretches of ocean—is a striking fact in geographical distribution, but it does not stand alone, the distribution of many freshwater fish, crustacea, molluscs, etc., having a similar character in the Southern Hemisphere.

"These facts, taken in conjunction with geological evidence, have led many naturalists to assume a much greater extension of the Antarctic Continent in past times which is supposed to have been connected with South America, Australia, and New Zealand, and possibly, at a very remote period with Madagascar, thus permitting the migration of land and freshwater animals to and from those countries. In the case of the Parastacidae the only alternative theory is that the South American, Australian, and New Zealand genera have been independently derived from some common marine ancestor."

This is a case in which parasites can be used to aid us. The four southern groups of crayfishes all carry ectoparasitic Temnocephaloids, a group generally associated with the Monogenetic Trematodes, though differing from these in certain important features. They are confined to fresh water, and are parasitic on the following hosts other than crayfish:—tortoises (Brazil), shrimps (Argentine), mollusc (Brazil), crab (Matto Grosso); shrimps and an Isopod (Australia); Crustacea (Java to Philippines). In addition, one species has apparently succeeded in reaching the northern crayfishes at their southern limit, *Temnocephala mexicana* being recorded from *Cambarus digneti* of Mexico.

Unless we make the assumption, for which there is no evidence, that Temnocephaloids were once found upon the Potamobiidae, but have become extinct upon all but *Cambarus digneti,* their distribution appears to prove quite conclusively the wide divergence between the northern and southern groups, which may have been due to a separate origin from hypothetical marine ancestors, as suggested by Smith, but which seems more likely to be due to the fact that, though having a common ancestry, they have been separated for a very long period of time, and the Parastacidae are simply less highly differentiated offshoots of primitive Holarctic Potamobiids. From the greater variety of hosts upon which they are found in South America, it would seem that the Temnocephaloidea were evolved there, becoming parasitic upon the ancestors of *Parastacus,* and were carried with the migrating Crustacea to Antarctica, New Zealand, Australia, and Madagascar (perhaps by way of the Moluccas and Seychelles, as has been suggested for many other animals).

The weight of evidence is entirely against the separate colonisation from the north of New Zealand and Australia, and from Africa of Madagascar, which Matthew suggests. If crayfish had ever existed in Africa, they must have had Temnocephaloid parasites, since the Malagasy genus *Astacoides* has them, if it

be presumed that the latter were derived from the former. It would follow that the Holarctic crayfish must have had these parasites. If so, where are they now? It is too much to ask us to believe that they have become extinct in the northern temperate zone when we find them so widely spread and holding their own in the southern. There is no evidence that crayfish have ever existed in the tropical belt, and the fact that their place is filled there by other creatures, such as fresh-water crabs, and giant prawns, seems to indicate positively their non-existence at any time. The real explanation of the southern crayfishes seems to be that put forward by Geoffrey Smith (1909) that *the Andes offered the only temperate path by which creatures of the northern zone could pass the tropics and enter the southern zone.* This would account for the fact that many groups of animals which reached South America from the north have failed to reach either Africa or Australia.

We may conclude, then:—

1. That Matthew's hypothesis of Holarctic dispersal holds for man, and most, though not all, of the Tertiary mammalia, but that it does not hold for Mesozoic dispersal, nor for such groups as crayfishes and Hylid frogs.

2. That Australia has been isolated from the northern land masses since the late Mesozoic, and that those portions of its fauna which had to depend upon land migration have come in from the south.

3. That the Antarctic continent had, during the greater part of the Mesozoic and the early Tertiary a temperate climate, and a rain-forest flora, and was therefore habitable by animals.

4. That there are geographical indications of former connections between this continent and South America, New Zealand, Australia, and Africa, which, taken in conjunction with the evidence from faunal distribution, render it probable that land migration has from time to time been possible along such connections. No other hypothesis is adequate to explain some cases of distribution.

5. That evidence afforded by parasites strengthens that from faunal distribution, and minimises the suggestion of multiple and convergent origins.

6. That the Andes have always formed the only temperate pathway through the tropics.

7. That the Australian marsupials, together with the Parastacid crayfishes, the Leptodactylid and Hylid frogs, and a host of other forms, vertebrate and invertebrate, have reached Australia from South America by way of Antarctica.

Literature Cited.

BARBOUR, T. (1912).—A Contribution to the Zoogeography of the East Indian Islands. *Mem. Mus. Comp. Zool. Harvard,* xliv., No. 1, pp. 1-168.

BENHAM, W. B. (1909).—Report on *Oligochæta* of the Subantarctic Islands of New Zealand. The Subantarctic Islands of New Zealand, pp. 251-294. Wellington, 1909.

CHEESEMAN, T. F. (1909).—On the Systematic Botany of the Islands to the South of New Zealand. *Loc. cit. supra,* pp. 389-471.

DAVID AND PRIESTLEY (1914).—British Antarctic Expedition, 1907-9. Geology, Vol. i. London, 1914, Heinemann.

DUNN, E. R. (1923).—The Geographical Distribution of Amphibians *Amer. Nat.,* lvii., No. 649, pp. 129-136.

FERRIS, G. F. (1922).—The Mallophagan Family Trimenoponidae. *Parasitology,* xiv., pp. 75-86.

HARRISON, L. (1912).—The Taxonomic Value of Certain Parasites. Abstract in *Ann. Report. Syd. Univ. Sci. Soc.,* 1911-1912.

——————— (1914).—The Mallophaga as a possible clue to bird Phylogeny. *Australian Zoologist,* i., pp. 7-11.

——————— (1915).—Mallophaga from *Apteryx,* and their Significance. *Parasitology,* viii., pp. 88-100.

——————— (1915a).—The Relation of the Phylogeny of the Parasite to that of the Host. *Report. Brit. Ass. Adv. Sci.,* 1915, pp. 476-7 (Abstract).

——————— (1916).—Bird-parasites and Bird-phylogeny. *Ibis,* April, 1916, pp. 254-263.

——————— (1922).—The Mallophagan Family Trimenoponidae. *Australian Zoologist,* ii., pp. 154-158.

JOHNSTON, S. J. (1913).—Trematode Parasites and the Relationships and Distribution of their Hosts. *Report. Aust. Ass. Adv. Sci.,* xiv., pp. 272-278.

——————— (1914).—Australian Trematodes and Cestodes; a Study in Zoogeography. *Medical Journ. Aust.,* Sept. 12, 1914 (Abstract in *Report Brit. Ass. Adv. Sci.,* 1914, p. 424).

KELLOGG, V. L. (1914).—Ectoparasites of Mammals. *Amer. Nat.,* xlviii., pp. 257-279.

LONGMAN, H. A. (1924).—The Zoogeography of Marsupials. *Mem. Queensland Mus.,* viii., pp. 1-15.

LONNBERG, E. (1921).—A second Contribution to the Mammology of Ecuador with some Remarks on Caenolestes. *Ark. Zool.,* xiv., No. 3, pp. 1-104.

MATTHEW, W. D. (1915).—Climate and Evolution. *Ann. New York Acad. Sci.,* xxiv., pp. 171-318.

METCALF, M. M. (1921).—Upon an Important Method of Studying Problems of Relationship and of Geographical Distribution. *Proc. Nat. Acad. Sci.,* vi.

——————— (1923).—The Opalinid Ciliate Infusorians. Bulletin 120, Smithsonian Institution.

——————— (1923a).—The Origin and Distribution of the Anura. *Amer. Nat.,* lvii., No. 652, pp. 385-411.

NOBLE, G. K. (1922).—The Phylogeny of the Salientia. *Bull. Amer. Mus. Nat. Hist.,* xlvi., pp. 1-87.

——————— (1924).—Contributions to the Herpetology of the Belgian Congo, etc. *Bull. Amer. Mus. Nat. Hist.,* xlix., pp. 147-347.

ORTMANN (1902).—Geographical Distribution of Fresh-water Decapods and its Bearing upon Ancient Geography. *Proc. Amer. Phil. Soc.,* xli., pp. 267-400.

SMITH, G. (1909).—*Crustacea,* in the Cambridge Natural History, Vol. 4. London, Macmillan.

——————— (1912).—The Freshwater Crayfishes of Australia. *Proc. Zool. Soc. Lond.,* 1912, pp. 144-171.

STILES AND HASSALL (1908).—Index-catalogue of Medical and Veterinary Zoology. *Trematoda.* Washington, 1908.

FAIRY WRENS.

By Tom Iredale.

A very typical Australian bird-form may be seen in the common Blue Wren, a thing of such marvellous beauty, that the early English authors christened it the Superb Warbler, a name too high sounding for the modest Australian. Yet it is much more appropriate than Blue Wren, a wretched misnomer for this fairy-like sprite of azure. Scandalmongers have condemned it as a Mormon, but its chastity and fidelity have been vindicated, and its sober home-life is now admitted. Fine feathers make fine birds, and because the male did not wear these all the year round his reputation was assailed: it is now allowed that he puts on his fine clothes to please his mate while he is young, but when he has reached a respectable age he keeps them all the year round. This seems contrary to the usage of humans in the best society, but it may be due to the desire of the female sex, and such requests cannot be denied. Further, it was due to his very respectable habit of taking his family with him always that he got himself talked about; from a human point of view no good bird could do such a thing, and he was accused of gadding about with a lot of young females.

However, as aforesaid, its moral life has been vindicated, and the theme of this essay is a sketch of its suggested ancestry and relations throughout the Australian Continent.

When the bird-life of Australia and Tasmania is studied, a number of strange coincidences are met with, and when these are arranged in order certain facts stand out. From these facts deductions may be drawn, and by means of these deductions dim views of past ages may be seen darkly. Probably never will the past read clearly, so that any data and hypotheses therefrom are useful. The "Blue Wrens" taken as a group will provide a series of facts from which we can suggest and theorise, and possibly these suggestions may prove of assistance to workers in other classes. "Blue Wrens," the genus *"Malurus"* of older workers, fall into five groups with definite characters, range, and colouration.

The original colouration of the whole series appears to be represented by the plumage of the juvenile of the common Blue Wren. This insipid phase is characteristic of the groups of small birds throughout the world, so that a great deal of importance cannot be attached to it in connection with any particular series such as here treated of. However, the earliest migrants into Australia appear to have been modest birds, who, finding a land of glorious sunshine, resolved to better their appearance to be in harmony with their surroundings. They travelled down the East Coast into Tasmania, and along the southern coast into South-west Australia before Tasmania or South-west Australia were separated from the mainland and settled down to produce fine feathers. Their choice fell upon blue and black, why, we cannot say, unless it were to outshine the blue sky, but the blue was developed in an extraordinary manner. There was always a lurking suspicion that red would have been more suitable, and experiments appear to have been instituted to try the effects of a little red with it. Hence we have wonderful shades of purple, as well as turquoise and every other shade of blue. These experiments were undertaken under different conditions, and thus we have a graduated series of results. As noted above, apparently the oldest migration ran as far south as Tasmania, where the colouration may be seen, thusly disposed, head, neck and breast dark-blue, practically black, the top of

the head, ear coverts and middle of back various shades of blue, varying in localities, and the parts differing *inter se*, the abdomen white, the wings and tail bluish. This style of colouring occurs from Southern Queensland, through New South Wales, Victoria, Tasmania and South Australia, as far as Eyre's Peninsula, also on Kangaroo Island, and constitutes the common Blue Wren. This distribution is suggestive, as it is confirmed by the range of other bird forms, and premises very distinctly that Tasmania and Kangaroo Island were separated from the mainland about the same time, and also that that time was practically coincident with the re-joining up of the centre of Australia. The same style of bird had travelled along the south coast into Western Australia before the centre was flooded by the Great Bight, and became isolated there. Here the interference of the red element abovementioned has produced a gorgeous purple tinged atom, and, later, when the internal sea became dry again, this delightful production travelled east, but never reached the coast, stopping inland through subtropical Australia. The purple spread all over the abdomen, so that this is one of the most beautiful little morsels of bird-life known. The common (!) name for this elegant little fairy is the Banded Wren. Could bathos descend lower? The eastern product is named the Black-backed Wren, because a line of black divides two areas of purple. The poverty of imagination seen in these nominations is being redressed slowly, but surely some more appropriate names can be invented for these whiffs of beauty. Whiff is descriptive of their flight across a path, as with their long tail they fly undulating and zigzagly as if wafted by a gnome-driven wind, disappearing into the thicket, leaving an impression of dainty fairiness. Fairy Wren would be an appropriate name for the group, then Purple Fairy Wren could be used for the Banded Wren, and so on.

However, the separation of the East and West of Australia produced a startling innovation in the colouring of some of these birds. How this was instigated it is quite impossible to guess, but forgetting to improve its face with erectile ear-coverts and foregoing the use of red at all, blue was utilised in its pure state, and a wholly blue-bird was created; as if this were too much altogether, a white mantle was thrown on the shoulders and the White-backed Wren was achieved. Here, again, the name is inconclusive, as Wren suggests a little brown bird with a short tail, whereas all this group have long tails. However, as the females and young are dull, if Fairy Wren be not acceptable, probably Wren will be continued. It does not much matter in this case, as this Blue Wren is quite beautiful enough to allow any name, even as the rose's scent could not be sweetened by any longer name. Apparently this wonderful blue bird was produced when the East and West of Australia were separated, and when the islands of the coast of West Australia were joined to the mainland. The convulsion which made Central Australia dry again separated these islands, but left them above water with the blue-birds living thereon. These blue-birds darkened, but otherwise did not change much, save as isolation would allow, i.e., stronger feet, thicker bill and weaker wings. With the drying up of the central portion, the blue-bird spread eastwards, even as the preceding purple form had done, and, like it, stopped before reaching the coast.

We have conjectured that these birds came from the North and traced their evolution since their settlement in Australia, and the ones we have mentioned we regard as representing the first migration, at any rate, of this group of birds. A later migration followed, also of modest birds, who went inland and spread all over the interior of Australia, east and west, north and south, but these did not get into Tasmania, so that it seems obvious they must have arrived in the south after Tasmania was separated. They have penetrated into the South-west of Australia, where two rather different little birds have been produced, though obviously of the same stock. These birds are very like the Common Blue Wren,

but in flirting with the red paint have got their shoulders stained. This is a curious feature, as four different kinds are allowed, all showing this red patch, but otherwise no red, save that some of them show purple-blue and purple-black, while one has greenish blue, yet has red scapulars. The most widely spread form, reaching from Sydney to the islands off West Australia, and from the Gulf of Carpentaria to Eyre's Peninsula, is known as the Variegated Wren, a name that would not indicate that practically the only difference from the common Blue Wren consists of the red shoulder patch. Another form, the one with the greenish-blue head and back colouring, has a more vivid red shoulder patch, and hence is called the Red-winged Wren! Another one, whose chief characteristic is the purple-black of the throat (the others have black throats with a blue tinge), has been called the Blue-breasted Wren! More unmeaning names could scarcely have been chosen. These last two both live in the south-west of West Australia only, the former hugging the coast line, the latter keeping close, but in the drier districts in the same restricted habitat. Having thoroughly accustomed itself to the conditions of Australia, this form began to spread northwards again. This has happened more than once in the history of Australian bird-life; after a bird has evolved in a suitable manner in Australia it has spread out and even gone back into New Guinea, and it would appear that this was not a difficult passage until very recently. The further north it went it changed very little, but a change in the female began to take place. Owing to the travelling she felt herself subordinated by the fine habit of her mate, an item that had never troubled her or her friends when they stayed at home, so she resolved to become like him. So far she has not succeeded, but she is quite a nice little bluish bird, and in time may rival her mate. It is conjectured that some of the birds which remained in New Guinea were inculcated with the same love of finery, and they resolved themselves into gorgeous little beauties like our Purple Fairy Wren. Under the climatic conditions they had to move quicker and chase bigger insects, so that at the same time they grew bigger with broader bills, lived more up bigger trees, and, as the male set the pace in brilliant clothes, the female did likewise, and at the present time both sexes are gorgeously coloured, larger, with longer broader bills, and consequently by the wise men who do not believe in fairies they have no right to be called Fairy Wrens, nor do they allow them any relationship. Yet they pretend that a little black and white bird hopping about the New Guinea forests belongs to our little fairy group. We cannot understand how such a pretence can have originated, and have no doubt that the conceit of the Påpuan stranger is unfounded.

Now all the Blue Wrens of Australia have been accounted for, but there are still strangers in our land to be considered. For some years bookmen, and, following their lead, field ornithologists have associated intimately with our Fairy Wrens, two very different looking little birds. Each of these is a delight in itself, and each deserves as beautiful a name as can be coined for it, but neither is a real Fairy Wren. A real fairy would probably call the one I shall first mention an Elf Wren or Elfin Wren. Dressed in a garment of the finest black across his back is flung a band of scarlet. His every movement is sprightly, his little song is even fairy-like music, so there really is little wonder that he has been associated with the Fairy Wrens, though obviously his choice of apparel denies the relationship. The only colours he shows are red and black, the red lightening to orange, a colour in no way approached in any Fairy Wren. His present range of life in Australia indicates that he has arrived in this country at a later period than the Fairy Wrens, as he belongs to the migration of northern birds, which have advanced into Australia in comparatively recent times, ranging down the east as far as New South Wales, and along the northern coast as far south as Derby in North-west Australia. This migration consists generally

of birds whose relatives still live in New Guinea, without much change in appearance or structure. It is possible that when Australians know more about Papuan birds some one will recognise the relatives of this Elfin Wren, and show exactly how very different it is to the Fairy Wrens.

These dainty little feathered gems would appropriately dwell in Wonderland, and had Alice met with them she would have indubitably christened the Blue Wrens, Fairy Wrens, but as certainly called the lastmentioned (the Red-backed and Purple-crowned), Not-Fairy Wrens, and might have suggested the name Elfin Wren for the little black and red midget.

The Purple-crowned which Alice would have called Not-Fairy Wren, is one of our rarest and most beautiful, among the many glorious Australian birds. Purple-crowned Wren does not suggest the modest lilac which adorns the crown as a wreath. It really is a lilac crown, but the word crown has become illegally used in bird descriptions for the top of the head, which in this bird is not lilac. There is no purple present at all, so that "Lilac-wreathed" describes the nature of the ornament and colour, but what to propose instead of Wren is puzzling in this case. Perhaps Blue-tail would suit the case, as otherwise there is little distinctive colour in this delightful species. Its distribution again is very suggestive, as it occurs only in the north-west, and does not occur in North Queensland. It may be conjectured that it arrived in the north-west direct from Northern New Guinea by way of the Aru bank. There are a few birds that seem to suggest such a migration, and these are of such a type that the migration would be contemporary with the lastmentioned one, via Cape York.

Such then appears to be the story of the Blue Wrens of Australia. The sober results of this effusion may be crystallized thus.

The Blue Wren (*Malurus cyaneus* Latham) appears to belong to the oldest immigration of small Passerine birds into Australia from the north, and is therefore found in the south-east of Australia, Tasmania and Kangaroo Island. Its progenitor travelled along the south coast into West Australia, where two very different forms evolved, one in the south-west developing into the Banded Wren (*Malurus splendens* Quoy and Gaimard) and then into the Black-backed Wren (*Malurus melanotus* Gould), the latter retracing its steps eastward when opportunity offered. The very close relationship of these species must be acknowledged, but in the west was created a new style altogether, the White-winged Wren (*Malurus cyanotus* Gould). A remnant of this form isolated upon a few islands off the west coast of Australia has produced the Black and White Wren (*Malurus leucopterus* Dumont). A peculiar little colony which probably crossed the continent as soon as the dry land appeared became isolated in South Australia and produced the White-backed Wren (*Malurus leuconotus* Gould).

After the formation of the Continent of Australia, Tasmania, Kangaroo Island, and the West Australian Islands being simultaneously separated, a later immigration of similar birds crossed while Torres Straits was dry land, and spread all over Southern Australia from east to west, and again evolved little groups in the south-west, the common widespread species being the Variegated Wren (*Malurus lamberti* Vigors and Horsfield), the two south-west species being the Red-winged Wren (*Malurus elegans* Gould), and the Blue-breasted Wren (*Malurus pulcherrimus* Gould). After becoming well established this form began to retrace its steps northward, and is known in the extreme north as the Lovely Wren (*Malurus amabilis* Gould). These constitute the Blue Wrens proper, and it is obvious that the three groups indicated may be associated together, but their different structure and distribution should be indicated by group names. Two entirely different bird forms have been confused with these, and are still called Wrens, the Red-backed Wren and the Purple-crowned Wren. The former (*Ryania melanocephala* Vigors and Horsfield) and the latter (*Rosina coronata*

Gould) only occur in the northern portion of our Continent and represent the latest immigration of Papuan bird-forms, the main route of which was down the east coast, rarely reaching as far as Sydney (as the former species does), and along the north and north-west as far south as Derby, North-west Australia. The Purple-crowned Wren seems to represent a simultaneous migration, which reached Northern Australia from North-west New Guinea, via the Aru group. Neither has any close relationship with the Blue Wrens proper, whose representative in New Guinea is a similar gorgeously coloured form known as the genus *Todopsis,* the so-called *Malurus* of Papua (*M. alboscapulatus* Meyer) being unrelated to the present series in any way.

NOTE ON SOME NATURAL HABITS OF ECHIDNA (*TACHYGLOSSUS ACULEATUS*).

By Harry Burrell, C.M.Z.S.

Upon examining several female Echidna "in season," when the pouch is developed, on three occasions, after persuading the animals to relax and unfold themselves from their natural curved position, I have found fresh excreta deposited in their pouches. (The circumference of Echidna excreta is fully twice that of the egg, and, as in the case of birds, both objects traverse a single canal). This discovery strongly suggests that the egg is deposited directly into the pouch, without the assistance of either limbs or beak. After deposition, the pouched egg is carried about by the animal during her wanderings, until the embryo finally breaks through the egg shell with its up-turned projecting snout, or egg bursting apparatus. Although development of the embryo is comparatively rapid, it is very questionable whether it requires mother's milk or not for some considerable period after it has emerged from the egg. Quite possibly, like its nearest relation *Ornithorhynchus,* it does not. For my part, I say emphatically, that it does not. From personal examination of a hairless juvenile Echidna taken from the pouch, measuring 2¾ inches from tip of snout to tip of tail, the occasional protusion and wriggling of its lengthy narrow tongue, combined with a sort of perpetual motion of its well developed fore-paws, convinced me that it had now become expert in the art of inducing the milk to flow from the mother's internal teatless glands, and that lapping was going on in earnest at the nourishing fountain of life.

The young of Echidna are usually carried about in the pouch until the tiny quills become troublesome to the mother; at that stage the youngster is deposited in a small burrow, excavated by the parent, until it can fend for itself. It has been surmised by several naturalists, and vouched for by some aboriginals, that the mother Echidna occasionally visits her imprisoned offspring to supply it with food while it is so helpless. Be that as it may, theories based on aboriginal information can hardly be accepted as final, therefore this problem is still open to discussion. In this respect I wish to place on record the following notes supplied me by Mr. C. H. H. Jerrard, a naturalist, residing at Blackdown, Gayndah, Queensland, who rescued a young Echidna measuring nine inches in length, that had just been unearthed from a burrow by a Lace Lizard. The fat, flabby youngster was naked save for a sparse crop of stubbly black hairs, and here and there rudimentary quills measuring one-eighth of an inch in length. After carrying his prize home, Mr. Jerrard states that it did not respond to his care; attempts to feed it met with very limited success, but by holding its snout forcibly in a saucer of milk it could be sometimes induced to protrude its long slender tongue and lap a little. One such meal sufficed it for several days. It

was a month before Mr. Jerrard observed the creature to crawl a few inches to the saucer of bread and milk that always stood in the box, and help itself. Its abstemiousness practically amounted to a "hunger strike." It lost weight; the only growth observable was in the length and number of its quills. After ten weeks of similar treatment it showed signs of nuzzling around in search of food, and from then on it thrived and fared well, until, unfortunately, it was killed by a dog while wandering out of bounds from its garden patch.

As a result of comparing the above data with my personal observations, I unhesitatingly suggest that the prolonged period during which the young Echidna is imprisoned beneath the earth, is in fact a kind of hibernation, and that there is no necessity whatever for the wandering mother to return to her offspring after she has once deposited it in the burrow. Probably the youngster falls naturally into a state of semi-coma while in the pouch, and that such condition reminds the parent that it is due time for the final deposition of her then troublesome burden. I liken the history of Echidna, to that of a Butterfly.

Firstly, it frees itself from an egg; then turns to a caterpillar, which does little but eat and develop; then to a chrysalis, which does little but sleep and develop; then to a perfect butterfly.

ON THE SIMILARITY OF *PSOPHODES* AND *SPHENOSTOMA*.

By A. G. Campbell, R.A.O.U.

The influence of desert conditions in the interior of Australia is shown in a very marked manner upon the bird life, so much so that new and distinct species are already in existence in direct response to the changes that have occurred in their environment. It is interesting to speculate how these have differentiated in their several ways from species inhabiting the coastal regions, and to associate one with another as divergent forms from a common ancestral stock.

The change may be slight, as in *Geobasileus chrysorrhous*, where the desert races lose the olive from the mantle and become brownish; or it may, in the same genus over a somewhat similar range of habitat, be much more pronounced.

G. tenuirostris, for instance, is undoubtedly the interior form of *G. reguloides* from which the buff colour on the basal portion of the tail has entirely disappeared.

Acanthiza pusilla is a coastal species, *A. pyrrhopygia* may be considered the interior species from the same stock.

Interior forms have a zoological interest of their own, if only because of the vast extent of the region they inhabit, and the remarkable climatic conditions in which they manage to persist.

But apart from the specific changes referred to, there are genera which appear to show still more marked divergence. *Amytornis*, one of the most widespread through the vast interior, is the inland representative, as can be shown, of *Sphenura* found in coastal regions, and *Sphenostoma* is the representative of *Psophodes*. The object of this note is to point out the affinities that exist between the lastnamed.

The range of *Psophodes crepitans* is the coastal portion of the east from near Cape York round to Port Phillip, but not including Tasmania. A second species *P. nigrogularis* is found only in a restricted portion of South-west Australia. *Sphenostoma* is common throughout practically the whole of Australia with exception of the range set down for *Psophodes*, and with exception also of the northern coast.

That one is merely a pallid form of the other is shown by a closer inspection of the plumages. *P. crepitans* is olivaceous above, including the tail, to which there are white tips on three outer pairs of feathers: crown black, with elongated feathers forming a crest: large white patches are found on the cheeks, centre of breast and abdomen: rest of under surface black. Average length, 251 mm.; bill, 21 x 10 deep; wing, 95; tail, 133; tarsus, 32.

In *P. nigrogularis* the tone, brownish citrine, not so bright, is found over a greater surface of the body; there is no black on the crest, and the white on tail is reduced to the two outer feathers only, a subterminal black bar about half an inch wide is all that remains on the tail: throat is black, with thin white stripes on either side, a trace only of white on abdomen. Length of specimen, 5,532, in H. L. White Collection, National Museum, Melbourne, 215 mm.; bill, 21 x 9 deep; wing, 80; tail, 115; tarsus, 28.

Sphenostoma has plumage entirely brownish drab above, greyer beneath: the crest is developed to a fine point about an inch in length, while the tail is blackish with large white tips on all but the two central feathers. Two

primaries (fourth and fifth) show white on the outer web almost their whole length. Average length, 189 mm.; bill, 14 x 9 deep; wing, 77; tail, 95; tarsus, 24.

Young of *P. crepitans* are interesting stages. In one specimen, No. 5,527, in H. L. White collection, the crown and under surface are wholly brown with no trace of white, while No. 5,546 is advanced a stage with black only on the throat. No. 5,551 is a further stage, showing white on cheeks and centre of breast, but still brown beneath, not black like adult.

Wing formulae, as shown in the appended table, are very much alike, with this difference, that there is a development of the fifth primary in *P. crepitans*, not found either in *P. nigrogularis* or in *Sphenostoma*. In fact, the two last-named are in formula more nearly alike than are *P. crepitans* and *P. nigrogularis*.

			Primaries in mm.				
No.	Sec.	Locality.	1st	2nd	3rd	4th	5th
		Psophodes crepitans.					
5529	♂	Narrabeen, N.S.W.	37	53	66	72	76
5543	♀	Chichester, Riv.	36	51	62	68	70
5552	♂	Monbulk, Vic.	40	70	77	80	82
5533	♂	Murray Riv., Q'ld.	39	53	68	72	74
4565	♀	Ravenshoe, N. Q.	33	49	59	67	69
		Psophodes nigrogularis.					
5532	♂	Perth, W.A.	31	45	56	64	64
		Sphenostoma cristatum.					
5427	♂	Byrock, N.S.W.	36	52	59	60	60
	♀	McDonnell Rgs.	29	44	51	53	53
5428	♀	Nullarbor Plain	34	49	59	61	61
5430	♂	Carnarvon, W.A.	33	50	59	61	61
5429	♀	Carnarvon, W.A.	33	50	59	61	61

The above measurements in millimetres are taken by laying a glass scale against the underside of the wing, commencing at the base of the first primary. It will be noticed that the first primary is, in all three species, two-thirds the length of the second, and that the second is about five-sixths of the third with a slight advance (about 4%) in length of third in *P. nigrogularis*. It is in the longer primaries the greatest differences are found. The fourth primary is relatively shortest in *Sphenostoma*, which is in accord with the general trend of climatic variations shown by that species.

NOTES ON SOME ROCK WALLABIES, GENUS *PETROGALE*, WITH DESCRIPTIONS OF TWO NEW SPECIES.

By A. S. Le Souef, C.M.Z.S.

The Rock Wallabies form a well defined group, inhabiting rocky terrain all over Australia, but they do not extend into Tasmania or New Guinea.

The members of this genus, being specially adapted to live in rough rocky country, and on precipitous hill-sides, are perhaps the most agile of all the marsupials. On flat ground, they proceed by a series of short hops, quite a different gait from that of the ordinary wallabies, but, once among the rocks, they show surprising agility, and can travel at a great pace among boulders, which would baffle any other marsupial. For all their agility, however, they fall victims to very sluggish enemies, in the form of carpet snakes, which almost invariably inhabit the same class of country. Like most of the Kangaroo tribe, they have special tracks leading to and from their feeding-grounds, and it appears that the fox knows all about this habit, for the Brush-tailed Rock Wallaby has become very scarce within Reynard's range during the past few years. Skins of this species used to come into the sale rooms in bales, now it is rare to see one.

The legs of the Rock Wallabies are shorter and more robust, and the fore-limbs proportionately stronger, than those of the members of the genus *Macropus*. Their tails, too, are long and flexible, and do not form a support to the body as they do in the kangaroos. They thus, in some respects, form a connecting link between the terrestrial Wallabies and the Tree Kangaroos.

This genus naturally falls into three groups. In the south-east we have *Petrogale penicillata*, which, as in many others of our animals, gets lighter in colour towards the north. In Victoria, this species is blackish-grey, but the New South Wales specimens are lighter and brownish-grey, especially in the more open country. In Queensland, we find the closely allied *P. assimilis* and *P. godmani*, which are smaller and less conspicuously marked. In the far north they are replaced by the plain, sandy-grey *P. inornata*.

The second group is represented by the handsome *P. xanthopus* of Flinders Range, South Australia. This group was only known from a rather restricted range, but through the kindness and interest of Mr. M. Hammond and Mr. Frank Tully, I have lately received a second species from south-west Queensland. So far as is known this new species inhabits the ranges in the vicinity of the Bulloo River. The skins received came from Terachy Station, near Adavale. In writing of these animals, Mr. Tully states, "The wallaby out here seldom leaves the ranges, and I know for a fact that it can live without water in the driest summers. When there is no grass it lives on the shrubs and bushes. It can go up the face of a cliff, which is almost perpendicular."

In Central and Western Australia we have the Grey Rock Wallabies, represented by *P. lateralis*, and two very closely allied species found on Mondrain and Pearson Islands in the Australian Bight. *P. brachyotis* is found in the north-west.

In 1904 a Rock Wallaby was described by Thomas (Nov. Zool., xi., p. 366) as *P. rothschildi* from the Cossack River, near Roebourne, North-west Australia. This is a rather plain coloured animal with practically no markings, but it has two peculiarities, the hair on the nape being reversed and purplish in colour. This last is described by Thomas as brown, but my brother, who has observed

and collected this species near Roebourne, states that the colour of the nape is purple in the live animal, so I assume it had faded to brown in the holotype. As this species was described from a skin only, its relationship cannot be satisfactorily determined until a skull is available.

Through the kind offices of Mr. Wilson B. Sinclair, of Ardmore Station, Dajarra, North-west Queensland, I have lately received a skin and skull of another very distinct species of Rock Wallaby, though two of its characters approach those of *P. rothschildi*—the hair on the back of the neck is inclined to be reversed, and the colour of the base of the hair on that part is pinkish purple or puce. The back is grey, irregularly mottled with blackish and tawny-brown, while the lateral and occipital markings are indistinct. It is interesting to note that this eastern species is found in about the same latitude as the western *P. rothschildi,* and only *P. lateralis* has been recorded from the intermediate central districts (Horn. Exped. Zool., p. 15). The skull characters of the new species are rather similar to those of *P. penicillata.*

Mr. Sinclair, who is much interested in the native animals, gives the following splendid account of the habits and habitat of this new wallaby. "Rock Wallabies are fairly numerous here, though I gather from men who have been in the locality for the past ten years, that they seem to be decreasing in numbers. I reside just on the edge of the vast open downs, which stretch for hundreds of miles, extending westward into the Territory. To the east is very rough and mountainous country. Here is a great granite intrusion that reaches almost to the edge of the downs, and huge granite boulders are strewn about the surface of the ground everywhere. At intervals, are little round hills, averaging 150 feet above the surrounding level, and appearing as heaps of huge granite boulders which someone had gathered and thrown together. These are the homes of the Rock Wallabies. In the early morning and late in the evening they can be seen sitting about on the rocks everywhere, and climbing about on the little hills. Old skeletons are noticeable in the small caves, crevices, and other places under the rocks. When one takes the trouble to explore these hills and sees the natural protection they afford the wallabies, one naturally comes to the conclusion that the animals should increase in numbers, but I think the number dying from natural causes, together with those killed by the Wedge-tail Eagle and occasionally by Dingoes, about balance the scale of life. The Eagles are, I think, their worst enemies. I often see them sitting on the rocks when riding by."

The types of the two species described in the following pages are in the Australian Museum, and I wish to thank the Director of that Institution for permission to examine specimens in the collection under his charge, and Mr. E. Le G. Troughton for reviewing the material and the descriptions.

Petrogale celeris, sp. nov.

Related to *xanthopus* but smaller. General colour of back, varying shades of grizzled greyish-brown (about wood brown, of Ridgway, tinged with grey), the grey predominating on the nape and between the shoulders; the brown is darker down the centre of the back. A well defined blackish-brown streak runs from the crown, down the upper back, becoming ill defined on the rump, but showing distinctly through the reddish cinnamon patch on the tail-base, thence continuing along the tail to its tip. Forepart of shoulders, and front and inner side of arm to wrist pinkish cinnamon; forepart of thigh, and over knee to ankle, cinnamon. Hindpart of shoulders and forearm, and inner part of upper thigh, bister. A narrow buffy-white lateral streak runs from wither to hip, and is separated by a dark line from the buffy-white under surface. There is a conspicuous patch of reddish cinnamon at the base of the tail, which is more prominent than a somewhat similar patch in *xanthopus.* Face, varying shades of

grey, suffused with tinges of cinnamon; a well defined whitish cheek stripe present. Back of ear uniform sayal brown; inner sides edged with white for basal half (tips missing on skins). A light spot above the eye, but of sayal brown rather than the "rich orange" spot of *xanthopus*. Forepaws blackish-brown. Hind-foot, light tawny-olive, becoming dark brown on the toes, with black hairs covering the tip of the longest toe. The tail is shorter haired than that of *xanthopus;* in the female the dark brown line along the tail is widened into blotches at regular intervals, which are faintly extended laterally, thus producing an effect of ill defined annulations of blackish-brown, alternating with light greyish buffy-brown. In the male the dark tail stripe is very ill defined, and correspondingly the blotches are but faintly indicated; the annulations are barely discernible, except for a few inches at the tail-tip.

The type skull is that of a female, which is not quite adult; there are no notable features distinguishing it from the skull of *xanthopus,* the shape of the nasals and size of the teeth conforming to those of the latter species.

Dimensions of type, flat skin:—Head and body, 600; tail, 565; hind-foot, 158 mm.

Skull:—Basal length, 88; greatest breadth, 52; nasals:—length 38, greatest width 14, least width 7; constriction breadth, 17; palate length, 54; breadth outside m^2 26; diastema, 20; i^3 5 mm.

Hab.—Ranges in the vicinity of the Bulloo River, South-west Queensland. Type from Terachy Station, near Adavale.

Type.—Nearly adult female, Australian Museum collection, M.3219. A flat skin of a male, M.3220 also examined. Both specimens were donated by myself.

Comparison with Ally.—By its general colouration *celeris* is clearly related to *xanthopus* of South Australia. The general colour of the back is not so uniform as in *xanthopus,* but as the white markings of *celeris* are washed with buff, the actual markings are not glaringly contrasted as in *xanthopus.* The striking white hip patch of *xanthopus* is absent in *celeris,* the lateral stripe of the latter being buffy-white and only about half as broad as in *xanthopus,* therefore it does not present the striking contrast made by the broad, clear white lateral stripe of the latter.

Externally *celeris* may be distinguished from *xanthopus* by the absence of the large white hip patch, the narrow and rather inconspicuous buffy-brown lateral streak, and the shorter haired tail with the absence of definitely ringed annulations.

Petrogale purpureicollis, sp. nov.

Fur short, and very soft. General colour above pale grey (about light drab), irregularly marbled with black or brown, interspersed with fleckings of a shade of buff; the colours tending to form short lines. Under surface a lighter buffy-grey. Hair on the back of the neck radiating laterally from the centre and washed with brownish vinaceous with grey tending to predominate on the nape, whereas the former colour predominates on the crown, fading into a lighter wash on the cheeks and throat. A dark brown mark commences before and extends over the eye to the ear-base. Nose, from tip to front of eye, darker than the rest of the head. There is a paler patch under the eye, which does not form a cheek stripe. Ears parti-coloured behind; upper forepart of outside dark mummy-brown; lower forepart and entire posterior half of outside of the ear lighter, brownish-buff. No lateral stripe is discernible, though, as usual, the sides are lighter. Edging the back of the shoulder and extending onto the side is a strongly defined irregular patch of blackish-brown; the outer edge of this patch is dark tawny-brown, which colour extends down the back of the arm. Front of arm,

cinnamon-buff, suffused with tawny-olive; paws, sayal brown, outer digits blackish-brown, which gives way to rich dark brown on the inner ones. A prominent blackish-brown streak commences a little below or on the knee, and extends over the knee and up the side almost half-way to the wither. The outside of the hip is lighter, but there is no distinct stripe. Front of legs tinged with buffy-grey. The foot is light ochraceous-buff near the ankle, pencilled with brown, which is darker along the centre of the foot, grading into blackish-brown on a level with the toes; the hairs are black on the longest toe. Tail short-haired to about the terminal fourth, upon which the hairs gradually lengthen, forming a slight tuft at the tip; general colour of proximal two-thirds tawny-olive, pencilled with grey, buff and brown, the terminal third gradually darkening from blackish-brown to black at the tip.

Skull.—Of the *assimilis-penicillata* type. Adult skulls of both sexes have a basal length of over 90 mm., associating the species with the larger varieties in section A. of Thomas' key. The interorbital region is more markedly concave than in *penicillata* or *lateralis*, though the depth is variable. The skull is proportionately shorter, broader, and more heavily built, and the diastema is considerably shorter, than in *penicillata*. Supraorbital edges sharp and flattened, inclining to be inflected upwards, the ridges converging to a varying degree behind. The sides of the muzzle are not inflated to the same degree as in *penicillata*, but are slightly and evenly convex, dropping more sharply downward from the edges of the nasals. Size of the teeth much as in *penicillata;* p^4 broader anteriorly.

Dimensions of the type, flat skin:—Head and body, 670; tail, 510; ear, 50 mm. The hind-feet of two other specimens, male and female, each measure 150 mm.

Skull:—Basal length, 94.5; greatest breadth, 57.5; nasals:—length 44, greatest breadth 13, least breadth 7; constriction, 14; palate length, 61.5; breadth outside, m^2 29.3; diastema, 16.5; i^3 3.5; p^4 7.5 mm.

Hab.—Dajarra, North-west Queensland.

Type.—Aged male, in the Australian Museum collection, M.3405. Flat skins of two males and two females also examined. All the specimens have been donated to the Australian Museum.

Variation.—Five flat skins show the colour to be extremely variable in shade, but the markings described above are consistently present, though they may vary in density. All the skins are irregularly marked with shades of a rich tawny-brown, mostly between the shoulders and on the tail-root; one skin in particular, secured in the autumn, is heavily mottled with the tawny-brown, which is deepest at the tail-base. This mottling suggests that the colour undergoes a drastic change to the winter coat described above, and, if this supposition is correct, the summer pelage is probably of a much richer colour, with the tawny-brown predominating; doubtless the general colour would still be decidedly mottled. The cheek of one skin is washed with rich pinkish-cinnamon, while the other cheek is a light buffy-grey. The colouration of the tail is very variable in shade, though the basal half to two-thirds is consistently lighter than the remainder, and varies from tawny greyish-brown to clay colour, mixed with grey. In the females the final two and a half inches of the tail is lighter than in the male, dark-brown predominating, whereas in the males the dark colour covers the distal quarter of the tail and is blackish-brown.

Measurements of seven crania show the diastema to be consistently shorter than in adult *penicillata;* six specimens have the diastema measuring from 13.5 to 17.5, the seventh, an adult female, measuring 19 mm. These measurements serve to indicate the shorter and broader nature of the skull.

Comparison with allies.—Of the *P. penicillata-assimilis-rothschildi* group this

species is distinguished from the two former by having at least the basal half of the tail much lighter than the rest, instead of blackish-brown or black for the whole length. From *rothschildi* it is distinguished by its parti-coloured ears, and from *lateralis* by the absence of the white lateral streak and flank patch characteristic of the latter. *P. godmani* differs from *purpureicollis* in having the tail drabby whitish for its terminal third or half instead of grading from blackish-brown to black at the tip as in the latter species.

The specimen described above was taken early in June; one taken a month earlier was darker in general colour and heavily flecked with rich tawny-brown, indicating that the summer pelage is more rufous or tawny in tone. The purple colouration on the neck and face is very fugitive and soon fades; referring to this, Mr. Sinclair writes: "When I secured the specimen sent along, the pink round the neck was very marked, but after the skin was pegged out and dried it seemed to fade."

REVIEW.

A Synopsis of the Vertebrate Animals of Tasmania, by Clive E. Lord and H. H. Scott, Hobart, 1924. (21/-).

In a handy octavo volume of 340 pages the authors of this welcome addition to Australian zoological literature have compressed a wealth of information. The fishes, birds, reptiles and mammals of the Island State are faithfully listed, briefly but clearly described, in some cases figured, and in every case a reference given to the original author's description. The work does not claim to be more than a synopsis of the species, but it will serve admirably as a handbook for the use of beginners and students alike. The notes as to the frequency or rarity of occurrence of many species are of considerable value, and the authors have been careful to state the evidence in most instances where the records are of occasional or accidental visitors. In some cases, for instance, the Sooty Tern and the Fleshy-footed Petrel, one would appreciate a more definite reference. The fact that Alexander places the latter as breeding in the south-west region of the Australian coast line hardly qualifies the bird for inclusion in the Tasmanian list; and that the "Sooty Tern is more plentiful in the tropical seas than around the coasts of Tasmania, but . . . . an occasional bird or so wanders south" is slender evidence upon which to base its inclusion in the Island fauna.

While commending the authors upon the concise but comprehensive nature of their text, it is not possible to compliment them upon the illustrations. Many of the plates from original photographs are lacking in clearness, and the text figures in outline are unnecessarily large, occupying space which could have been more usefully employed otherwise. Further, some of these outlines, notably that purporting to depict the head of the Crested Grebe, are more like cubist drawings than the objects they are intended to illustrate.

That the responsibility as regards cost of production was allowed to fall largely upon one of the authors is a reflection upon the liberality of the Tasmanian Government and the local scientific societies alike. Had some assistance been forthcoming from either or both of these sources, the work might have been published at a more popular price.

A MONOGRAPH OF THE AUSTRALIAN LORICATES.

(Phylum Mollusca—Order Loricata).

By Tom Iredale and A. F. Basset Hull.

III.

Ischnochiton distigmatus.

(Plate xxxv., fig. 2).

Ischnochiton distigmatus Hull. Proc. Roy. Soc. Queensland, xxxvi., 1924, p. 111, Pl. xxi., f. 1. Type in the Queensland Museum.

Shell small, elongate oval, not carinated. Colour purplish-brown when alive, much of the purple disappears when the shell is dry; a dark purple spot on each side of the jugum near the posterior margin of valve iv. The sculpture of the whole shell is finely granulose, graduated in quincunx. The lateral areas of the median valves are raised, but there is no differentiation in the sculpture.

Posterior valve larger than the anterior, with mucro rounded, slightly in front of the middle; posterior slope convex.

Girdle densely packed with small, elongated, lozenge-shaped scales directed backward and outward; not striated; on the underside there are closely packed spicules, radiating outwards from the sutural margins to the outer edge of the girdle.

Interior bluish-white; anterior valve interiorly grooved and with about nine rudimentary slits, median valves 1-1 (in one case there are two obscure slits on one side); posterior valve crenulated but unslit.

Dimensions: 8 x 4½ mm.

Station: On the under side of small stones embedded in the sand between median and low water mark.

Habitat: North Head, Port Denison, Queensland.

Remarks: This shell is easily distinguishable from *Ischnochiton luticolens* Hull, with which it is found associated, by the absence of any marked differentiation in the sculpture on the lateral areas; the uniform colouration, and the shape of the posterior valve, which in *I. luticolens* has the mucro considerably in front of the middle and the posterior slope is concave. It differs from *Subterenochiton gabrieli* Hull in the obscurely slit median valves. It is a degenerate species intermediate between *Ischnochiton* and *Subterenochiton,* the insertion plates and slitting becoming obsolete, and the girdle scales approaching the elongate spiculose character of those of the *Lepidopleuridae.*

Genus Subterenochiton.

Subterenochiton Iredale and Hull, Aust. Zool., iii., 1924, 227. Type by original designation *Ischnochiton gabrieli* Hull.

Shells of small size for the family, of modest colouration, elongate oval, elevated, sculpture of quincuncially arranged pustules, generally simple. Girdle scales small, smooth, imbricating, irregular. Insertion plates weak, showing slitting in anterior valve only.

The species may be separated by means of elevation and girdle scales.

Subterenochiton gabrieli.

(Plate xxxv., fig. 1. Plate xxxvii., figs. 1-6).

Ischnochiton gabrieli Hull, Proc. Roy. Soc. Vic., xxv., 1912, 120, Pl. viii., f. 1 a-f. Type in coll. Gabriel.

Shell small, elongately oval, elevated, subcarinated, side slopes steep and straight. Colour uniformly pallid, of various shades of cream and pink mottled and streaked with yellowish brown.

The whole shell is granosely quincuncially sculptured, but no radiation of grains is at all discernible. Senile shells show concentric growth lines on all valves. The lateral areas of the median valves are well elevated and notably narrowed; and the grains are a little more regular towards the edges.

Posterior valve with mucro slightly post-median.

Girdle fairly wide; scales very small.

Interior white. Slits 10-0-0. Sutural laminae large, broad, distant.

Dimensions: 6 x 4 mm.

Station: Dredged in five to twenty fathoms.

Habitat: Victoria; New South Wales.

Remarks: This species is apparently common in Sydney Harbour, having been dredged in numbers near the Sow and Pigs Reef by Brazier fifty to sixty years ago, and by Hull in 1911. The type was dredged in Western Port, Victoria, by C. J. Gabriel.

Subterenochiton bednalli.

(Text-fig. a).

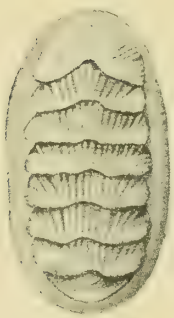

Fig. a

Ischnochiton bednalli Torr, Trans. Roy. Soc. S. Aust., xxxvi., 1913, 166, Pl. v., f. 3 a-f. St. Francis I., Nuyts Archipelago, South Australia. Type in coll. Torr.

Shell small, elliptical, valves wide, rounded, slightly carinated, side slopes curved. The posterior margins of the valves project considerably and give a verandah-like appearance. The valves are exceedingly delicate. Colour uniform cream.

Anterior valve having about twenty microscopically pustulose lirae converging towards the apex, with two or three ill-developed growth lines parallel to the girdle.

Median valves: Lateral areas distinctly raised and crossed transversely with four rows of pustulose lirae converging towards the dorsal area; four of these pustules project from the posterior margin; central areas divided into five irregular diagonal rows of pustules by reticulated sulci, giving the appearance of open network; dorsal area uniform in width, composed of five or six rows of pustules either worn or compressed.

Posterior valve with mucro ante-median, almost covered by the seventh valve; post-mucronal area concave. The mucro is covered with pustules, and the rest of the valve has two or three concentric rings of pustulose lirae parallel to the girdle; the pustules become smaller towards the mucro.

Girdle scales microscopically striated.

Interior pearly-white. Anterior valve with about twenty slits with regularly scalloped pectination between. Median valves showing diminutive slit rays under ¼ in. lens. Posterior valve with about twenty-six slit rays. Sutural laminae small and delicate. Sinus very wide.

Dimensions: 6 x 3 mm.

Station: ?

Habitat: St. Francis Island, Nuyts Archipelago, South Australia.

Remarks: Two examples were taken by the author, who has kindly lent us the type for examination. From its peculiar slitting we have included this species in *Subterenochiton*, owing to the absence of definite slits in the median and posterior valves, though the scales are finely striated.

The above description is that of the author, slightly adapted to the form used in this Monograph, and we have little to add to it, except that the gills are posterior, thus indicating the close relationship of the animal to those of the genera *Terenochiton* and *Parachiton*.

Genus Heterozona.

Heterozona Dall, Proc. U.S. Nat. Mus., 1878, 331. Type by monotypy *Heterozona cariosa* Carpenter.

Heterozona Pilsbry, Man. Conch., xiv., 1892, 65. Type by original designation *Ischnochiton cariosus* Pilsbry.

Shells of large size for the family; colouration of species constant and subdued; sculpture as in *Ischnochiton*, but girdle scaling peculiar: the girdle scales near the valves become larger and even irregularly elongated, while those on the outer half of the girdle remain small and regular; all scales finely striated, the larger ones even deeply grooved; the insertion plates as in *Ischnochiton*.

Heterozona fruticosa.

(Plate xxxv., fig. 3).

Chiton fruticosus Gould, Proc. Bost. Soc. Nat. Hist., ii., 1846, 142, New South Wales. U.S. Expl. Exped., 1859, 319, f. 428. Otia, 1862, 4, 242. Type lost, or in Acad. Nat. Sci. Philad.

Chiton divergens Reeve, Conch. Icon., iv., 1847, Pl. viii., sp. and f. 44. New Holland (Jukes). Type in Mus. Cuming in Brit. Mus.

Chiton (*Callistochiton*) *coppingeri* Smith, Zool. Coll. Alert, 1884, 80, Pl. vi. Port Jackson, New South Wales. Type in Brit. Mus.

Ischnochiton fruticosus Pilsbry, Man. Conch., xiv., 1892, 91, Pl. 23, f. 78-80.

Ischnochiton sowerbyi Pilsbry, *loc. cit.*, 92, ex Carpenter M.S. in synonymy Type in Brit. Mus.

Shell elongately oval, rather depressed, round-backed but semi-carinated; minutely quincuncially punctate throughout. Colour (a) buff or pale brown, greenish or pale blue, with broad light or whitish dorsal stripe; (b) wholly buff, dark brown, or blackish; girdle sometimes barred.

Anterior valve having from 30 to 50 radiating ribs, sometimes splitting towards the margin; apex smooth; posterior edge of valve semi-nodulose.

Median valves: Lateral areas with three or more strong ribs, divaricating towards the margin; posterior edge irregularly obliquely toothed with elongate pustules; central areas with fine zig-zag striations in the jugum, these striations becoming more pronounced laterally, and at the edges of the valves becoming irregular linear ridges, more noticeable in older shells.

Posterior valve with mucro ante-median; post-mucronal area depressed and slightly concave behind; ante-mucronal area as in median central areas; post-mucronal area having long irregular pustules, massing more or less into radiating ribs, but more irregular than on the anterior valve. Some specimens show fairly regular ribs towards the edge only, and below the mucro only quincuncial punctation.

Girdle wide; scales very small near the shell, becoming microscopic at outer edge; striated.

Interior bluish-white, often with brown rayed markings in the centre of the terminal valves. Slits 12-1-12. Sutural laminae broad and distant.

Dimensions: 35 x 28 mm.

Station: Between tide marks, under stones; frequently found in muddy situations.

Habitat: Southern Queensland, New South Wales, Eastern Victoria, South Australia (one example), Tasmania (doubtful record).

Remarks: This is one of the common species found on the eastern coast of Australia; the single example reported from South Australia was collected at Sultana Bay by Mr. E. H. Matthews, and it is a typical shell.

Heterozona cariosa.

(Plate xxxv., fig. 5).

Heterozona cariosa Dall, Proc. U.S. Nat. Mus., 1878, 331. Description indeterminate.

Ischnochiton cariosus Pilsbry, Man. Conch., xiv., 1892, 65, Pl. xxiv., f. 20-22, ex Carpenter M.S. Australia. Type Acad. Nat. Sci. Philad. May, Illus. Index Tas. Shells, 1923, Pl. xv., f. 5.

Ischnochiton subcariosus Pilsbry, *loc. cit.* 67, Australia. Type Mus. Cuming in Brit. Mus.

Anisoradsia mawlei subsp. *saundersi* Ashby, Trans. Roy. Soc. S. Aust., xlii., 1918, 82. Port Lincoln, South Australia. Id. ib., xliii., 1919, 73 (correction). Type in coll. Ashby.

Ischnochiton auratus Ashby, Trans. Roy. Soc. S. Aust., xliv., 1920, 227, Pl. xii., f. 6a and b. Marino, South Australia. Type in coll. Ashby.

Ischnochiton (*Heterozona*) *properensis* Ashby, Ib., 1920, 278, Pl. xii., f. 7a and b. Proper Bay near Port Lincoln, S.A. Type in coll. Ashby.

Ischnochiton (*Heterozona*) *cariosus* var. *occidentalis* Ashby, ib., xlv., 1921, 42. Western Australia. Type in coll. Ashby.

Shell large, depressed, round-backed, elongately elliptical. Colour generally pale yellow to orange, buff, and dark brown; young examples showing a darker streak along the jugum and on the outer margins of the valves.

Anterior valve irregularly rayed, the ribs, about twenty, springing from an almost smooth apex, divaricating by intercalation and increasing to about fifty at the edge, scarcely nodulose; the posterior edges irregularly obliquely dentate; concentric growth lines sometimes strongly represented.

Median valves: Lateral areas irregularly rayed with four to six rays, a few divaricating and becoming nodulose through the breach in continuity caused by the growth lines; others more irregularly nodulose, the posterior edge with large oblique pustules more prominent in younger shells; central areas rather strongly longitudinally ribbed at sides, delicately engraved in zig-zag on the jugum, the sculpture laterally very variable in strength.

Posterior valve with mucro slightly in front of the middle, posterior slope straight; post-mucronal area irregularly rayed with elongate pustules coalescing with age into ribs; ante-mucronal area sculptured as in central areas of median valves.

Girdle broad; scales of two sizes, those nearest the shell larger than the outer series, but in both cases individual scales increase erratically, and near the margin sometimes become tall, semi-curved turrets, notably striate: all scales deeply grooved with eight to twelve grooves; flattened. Some shells show a perfectly normal scale covering until more than half-grown, others show peculiar scale formation at an early age.

Interior white, sometimes shaded with red in centre of posterior valve. Slits 12-1-12.

Dimensions: 52 x 22 (maximum size of a series from Port Fairy, Victoria).

Station: Under stones between tide marks; probably sessile when adult, as old shells are frequently attacked by parasitic growths.

Habitat: Victoria, Northern Tasmania, South Australia, South Western Australia.

Remarks: This is a common and remarkably variable species. We consider that the shells separated by Ashby and included in the above synonymy are merely individual variations and not constant local varieties. The sculpture varies from coarse to fine; the colouration is strongly affected by the nature of the rock, ironstones producing dark red-brown shells and granites producing grey with darker margins; while the girdle scales vary a great deal.

Heterozona subviridis.

(Plate xxxv., fig. 4).

Heterozona subviridis Iredale and May, Proc. Mal. Soc., xii., 1916, 105, Pl. iv., f. 2. Port Arthur, Southern Tasmania. Type in Tasmanian Museum.

Ischnochiton subviridis May, Illus. Index Tas. Shells, 1923, Pl. xv., f. 6.

Shell medium to large, rather depressed, scarcely carinated but sometimes a little angulate, side slopes slightly convex. Colour a little variable, generally blue-green, striped along the jugum with white, extremes of colour deepening to blue black or becoming pale cobalt blue; rarely reddish brown.

Anterior valve rayed closely with about 50 flattened fairly regular ribs, intercalating with age; apex smooth; concentric growth lines deeply marked on all adult shells, but rarely forming nodules.

Median valves: Lateral areas having eight or nine close-set rays, sometimes broken into nodules by concentric growth lines, posterior edges feebly denticulate; central areas finely wrinkled in zig-zag on jugum, towards the edge the linear wrinkles become wavy.

Posterior valve with mucro ante-median; post-mucronal area rayed as in anterior valve but less regularly and more nodulose; ante-mucronal area as in central areas of median valves.

Girdle wide, scales of two sizes, those near the shell larger than the outer series and tending to mucronate and lengthen. All the scales are very small compared with those of the preceding species, those on the outer edge being microscopic; all scales are striate. (Plate xxxvii., fig. 11).

Interior bluish-green, centre of posterior valve marked with purplish. Slits 11-1-12.

Dimensions: 30 x 16 mm. (Type). 50 x 24. (Maximum of series from Port Arthur, Tasmania).

Station: Under stones between tide marks.

Habitat: Tasmania, Victoria.

Remarks: This shell is very plentiful on King Island, Bass Strait. Iredale and May noted that two variations in shape occurred, one narrow and high, the other broader and lower, and suggested that these varieties might be sexual.

Genus Strigichiton.

Strigichiton Hull, Aust. Zool., iii., 1923, 195. Type by original designation *Ischnochiton verconis* Torr.

Shell of large size for the family, of dull colouration; broad rounded oval; sculpture complex and peculiar; girdle scales semi-erect, deeply grooved, of dif-

ferent sizes. Insertion plates strong, teeth sharply defined, not pectinated, but suggestions of denticulation. Slits 12-1-12.

Strigichiton verconis.

(Plate xxv., fig. 10. Plate xxxvii., figs. 12, 13).

Ischnochiton verconis Torr, Trans. Roy. Soc. S. Aust., xxxv., 1911, 102, Pl. xxiv., f. 1 a-f. Type in coll. Torr.

Shell large, rounded oval, depressed, semi-carinated, side slopes convex. Colour slaty greyish-green, longitudinally marked with paler.

Anterior valve small, very finely rayed with from eighty to one hundred flattened riblets, growth lines forming semi-nodulose pustules towards the edge.

Median valves: Lateral areas little raised, radially ribbed with fine flattened rays, twenty being counted at edge, and all semi-nodulose through the intersection of growth lines; central areas sculptured rather finely on jugal area with zig-zag ribs which strengthen and extend broadly towards the edges; all ribs flattened.

Posterior valve larger than anterior valve; mucro median, post-mucronal slope a little concave; ante-mucronal area sculptured as in central areas of median valves; post-mucronal area as in anterior valve, about eighty flattened ribs.

Girdle broad; scales large, mucronate, semi-erect, semi-circular in section, deeply grooved with six to ten grooves. (Plate xxxvii., fig. 13).

Interior white, with red-brown rays in anterior and posterior valves. Slits 12-1-12. Sinus between the sutural laminae very broad.

Dimensions: 44 x 28 mm. (Type). 47 x 29 mm. (Hopetoun example).

Station: Under large stones below low water mark.

Habitat: Western Australia (Hopetoun in the Great Australian Bight to Bernier Island on the central western coast).

Remarks: The type of this remarkable species was a unicum taken by Dr. Torr, at Ellenbrook, South-western Australia, in 1910. Hull took two at Hopetoun, about 100 miles east of Esperance Bay, and a single example in the Perth Museum was taken on Bernier Island, Sharks Bay. The range is therefore fairly wide, although the shell is exceedingly rare. It is very active, moving rapidly over the stone when exposed to the light. The girdle scales are the most remarkable feature, the grooving being very deep.

Genus Autochiton.

Autochiton Iredale and Hull, Aust. Zool., iii., 1924, 227. Type by original designation *Ischnochiton torri* Iredale and May.

Shells small to large, of varied colouration; elongate oval; sculpture of *Ischnochiton* generally suppressed or forming elongate pustules through longitudinal concentric growth lines; girdle scales very small, closely imbricating, striated. Insertion plates normal, sutural laminae widely separated, projecting forward.

The three species here associated on account of their weak sculpture, coupled with very small girdle scales, may not be phylogenetically allied. Thus *A. virgatus* develops strong sculpture on the lateral areas in Western Australian examples, and is otherwise aberrant in colouration and size; it may therefore be distinguished by the new subgeneric name *Euporoplax*. The species *A. wilsoni* is as different in its distinctive colour, keeled shape, and smooth glossy surface, and may be differentiated subgenerically by the new name *Euretoplax*.

Autochiton torri.

(Plate xxxv., fig. 6).

Ischnochiton torri Iredale and May, Proc. Mal. Soc., xii., 1916, 111, Pl. v., f. 3. Cape Barren Island, Flinders Group, Bass Strait. Type in Tasmanian Museum. May, Illus. Index Tas. Shells, 1923, Pl. xv., f. 1.

Ischnochiton ustulatus Pilsbry, Proc. Acad. Nat. Sci. Philad., 1894, 70, footnote, and subsequent writers to 1916.

Shell large, elongate oval, round-backed, side slopes rounded, moderately elevated. Colour cream longitudinally flamed with brown, anterior valve often uniformly red-brown (burnt sienna).

Anterior valve with about fifty rays, sometimes traversed by concentric growth lines.

Median valves: Lateral areas raised, rayed in senile shells, rays strongly concentrically cut, forming elongate pustules; valve vii. always most strongly sculptured; central areas very finely decussate in quincunx, a little coarser and tending to linear arrangement laterally.

Posterior valve with mucro elevated, ante-median; post-mucronal slope a little concave; ante-mucronal area sculptured as in central areas of median valves; post-mucronal area showing faint radials, concentrically pustulose.

Girdle broad, scales very minute elongate ovals, flattened, closely imbricating, striate. (Plate xxxvii., fig. 17).

Interior bluish-white, with centre of end valves and of median valves purplish. Slits 12-1-15.

Dimensions: 42 x 20 mm.

Station: Under stones below low water mark.

Habitat: South Australia, Victoria, Islands of Bass Strait.

Remarks: This is a fairly active species, except in senile examples, which become sessile. The elongate shell, constant notable colouration, and minute girdle scales have suggested that it may be representative of the stock whence *Stenochiton* was derived, the colouration of *S. juloides* being very similar in essence.

Autochiton virgatus.

(a) Autochiton virgatus virgatus.

(Plate xxxv., fig. 7).

Chiton virgatus Reeve, Conch. Icon., iv., 1847, Pl. xxviii., sp. and f. 192. Port Lincoln, South Australia. Type in Mus. Cuming in Brit. Mus.

Ischnochiton virgatus Pilsbry, Man. Conch., xiv., 1892, 78, Pl. 8, f. 72, 73. May, Illus. Index Tas. Shells, 1923, Pl. xv. f. 2.

Shell small, elongate oval, round backed, not much elevated. Colour olivaceous, varied with yellowish, and spotted with blue-green, a generally well defined colour pattern. The whole shell minutely quincuncially punctate.

Anterior valve faintly striate, rarely concentrically pustulose near the edges.

Median valves: Lateral areas small, smooth, but with elongate pustules concentrically arranged appearing on senile shells.

Posterior valve with mucro ante-median (anterior third); post-mucronal area concave; a few elongate pustules round the edge.

Girdle scales minute, striate.

Interior: Bluish-white. Slits 12-1-12.

Dimensions: 5 x 2 mm. (Type). 11.5 x 4.5 mm.

Station: Under stones between tide marks.

Habitat: South Australia, Victoria, Islands of Bass Strait.

(b) AUTOCHITON VIRGATUS EXAGGERATUS, n.subsp.

Shell medium, generally of a dark brown or blackish colour, with faint blue spots; sometimes creamy white. The terminal valves and the lateral areas of the median valves are strongly sculptured with pustules concentrically arranged.

Dimensions: 14 x 6½ mm.

Habitat: South Western Australia (King George Sound).

Remarks: This subspecies differs from the dominant form in its much greater size, darker colouration, and marked sculpture.

AUTOCHITON WILSONI.

(Plate xxxv., fig. 8).

Ischnochiton wilsoni Sykes, Proc. Mal. Soc., ii., 1896, 89, Pl. vi., f. 1, 1a. Port Phillip, Victoria. Type in Nat. Mus. Melb.

Ischnochiton levis Torr, Trans. Roy. Soc. S. Aust., xxxvi., 1913, 168, Pl. vi., f. 6 a-f. Edithburg, South Australia. Type in coll. Torr.

Shell medium, moderately elevated, semi-carinated, oval, glossy, side slopes a little convex. Colour pinkish-white, longitudinally marked with pinkish-brown linear separated markings on the central areas, and similar markings radially arranged on terminal valves and lateral areas of median valves.

Anterior valve very minutely decussate.

Median valves similarly decussate: Lateral areas only indicated by a slight elevation; growth lines indistinct.

Posterior valve with mucro median, elevated; post-mucronal slope concave, having a faint radial ribbing, only seen at the extreme edge.

Girdle broad, colour pale yellowish or flesh, with scattered black spots. Scales very small, imbricating, rounded, each having five deep grooves. (Plate xxxvii., fig. 10).

Interior white with pink tinge. Slits 9-1-10.

Dimensions: 16 x 8. (Type). 26 x 14. (Maximum).

Station: Dredged in shallow water; rarely found under stones below low water mark.

Habitat: Victoria, South Australia.

Remarks: This is a very rare species, notable for its distinctive colouration, lack of sculpture, and minute girdle scales.

Genus STENOCHITON.

Stenochiton H. Adams and Angas, Proc. Zool. Soc., 1864, 193. Type by monotypy *Stenochiton juloides* H. Adams and Angas.

Zostericola Ashby, Trans. Roy. Soc. S. Aust., xlii., 1918, 84, *nom. nud.* Ib. id., xliii., 1919, 66. Type by original designation *Stenochiton pilsbryanus* Ashby.

Shells small to large, but very narrowly elongate owing to their station; brightly coloured with glossy surface; sculpture indefinite; girdle scales small, flat, lozenge-shaped, smooth and highly polished. Insertion plates sharp, not pectinated, numerous in terminal valves, from two to four on each side in median valves; sutural laminae large, separated. The species are all restricted to the Adelaidean region.

STENOCHITON LONGICYMBA.

(a) STENOCHITON LONGICYMBA LONGICYMBA.

(Plate xxxvi., fig. 9).

Chiton longicymba Blainville, Dict. Sci. Nat. (Levrault), xxxv., 1825, 542. Ile King, *errore* = Kangaroo Island. Type in Paris Mus.

Stenochiton juloides H. Adams and Angas, P.Z.S., 1864, 193. Holdfast Bay, South Australia.

Schizochiton nympha Rochebrune, Bull. Soc. Philom. Paris, 7th ser. viii., 1884, 36. Ile King (ex Peron and Lesueur) based on Blainville's type of *C. longicymba* (*vide supra*). Type in Paris Mus.

Ischnochiton (*Stenochiton*) *juloides* Pilsbry, Man. Conch., xiv., 1892, 55, Pl. 16, f. 6-8.

Ischnochiton (*Stenochiton*) *nympha* Thiele, Rev. Syst. Chitonen, pt. II., 1910, 84, Pl. viii., f. 36-39.

Stenochiton longicymba Iredale and May, Proc. Mal. Soc., xii., 1916, 104.

Stenochiton juloides Ashby, Trans. Roy. Soc. S. Aust., xlii., 1918, 76, Pl. xiii. and xiv., f. 3, 8, 9, 10 (review).

Shell large, very narrow, elongated, about six times as long as broad, round-backed, elevated, glossy. Colour generally rich purplish-brown flamed with white along the central areas, uniform on anterior valve, lateral areas, and post-mucronal area, girdle banded.

The whole shell is minutely quincuncially reticulate.

Anterior valve smooth, convex.

Median valves: Lengthening from valve ii. to vii., the second valve nearly as long as broad, the sixth and seventh longer than broad: lateral areas large, conspicuously raised, as long as or longer than broad; growth lines pronounced.

Posterior valve with mucro post-median at about posterior third; post-mucronal slope a little concave.

Girdle narrow at sides, wider at ends; scales very small, lozenge-shaped, glossy. (Plate xxxvii., fig. 16).

Interior bluish-white. Slits, anterior valve fifteen to twenty, median valves two to four, posterior valve fifteen to twenty. The normal slitting is probably 15-3-15, many examples showing inter-slitting.

Station: Between the blades or within the root sheaths of sea-grasses (*Zostera*, etc.), occasionally on bottles or other smooth objects, below low water mark.

Habitat: South Australia.

Dimensions: 41 x 6 mm. The smaller shells are broader in proportion to length.

Remarks: Through a misusage of the species name *longicymba* given by Blainville to this species, the type of *Stenochiton* has been long known by the name *juloides* given many years later. Rochebrune found Blainville's type and, as was his wont, redescribed it as a new species, effectually masking its recognition by the selection of an unconformable genus. The correct generic location of Rochebrune's species was shown by Thiele from an examination of Rochebrune's type, and Thiele gave figures substantiating his conclusions. Iredale and May, familiar with Rochebrune's idiosyncrasies, recognised in Thiele's figures the long-lost *longicymba* of Blainville. As Hull and Ashby did not meet with the species on King Island, and Hull found it very common at King George Sound, West Australia, Hull suggested that the latter locality was the source of Peron's specimens. Re-examination of the series collected, however, has shown that the West Australian shell differs very appreciably from that from South Australia, and comparison with Thiele's figures shows that the latter locality is the correct one, and in this State Peron collected at Kangaroo Island, where this species is still procurable.

(b) STENOCHITON LONGICYMBA HISTORIA, n. subsp.
(Plate xxxvi., fig. 8).

Shell large, superficially similar to the preceding species, but proportionately broader, less elevated, with valves of different proportions; the median valves

always broader than long, the lateral areas being equilateral triangles. The seventh valve is not disproportionately elongate; and in the posterior valve the ante-mucronal area is not twice as long as the post-mucronal area. Colour is more commonly greenish, splashed throughout with white.

Dimensions: 45 x 9 mm.

Habitat: South Western Australia.

Stenochiton pilsbryanus.

(a) Stenochiton pilsbryanus pilsbryanus.

(Plate xxxvi., fig. 10).

Ischnochiton (*Stenochiton*) *pilsbryanus* Bednall, Proc. Mal. Soc., ii., 1897, 142, text-fig. Troubridge Shoal, Gulf St. Vincent, South Australia. Co-types in Acad. Nat. Sci. Philad. and coll. E. H. Matthews.

Stenochiton posidonialis Ashby, Trans. Roy. Soc. S. Aust., xlii., 1918, 72, Pl. xiii. and xiv., f. 2, 6, 13, a, b, c, d. Eastern side of Gulf St. Vincent. Type in coll. Ashby.

? *Zostericola pilsbryanus* Ashby, Trans. Roy. Soc. S. Aust., xliii., 1919, 66. (Redescription of a minute shell in the collection of Dr. Torr, which may be a juvenile example of *S. pallens*).

Shell medium, narrow elongate oval, glossy, round-backed, about three times as long as broad. Colour (a) pale yellowish-green, flamed with white. (b) dull brown and cream, some valves being wholly brown, others grey with a brown patch on the jugum.

The whole shell is minutely quincuncially decussate, but the decussation is more striking and a little coarser than in the preceding species.

Anterior valve broader than long, concave, but the concavity is not so noticeable in juvenile shells.

Median valves broader than long; lateral areas showing no diagonal elevation, little raised; second valve more elevated than apex of the anterior valve; valves iii. to vii. decreasing in elevation.

Posterior valve long, but not abnormally so; mucro median; post-mucronal slope a little concave.

Girdle narrow, sometimes banded; scales minute, but larger than those of *S. longicymba,* and more elongate ovals in shape.

Interior white or pale olive green. Slits 18-2 to 3-19.

Dimensions: 15 x 5 mm. (Type), 20 x 5. (Maximum of examples examined). 9.5 x 3.5. (Type of *S. posidonialis*).

Station: On the leaves of sea-grass. (*Zostera, Posidonia* sp).

Habitat: Victoria, South Australia.

Remarks: This shell was described by Bednall, and the next figures were prepared by Pilsbry from a juvenile specimen which (although the description is not exact) with our further knowledge we consider to be this species. Ashby (*loc. cit.*) has expressed the opinion that Bednall's figure and description of *S. pilsbryanus* were made from more than one specimen covering more than one species. In the first paper cited he rejected Bednall's name and re-described a shell under the new name of *S. posidonialis.* In the second paper he quotes Iredale (in correspondence) as agreeing with his action in renaming *S. pilsbryanus,* "as it did not agree with Bednall's figures at all." We have since had the advantage of examining a large series of shells from both South and Western Australia, as well as a personal discussion of the subject with Professor Pilsbry, and we have before us the original drawings and the co-types from Bednall's collection, lent us by Mr. E. H. Matthews. Professor Pilsbry informs us that the specimen from which he made the drawing is now in the Academy of Natural

Sciences, Philadelphia, having been segregated by him; there are also a number of more or less fragmentary specimens which he had shown to Mr. Ashby, who considered they comprised two species. Allowing for the fact that the original drawing was in outline only, and in view of the further fact that the concavity of the anterior valve is less perceptible in juvenile shells (the figured specimen was not full grown) we see no reason why the shell so long recognised and distributed by South Australian collectors as *S. pilsbryanus* should be renamed.

(b) Stenochiton pilsbryanus dilatus, n. subsp.

(Plate xxxvi., fig. 11).

This shell differs from the South Australian species in that it is flatter, the elevation being more uniform; in the different proportions of the valves which are broader in proportion to length; and in the rather less raised diagonal of the lateral areas. Both colour patterns, as described above, are found in Western Australia, and these two patterns are indicated in the respective figures on Plate xxxvi.

Station: On the blades of the sea grasses, rarely found in the root sheaths.

Habitat: Western Australia, from Lucky Bay, 25 miles east of Esperance, to Fremantle.

Stenochiton cymodocealis.

(Plate xxxvi., fig. 12).

Stenochiton cymodocealis Ashby, Trans. Roy. Soc. S. Aust., xlii., 1918, 70, Pl. xii. and xiv., f. 1, 4, 5, 11, 12 (a, b, c, d, e). Marino, South Australia. Type in coll. Ashby.

Shell small, narrowly elongate, round-backed, elevated, glossy. Colour brown or green, longitudinally streaked with white.

The whole shell is quincuncially decussate, the decussation being as fine as in *S. longicymba.*

Anterior valve shorter than broad; convex.

Median valves a little elongate, broader than long; lateral areas little elevated, normal in shape, being much longer than broad.

Posterior valve elongate; mucro ante-median, planate; post-mucronal slope straight and long.

Girdle narrow, in life clasping round the stalk of its host *Cymodocea;* scales minute, lozenge-shaped.

Interior greenish white. Slits 12, 13-1-13, 15.

Dimensions: 10 x 2.5 mm.

Station: On stalks of the sea grass *Cymodocea.*

Habitat: Victoria, South and Western Australia.

Stenochiton pallens.

(Plate xxxvii., fig. 8).

Ischnochiton (*Stenochiton*) *pallens* Ashby, Trans. Roy. Soc. S. Aust., xxiv., 1900, 86, Pl. 1, f. 1 a-g. Gulf St. Vincent, South Australia. Type in coll. Ashby.

Stenochiton pallens Ashby, Trans. Roy. Soc. S. Aust., xlii., 1918, 75, Pl. xiv., f. 14a, b. (Review).

Shell medium, elongate, three times as long as broad, round-backed, glossy. Colour olive-green, longitudinally streaked with pale brown.

Anterior valve twice as broad as long; smooth, glossy, showing faint concentric growth lines.

Median valves normal; lateral areas raised but scarcely differentiated.

Posterior valve elongate, as long as broad; mucro at the posterior third, nearly planate; post-mucronal slope straight; ante-mucronal area an equilateral triangle.

Girdle narrow; scales small, irregular, imbricating, finely striated.

Interior white. Slits 13-1 or 2-6 (? 16).

Dimensions: 26 x 7 mm.

Station: Dredged.

Habitat: South Australia, Victoria.

Remarks: The examination of a co-type of this distinct species lent us by Mr. Ashby suggests that it is closely related to *Autochiton wilsoni*, and that the Stenochitons may have arisen from two or three species of the same genus through adaptation to their new station.

Genus Anisoradsia.

Anisoradsia Iredale and May, Proc. Mal. Soc., xii., 1916, 104 and 108. Type by monotypy *Ischnochiton* (*Anisoradsia*) *mawlei* Iredale and May.

Shell large, elongate, elliptical, round-backed, moderately elevated; colouration constant. Sculpture of Ischnochitonoid appearance, but complexly exaggerated in detail. Scales small, regular, imbricating ovals, closely deeply striate. Interior with the sinus broad, two to four slits in median valves, multislit in terminal valves, eighteen to twenty-five.

Anisoradsia mawlei.

(Plate xxxv., fig. 9. Plate xxxvii., fig. 14).

Ischnochiton (*Anisoradsia*) *mawlei* Iredale and May, Proc. Mal. Soc., xii., 1916, 108, Pl. iv., f. 4. Port Arthur, S. Tasmania. Type in Tasmanian Museum. May, Illustr. Index Tas. Shells, 1923, Pl. xv., f. 4.

Shell large, elongate, elliptical, not much elevated, round-backed, side slopes rounded. Colour orange to pale yellow.

Anterior valve rayed with about fifty wavy ribs, divaricating towards the margin, apical portion devoid of ribbing; posterior edges crenulately irregular.

Median valves: Lateral areas with eight ribs divaricating into sixteen, all irregular and wavy; central areas finely wavy in zig-zag on jugal area, lines strengthening and becoming less wavy, but still never straight, towards the edge.

Posterior valve with mucro ante-median; post-mucronal area irregularly pustulose, forming ribs tending to become wavy towards the edge.

Girdle broad; scales small, striated (10-12 grooves) fairly uniform in size throughout, but slightly larger and suberect near the shell.

Interior white. Slits 20 to 25-2 to 4-18; teeth very short.

Dimensions: 34 x 18 mm. (Type). 51 x 24 mm.

Station: Under stones below low water mark. Animal fairly active, but apparently becoming sessile with age, as very old examples show parasitic growths on the posterior valves.

Habitat: South-western Tasmania.

Genus Ischnoradsia.

Ischnoradsia Shuttleworth, Mittheil. Naturf. Gesell. Berne, 1853, 65. Type by monotypy *Chiton australis* Sowerby.

Lepidoradsia Dall, Proc. U.S. Nat. Mus., 1878, 331. Ex Carpenter M.S. Type by original designation *Chiton australis* Sowerby.

Shells of very large size; constant dark colouration; elongate ovals; sculp-

ture in quincunx on central areas sometimes forming into linear aggregations; on end valves and lateral areas into ridges, few in some cases, many in others. Girdle scales large, rounded, uniform in shape, with peaked edge, faintly horizontally striate. Insertion plates strong, multislit in end valves, more than one (two to four) in median valves.

Ischnoradsia australis.

(a) Ischnoradsia australis australis.

(Plate xxxvii., fig. 9, scales only).

Chiton australis Sowerby, Mag. Nat. Hist. (Charlesworth), iv., 1840, 290. Australia. Conch. Illus. (Chiton), 1840, f. 46. Type lost.

Chiton metallicus Reeve, Conch. Icon., iv., 1847, Pl. xvii., sp. and f. 104. Australia. Type Mus. Cuming in Brit. Mus.

Chiton (*Lophyrus*) *lugubris* Gould, Proc. Bost. Soc. Nat. Hist., vii., 1859, 163. Otia, 1862, p. 116. Type lost (?).

Ischnochiton australis Pilsbry, Man. Conch., xiv., 1893, 144, Pl. 18, f. 57-59. Port Jackson, Australia.

Ischnochiton lugubris Pilsbry, Man. Conch., xiv., 1893, 146.

Ischnoradsia australis Ashby, Trans. Roy. Soc. S. Aust., xlii., 1918, 62, 64 (review).

Shell large, depressed, broad elongate oval, subcarinated. Colour uniform dark slaty-green, rarely brown or blue.

Anterior valve rayed with twenty to thirty irregular ribs, divaricating towards the edge.

Median valves: Lateral areas with four to six branching or divaricating ribs, irregular, wavy: central areas longitudinally ribbed throughout, ribs fine and closer together on the jugum, stronger and more distant towards the edge.

Posterior valve with mucro ante-median; post-mucronal slope concave; ante-mucronal area sculptured as on central areas; post-mucronal area sculptured as on anterior valve, but ribs still more irregular and tending to become nodulose through cutting by concentric growth lines.

Girdle moderately broad; scales as above (generic). (Plate xxxvii., fig. 9).

Interior blue, with reddish-purple centre to median valves, margined posteriorly with dark brown, purplish line along slit grooves; end valves with brown centre. Slits, anterior valve 19, median valves 2 to 4, posterior valve 16, teeth blunt, grooved interiorly.

Dimensions: 76 x 40 mm.

Station: Under stones below median tide mark.

Habitat: New South Wales, Eastern Victoria.

(b) Ischnoradsia australis divaricata.

(Plate xxxv., fig. 11).

Ischnoradsia australis divaricata Hull, Aust. Zool., iii., 1923, 196, Pl. xxvii, f. 1a, b, c, d. Caloundra and Point Cartwright, South Queensland. Type in Queensland Museum.

Shell large. Colour uniform dark slaty-green.

Differs from *I. australis* in the following particulars:—The central areas are strongly sculptured with two or three rows of straight vertical lines, separated by fine horizontal lines after the pattern of a picket fence. The sculpture of the lateral areas is much more branching and composed of fewer riblets than in the dominant species.

Habitat: Southern Queensland.

Remarks: This and the preceding subspecies are amongst the commonest

Loricates, being found, especially in New South Wales, in vast profusion in the shallow pools of the sandstone region. Examination of a series of juvenile specimens shows that the sculpture of the lateral areas commences in the form of three small rounded tubercles near the exterior margin. These tubercles are increased by one or more behind the first, which show a tendency to become elongated. The exterior margin then shows three tubercles, with a succession of three or more rows behind them; the tubercles are then rapidly elongated with the growth of the shell, gradually extending to and partially fusing with each other, thus forming the widely branching sculpture of the adult shell.

Ischnoradsia evanida.

(a) Ischnoradsia evanida evanida.

(Plate xxxv., fig. 12).

Chiton evanidus Sowerby, Mag. Nat. Hist. (Charlesworth), iv., 1840, 291. New Holland. Type lost. Conch. Illus. (Chiton), 1840, f. 139.

Ischnoradsia evanida Iredale and May, Proc. Mal. Soc., xii., 1916, 111.

Ischnochiton evanida May, Illus. Index Tas. Shells, 1923, Pl. xv., f. 3.

Shell very large, elongate oval, elevated, semi-carinated, side slopes nearly straight. Colour uniform dark slaty-green.

Anterior valve with about forty ribs, more or less irregularly broken, doubled, and sometimes divaricating; apex smooth.

Median valves: Lateral areas with seven to eight ribs, divaricating towards the edge; central areas very minutely reticulate, fine slanting striae developing towards the edge with age, entirely absent until the shell is about half-grown.

Posterior valve with mucro ante-median; post-mucronal slope concave.

Shell otherwise similar to *I. australis australis*, but reaching much greater dimensions.

Habitat: Tasmania, East and South.

(b) Ischnoradsia evanida novae-hollandiae.

Chiton novaehollandiae Reeve, Conch. Icon., iv., 1847, Pl. xxi., sp. and f. 142. Ex Grey M.S. New Holland. Type in Brit. Mus.

Ischnochiton novaehollandiae Pilsbry, Man. Conch., xiv., 1893, 145, Pl. 19, f. 67-69. Adelaide, South Australia.

Shell similar to the preceding subspecies, but the central areas are generally smooth, rarely showing any sculpture at all.

Habitat: South Australia, Western Victoria, Northern Tasmania.

Remarks: This and the preceding subspecies differ from *I. australis* in the weaker sculpture throughout, the median valves never show distinct ribs in the central areas, and the lateral areas are more closely and regularly ribbed. The young shells of both species show no striations on the central areas, and few ribs on the lateral areas; while the sculpture develops earlier on the northern species and becomes very strong in the adult, the southern species never at any time show a very strong sculpture. The girdle scales of the young of all the preceding forms begin as normal ovals, developing the characteristic rounded form with age.

Genus Haploplax.

Haploplax Pilsbry, Proc. Acad. Nat. Sci. Philad., 1894, 71. Type by original designation, *Lophyrus smaragdinus* Angas.

Shells of medium size for the family, of striking colouration, and generally shining surface; elliptical or rounded oval in form; sculpture weak, sometimes

negligent; girdle scales rounded, highly polished, smooth or faintly striate; insertion plates, slitting, and sutural laminae normal.

In this group the species are best separated by means of colour and form; while the girdle scales provide a useful character for the purposes of the following key:—

Girdle scales large, smooth:
- Sculpture: radials absent, except in senile shells:
  - Colouration variable .. .. *smaragdina.*
  - Colouration distinctive .. .. *resplendens.*
  - Colouration: blue spots always present:
    - Form broadly ovate .. .. *lentiginosa.*
- Sculpture: radials present:

Girdle scales small, smooth:
- Colouration consistent:
  - Form elliptical .. .. *thomasi.*
- Colouration absent:
  - Form narrowly ovate .. .. *pura.*

Girdle scales faintly striate:
- Sculpture: strong radials present .. .. *arbutum.*

HAPLOPLAX SMARAGDINA.

(Plate xxxvi., fig. 1).

Lophyrus smaragdinus Angas, P.Z.S., 1867, 115, Pl. xiii., f. 28. Port Jackson, New South Wales. Type in Brit. Mus.

Ischnochiton smaragdinus Pilsbry, Man. Conch., xiv., 1893, 137, Pl. 60, f. 20. Port Jackson, N.S.W., May, Illus. Index Tas. Shells, 1923, Pl. xiv., f. 15.

Ischnochiton smaragdinus picturatus Pilsbry, Proc. Acad. Nat. Sci. Philad., 1894, 72. Port Jackson, N.S.W. Type in coll. Acad. Nat. Sci. Philad.

Ischnochiton (*Haploplax*) *smaragdinus* Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 224.

Shell medium, broadly elongate oval; elevated; carinated. Colour extremely variable:—(a) Green, ocellate (typical), brown, slate, or dull purple, with or without ocellate markings. (b) White, yellow, slate with terminal valves black or other contrasting colour. (c) Wholly black with white or yellow girdle. (d) Having a broad dorsal stripe in purple, blue, or brown, unevenly margined with darker colour which extends to the girdle on valves ii. and vi., the remainder of shell variously coloured in contrast (typical *picturatus*). (e) Colours disposed somewhat like in variety d, but without distinctive dorsal stripe.

The whole shell is covered with a minute reticulate pattern, produced by the body colouration being broken by the finely punctate surface.

Anterior valve smooth, with fine concentric growth lines towards the margin.

Median valves having lateral areas indicated by elevated ridge; radial sculpture present in senile shells only; central areas having latitudinal lines resembling growth lines, faint but always visible, curving towards and sometimes crossing the diagonal.

Posterior valve with mucro ante-median, prominent; post-mucronal area showing indications of wavy radials near the margin, stronger in senile shells.

Girdle scales large, smooth, highly polished, largest in the middle of the girdle, diminishing as they approach the shell and the margin. (Plate xxxvii., fig. 7).

Interior white, green or pink, largely affected by the surface colour. Slits 10, 11-1-12.

Dimensions: 28 x 16½ mm. (Southern Tasmania).

Station: Under stones between median and lowest spring tide marks; occasionally found on roots of *Zostera*.

Habitat: Southern Queensland, New South Wales, Eastern Victoria, Tasmania.

Remarks: The animal is very active and evidently moves about considerably within its zone. It prefers clean waters, and is rarely attacked by parasitic growths. Its colours are brightest and most varied when found on the sandstones of Southern Queensland and New South Wales. The radial sculpture on the lateral areas is more marked, and appears in younger shells from Queensland. We have seen brilliant examples mounted in the form of sleeve-links, scarf-pins, etc.

Haploplax resplendens.
(Plate xxxvi., fig. 2).

Ischnochiton resplendens Bednall and Matthews, Proc. Mal. Soc., vii., 1906, 91, Pl. ix., f. 4. Gulf St. Vincent and Spencer's Gulf, South Australia. Type in coll. Matthews.

Ischnochiton (*Haploplax*) *smaragdinus* subsp. *resplendens*, var. *westernensis* Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 226. Yallingup, Western Australia. Type in coll. Ashby.

Shell medium, moderately elevated, semi-carinated, side slopes nearly straight: form elliptical. Colour bluish-green, dark blue or grey, with whitish rays and darker or brown band along the jugum ornamented with blue splashes; girdle generally banded.

The whole shell is covered with a coarse reticulation (as compared with the preceding species) the reticulation falling into wavy lines.

Anterior valve with very faint radial ribbing, only seen under a lens, superficially smooth.

Median valves: Lateral areas well raised, having faint radials discernible only under a lens.

Posterior valve with mucro raised, ante-median; post-mucronal area with faint radial ribbing as on anterior valve; posterior slope nearly straight.

Girdle scales large, round, polished, not striate.

Interior white or bluish, darker under the jugum. Slits 9-1-11.

Dimensions: 22 x 12½ mm. (Type). 29 x 17 mm. (Yallingup, Ashby).

Station: Under stones between median and low tide marks.

Habitat: Victoria, west of Wilson's Promentory, South Australia, South Western Australia.

Remarks: This species is easily separated from *H. smaragdina* by the colour pattern and the wavy lines of the reticulation. Further, the shell is not glossy, but of a soft texture that may be termed matt. The Western Australian shell attains large proportions, and is darker in colour than those from east of the Leeuwin. The nomination of this variety may be shortened to *Haploplax resplendens westernensis*, but the peculiar usage of *westernensis* for *occidentalis* calls for some comment. Quoy and Gaimard proposed *westernensis* for a bird from "Western Port," Victoria, and it has been erroneously adopted by other authors to express an occidental or Western Australian origin.

Haploplax lentiginosa.
(Plate xxxvi., fig. 5).

Chiton lentiginosus Sowerby, Mag. Nat. Hist. (Charlesworth), iv., 1840, 293. Australia (? Newcastle). Conch. Illus., f. 120. Type lost.

Ischnochiton (*Haploplax*) *lentiginosus* Pilsbry, Proc. Acad. Nat. Sci. Philad., 1894, 73. Port Hacking, N.S.W.

Shell medium, broadly ovate, little elevated, semi-carinated, side slopes a little rounded. Colour: On a ground colour of brown, yellow, or blackish, sometimes relieved by white bars or sections, numerous bright blue spots are distributed over the whole shell. These blue spots are generally square or oblong in shape, and sometimes fall into regular series raying out from the jugum; in other cases the spots are large, irregular, and show a tendency to become confluent. Where the ground colour is broken by pure white patches the spots are absent therefrom. We have seen a wholly white shell without any trace of the blue spots. The colour of the girdle is generally similar to the ground colour of the shell, but may sometimes be found in alternate bars of light and dark.

The sculpture of the whole shell consists of fine granules arranged in quincunx.

Anterior valve: Fine concentric lines, traversed in senile shells by faint radial ribbing.

Median valves: Lateral areas slightly raised and separated from the central areas by a broad low rib, increasing in width towards the margin. The central areas are latitudinally marked by growth lines which curve on reaching the diagonal and cross the lateral areas longitudinally.

Posterior valve with mucro, ante-median, a little depressed; post-mucronal slope slightly concave, subobsoletely rayed, more prominently towards the edge.

Girdle scales large, rounded, highly polished, not striate.

Interior: variable according to surface colouring, the brown shells being bluish, centre pink, with dark brown on posterior margin of valves; the yellow shells are greenish with dark green centre. Slits 11-1-13.

Dimensions: 27 x 18 mm.

Station: Under or at the edge of insertion of stones embedded in sand between high and median tide marks, rarely found lower.

Habitat: New South Wales, Eastern Victoria (Mallacoota and Lakes Entrance), South Australia (Gulf St. Vincent, E. H. Matthews).

Remarks: This species is mostly remarkable for its blue freckled colour, which is so constant as to come within the category of specific colouration. The granulose surface is much coarser than that of *H. smaragdina*, and differs from that of *H. resplendens* in the regular arrangement of the granules. Its station —the highest littoral zone—is also remarkable, as the only other Loricates inhabiting this zone are the large shells of the genera *Poneroplax*, *Sypharochiton*, *Liolophura*, and their allies, the other members of the genus *Haploplax* being found below median tide mark.

The ground colour of the shell is greatly influenced by the nature of the littoral rock, sandstones producing pale yellow and orange shells, while ironstones and shales produce dark brown to black shells, with occasional white patches.

Haploplax adelaidensis.
(Plate xxxvi., fig. 6).

Chiton adelaidensis Reeve, Conch. Icon., iv., 1847, Pl. xix., f. 123. Port Adelaide, New Holland (Harvey). Type Mus. Cuming in Brit. Mus.

Chiton (*Ischnochiton*) *adelaidensis* Smith, Zool. Coll. Alert, 1884, 79. Port Molle, Queensland.

Ischnochiton adelaidensis Pilsbry, Man. Conch., xiv., 1893, 136, Pl. 24, f. 7, 8.

Ischnochiton (*Haploplax*) *misimaensis* Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 228, Pl. xvi., f. 6. Misima, Papua. Type in coll. Ashby.

Shell medium, elliptical, moderately elevated, semi-carinated, side slopes rounded. Colour pale olive-green, streaked with dull red chiefly on the jugum and on the outer edges of the valves.

The sculpture of the whole shell consists of a minute granulose reticulation.

Anterior valve having about fifty radials, rather weak and becoming obsolete towards the apex; in senile shells the concentric growth lines break the continuity of the radials.

Median valves: Lateral areas raised, sculptured with five to seven radials, stronger than those of the anterior valve, and divaricating outwardly; central areas smooth, except for the reticulation and some fine growth lines.

Posterior valve with mucro ante-median, prominent; post-mucronal area concave, having about forty radials similar to those of the anterior valve.

Girdle scales large, rounded, highly polished, largest in the centre and diminishing towards the shell and the margin; each scale more or less blackish or dark green distally, the regular arrangement of the particoloured scales imparting a barred appearance to the girdle.

Interior greenish; slits 13-1-15, adult shell. (16-1-19 juv.).

Dimensions: 22 x 13½ mm.

Station: Under stones between median and low tide marks.

Habitat: North Queensland, Whitsunday Group (Coppinger), and Cooktown (Hull), Papua (Ashby).

Remarks: Reeve's locality, "Port Adelaide, New Holland," has been questioned by Bednall (Proc. Mal. Soc., ii., 1897, 157) and by most of the South Australian collectors with whom we have been in correspondence, and whose exhaustive search has failed to discover the species in South Australia. Bednall erroneously identifies Reeve's "Harvey" (the collector) with W. H. Harvey who collected in South Australia, 1854-6. As Reeve described the type in 1847, the reference was undoubtedly to Dr. J. B. Harvey, whose address in 1839 was Kingscote, Kangaroo Island, while he was at Port Lincoln (S.A.) in 1842 (Thomas, Ann. and Mag. Nat. Hist., 1921). E. A. Smith redescribed this species from several examples taken by Dr. Coppinger of H.M.S. *Alert* at Port Molle (Whitsunday Passage, North Queensland). As he had Reeve's type for comparison Smith's redescription is to be regarded as a valuable amplification of a previously incomplete diagnosis. Ashby, in describing his *H. misimaensis* from Papua, concludes that the Coppinger specimens from Port Molle are really conspecific with his shell. He also admits the possibility that Reeve's shell may have come from one of these northern localities, "and, after all, not conspecific with *H. lentiginosus*, to which species Mr. Iredale and the writer referred it in their examination of the type in the British Museum, with aid of pocket lens only." Iredale takes this opportunity of correcting a misapprehension. The reference of Reeve's type to Sowerby's *H. lentiginosa* was Ashby's, and was never acquiesced in by Iredale. In May, 1924, Hull, collecting on Grassy Island, one of the Whitsunday Group and a few miles only from Port Molle, Queensland, took several examples of a shell so absolutely in agreement with Smith's meticulous description of the Coppinger shell that he had no hesitation in identifying it as such. Later, in company with E. H. Matthews, the veteran South Australian collector, Hull took another example of the species at Cooktown, about 400 miles north of Port Molle, and Matthews at once acclaimed it the "long lost *H. adelaidensis*." The species may safely be omitted from the Adelaidean fauna. Possibly Reeve's type was collected by Jukes of H.M.S., *Fly*, in Queensland waters and wrongly attributed to Harvey by the author. The animal is extremely active, moving more rapidly than any other species known to the authors. It is very uniform in colour, and unaffected by parasitic growths.

Haploplax thomasi.

(Plate xxxvi., fig. 3).

Ischnochiton thomasi Bednall, Proc. Mal. Soc., ii., 1897, 149, text fig. and Pl.

xii., f. 4, 5. Marino, Gulf St. Vincent, South Australia. Type in coll. Matthews.

Ischnochiton cuneatus Matthews M.S., Journ. Conch. (Leeds), viii., 1897, 378, based on *I. thomasi* var. Bednall, *loc. cit.*, f. 4.

Shell medium, elongate oval, rather elevated, semi-carinated; smooth, glossy. Colour pale green, blotched with small white markings, sometimes wedge-shaped.

The shell is microscopically quincuncially punctate throughout.

Anterior valve having no radial sculpture.

Median valves: Lateral areas little raised, no distinct diagonal rib.

Posterior valve with mucro ante-median, elevated; post-mucronal area concave.

Girdle scales small, glossy, not so round as in other species of the genus. (Plate xxxvii., fig. 15).

Interior white with a bluish tinge. Slits 10-1-9.

Dimensions: 21½ x 12 mm.

Station: Under stones in pools between tide marks.

Habitat: Marino, Gulf St. Vincent, South Australia.

Remarks: The colour pattern and girdle scales of this species are so distinct that there is no difficulty in separating it from the other members of the genus. Bednall figured and described a variety, which Matthews in MSS named *cuneatus*. This name was published as a *nomen nudum* at the place cited. Although Matthews still contends that it is a distinct species and has sent us many specimens, we cannot at present recognise a specific difference. The colour pattern of *H. thomasi* may be found in some New South Wales examples of *H. smaragdina,* which suggests relationship.

Haploplax pura.

(Plate xxxvi., fig. 4).

Ischnochiton (*Haploplax*) *pura* Sykes, Proc. Mal. Soc., ii., 1896, 88, Pl. vi., f. 3, 3a. Port Phillip, Victoria. Type in Melbourne Museum.

Shell small, elongate oval, moderately elevated, semi-carinated; posterior valve large. Colour pure white, glossy.

All valves without radials, but with concentric growth lines; minutely quincuncially decussate throughout.

Median valves: Lateral areas scarcely elevated.

Posterior valve large, mucro central, post-mucronal area concave.

Girdle wide, scales small, elongate, smooth, flattened, closely imbricating.

Interior white. Slits 10-1-11.

Dimensions: 11 x 6 mm.

Station: Dredged in 10-20 fathoms.

Habitat: Southern New South Wales, Victoria.

Remarks: For this species, assigned by Sykes to *Haploplax,* and by other writers allowed to remain there on account of its smooth shell and extreme rarity, we propose a new subgenus *Chartoplax,* as the smooth scales are in form quite unlike those of any other member of the genus.

Haploplax arbutum.

(Plate xxxvi., fig. 7).

Chiton arbutum Reeve, Conch. Icon., iv., 1847, Pl. xxiv., sp. and f. 162. Loc. ? = Port Essington, N. W. Australia, on *Pinna.* Type in Brit. Mus.

Ischnochiton arbutum Pilsbry, Man. Conch., xiv., 1893, 139, Pl. 24, f. 16, 17.

Ischnochiton arbutum Hull, Proc. Roy. Soc. Queensland, xxxvi., 1924, 112.

Shell small, rounded oval, moderately elevated, semi-carinated, side slopes rounded. Colour rather variable, generally dull sage-green with a lighter jugal stripe irregularly projecting on valves iii. and vii.; rarely dull red or spotted with red (type colour of Reeve's "Strawberry" Chiton); pale yellow, or black.

The whole shell is coarsely quincuncially granulose.

Anterior valve closely radially ribbed, ribs a little flattened and semi-granose, as if merely elevated rays of the quincuncial sculpture.

Median valves: Lateral areas strongly raised, radially ribbed as in the anterior valve, the ribs generally six, splitting towards the margin.

Posterior valve with mucro at about the anterior third; post-mucronal area slightly concave, ribbed as in the anterior valve.

Girdle scales large, rounded, glossy, weakly striate.

Interior white or greenish. Slits 11 to 13-1-15 to 16.

Dimensions: 14 x 9 mm.

Station: Under stones embedded in sand or mud, or on *Pinna,* between median and low tide marks.

Habitat: Queensland from Port Curtis to Cape York; Northern Territory.

Remarks: Although Reeve assigned no locality in his original description of this species, the type tablet in the British Museum has the original label attached to the back. This label bears, in J. Macgillivray's handwriting, "on Pinna; Pt. Essington, Octr., 1844, 1090." (The last number is Macgillivray's collection number). When collecting on the coast of North Queensland, 1921-4, Hull found this the common littoral shell, inhabiting muddy situations, and frequently in the Mangrove association.

There is a shell in the British Museum, labelled *"Lepidopleurus cygneus,* Carpenter, Swan River," which comes close to *H. arbutum,* but it has finer sculpture on the anterior, posterior, and central areas of the median valves; while the lateral areas are more distinctly ridged. This form probably came from North-western Australia, for it must be remembered that "Swan River" was the original name of the present State of Western Australia, and the species does not live in South-western Australia. We anticipate that it will be rediscovered shortly north of Carnarvon.

EXPLANATION OF PLATES.

Plate xxxv.

Fig. 1. *Subterenochiton gabrieli* Hull.
2. *Ischnochiton distigmatus* Hull.
3. *Heterozona fruticosa* Gould.
4. *Heterozona subviridis* Iredale and May.
5. *Heterozona cariosa* Dall.
6. *Autochiton torri* Iredale and May.
7. *Autochiton virgatus* Reeve.
8. *Autochiton wilsoni* Sykes.
9. *Anisoradsia mawlei* Iredale and May.
10. *Strigichiton verconis* Torr.
11. *Ischnoradsia australis divaricata* Hull.
12. *Ischnoradsia evanida evanida* Sowerby.

Plate xxxvi.

Fig. 1. *Haploplax smaragdina* Angas.
2. *Haploplax resplendens* Bednall and Matthews.
3. *Haploplax thomasi* Bednall.
4. *Haploplax pura* Sykes.
5. *Haploplax lentiginosa* Sowerby.
6. *Haploplax adelaidensis* Reeve.
7. *Haploplax arbutum* Reeve.
8. *Stenochiton longicymba historia* Iredale and Hull.
9. *Stenochiton longicymba longicymba* Blainville.
10. *Stenochiton pilsbryanus pilsbryanus* Bednall.
11. *Stenochiton pilsbryanus dilatus* Iredale and Hull.
12. *Stenochiton cymodocealis* Ashby.

Plate xxxvii.

Fig. 1. *Subterenochiton gabrieli* Hull. Anterior valve, exterior.
2. *Subterenochiton gabrieli* Hull. Anterior valve, interior.
3. *Subterenochiton gabrieli* Hull. Half of a median valve.
4. *Subterenochiton gabrieli* Hull. Posterior valve, exterior.
5. *Subterenochiton gabrieli* Hull. Posterior valve, interior.
6. *Subterenochiton gabrieli* Hull. Girdle scales.
7. *Haploplax smaragdina* Angas. Girdle scales.
8. *Stenochiton pallens* Ashby.
9. *Ischnoradsia.* Girdle scales (generic).
10. *Autochiton wilsoni* Sykes. Girdle scales.
11. *Heterozona subviridis* Iredale and May. Girdle scales.
12. *Strigichiton verconis* Torr. Median valve, interior.
13. *Strigichiton verconis* Torr. Girdle scales.
14. *Anisoradsia mawlei* Iredale and May. Median valve, interior.
15. *Haploplax thomasi* Bednall. Girdle scales.
16. *Stenochiton longicymba longicymba* Blainville. Girdle scales.
17. *Autochiton torri* Iredale and May. Girdle scales.

OBITUARY.

Died at Bathurst, New South Wales, on the 8th September, 1924, Septimus Robinson, in his 81st year.

The late Mr. Robinson was known to most ornithologists in Australia as a keen field observer and collector, although he never contributed to our literature. His efforts were directed to securing a complete representative collection of the eggs of Australian birds, and at one time his collection was regarded as the most comprehensive. He collected in western New South Wales, southern and western Queensland, and made many trips to other States in quest of specimens. Always a stickler for "condition," he would reject all but perfect sets in irreproachable condition as regards preservation, blowing, completeness of data, and full number of normal clutch. He was liberal in his exchanges with other collectors, but very jealous of his pre-eminence. Amongst many first records established by him may be mentioned the discovery of eggs of the Glossy Ibis. When the competition for premier place became keen owing to the activities of younger and better equipped men, Mr. Robinson recognised defeat, and gradually lost interest, finally disposing of his accumulations. Even when approaching four score years he could not resist the temptation of climbing a tree to examine the handsome eggs of the wedge-tailed Eagles when he saw their nests. Tall, thin, wiry, and taciturn to most, he could entertain a brother collector with tales of rich finds and rare discoveries, with always a hint of something good yet to be discovered, and about which he had private information.


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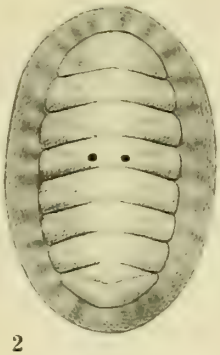
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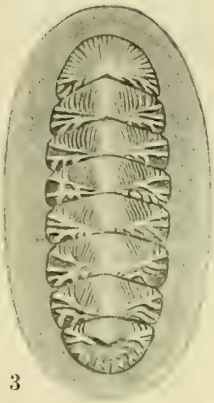
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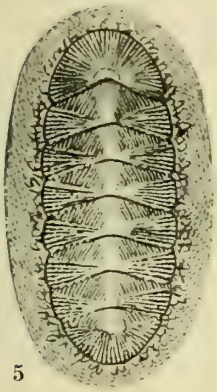
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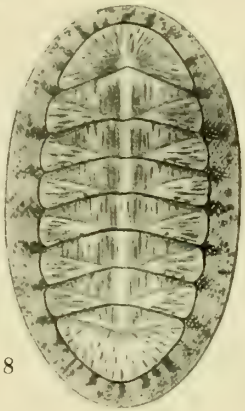
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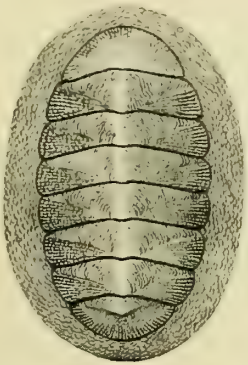
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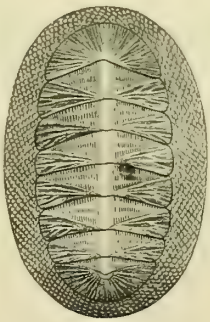
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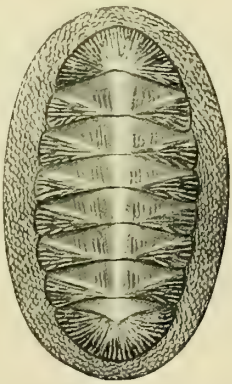
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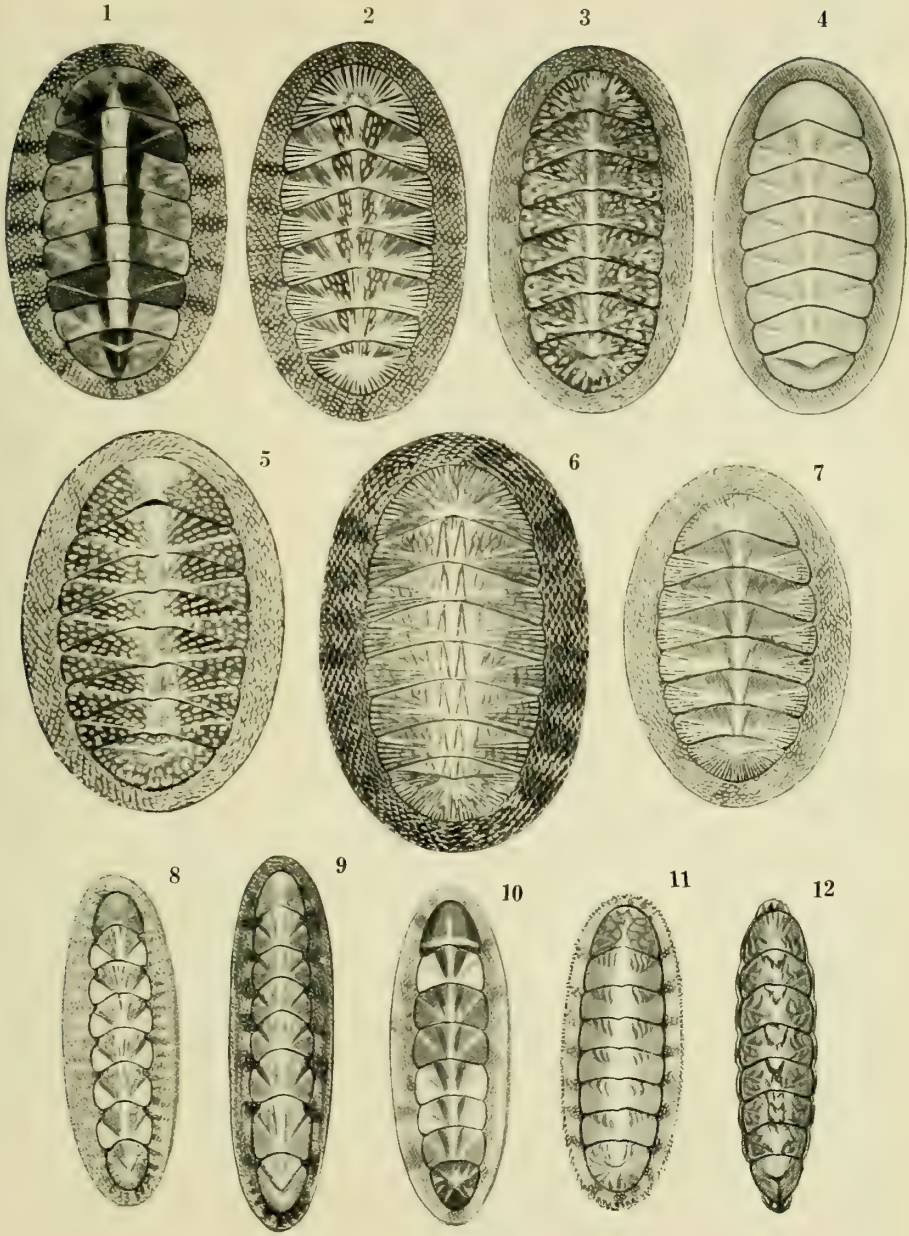
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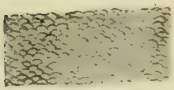
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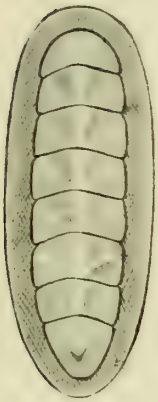
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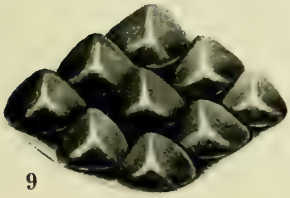
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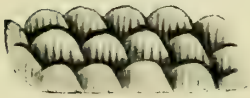
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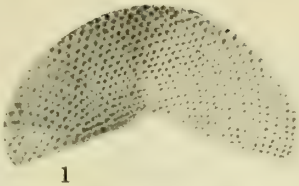
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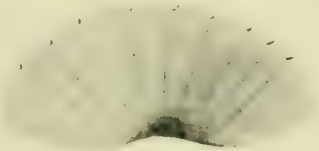
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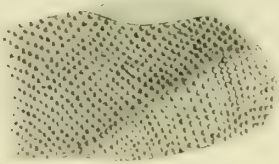
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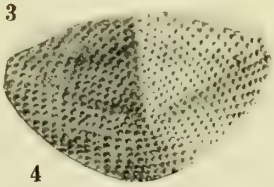
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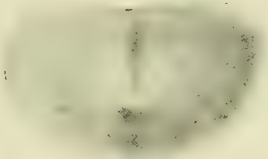
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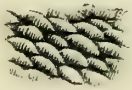
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GUNDAMAIAN.
The Society's Biological Station in the National Park, New South Wales.

Looking up North-west Arm, National Park, from the Gundamaian Biological Station.

Photographs by E. F. Pollock.

Royal Zoological Society of New South Wales.

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Royal Zoological Society of New South Wales.

NEW MEMBERS.

The following have been elected since the publication of the last list (7 October, 1924):—Ordinary: Thomas Buckland, Dr. E. D. Clark, H. J. Carter, Mrs. M. C. Messer. Associate: F. W. S. Mayer.

OUR JOURNAL.

It having come to the knowledge of the Council that some members consigned their copy of the *Australian Zoologist* to the wastepaper basket without even taking it out of its envelope, it was decided to ascertain how many members did not make use of it, and a circular letter was addressed to those who were not definitely known to be interested in it. The result has been somewhat disconcerting, no less than 85 members having courteously replied that the journal was not required by them. A few have replied in tones of appreciation, and we may quote the following:—"I hope you will continue to forward me copies of the journal from time to time. I regard it as most interesting and highly instructive, particularly for young people. . . . . After my family have studied the contents it is passed on to others who also appreciate seeing it.—Kelso King." " . . . . No doubt the Council will consider the advisability of supplying the paper to those members only who pay an additional subscription. In any case I do not think that Life Members like myself should receive it free of charge. I enclose my cheque for £1 and shall be pleased to pay annually (or periodically to cover longer periods) a subscription for the privilege of receiving the paper, if it is decided to prescribe one.—R. H. Todd."

Members who have joined the Society merely for the privilege of passing through Taronga Park form probably the bulk of those who do not require the Journal. As the actual cash cost (including postage) of three Parts in the year is in the neighbourhood of 10/-, the saving effected will be considerable, and the amount can be usefully applied towards improving the Journal.

SECTIONAL MEETINGS.

Entomological Section:—	*Ornithological Section*:—
Wednesday, February 11.	Friday, January 16.
April 8.	February 20.
June 10.	March 20.
	April 17.
	May 15.
	June 19.

Meetings are held at the Society's Office, 28 Martin Place, at 7.30 p.m., and are open to all ordinary and associate members.

EXCHANGES DESIRED.

Dr. A. L. Herrera, Director of the National History Museum of Mexico, informs us that a new Department has been established for the exchange of specimens of animals, plants, and minerals. He will be glad to receive lists of Mexican species, etc., desired, and those that can be offered in exchange by any collector.

"BIRDS OF A FEATHER FLOCK . . .?"

By A. H. Chisholm, F.A.O.U.

Chairman of New South Wales members of the Royal Australasian Ornithologists' Union and the Ornithological Section of the Royal Zoological Society.

A Rockhampton journalist breathed deeply as he emerged from a session of the Ornithologists' Union. "Well," he said, "who would have expected that?"

The Birdman smiled. "Did you," he asked, "ever know a society to live any length of time, to any purpose, without a few feathers being ruffled now and again?"

"Ah!" cried the Pressman, "there lies my point. For the fact is that I, as a General Citizen, a Man-in-the-Street, had developed an idea that you naturalists were not as other folk are. Municipal councils and the like, I told myself, might rage and imagine vain things, but you, ornithologists and kindred, would go placidly on your way, filled with unworldly aspirations, serene in spying upon ways of the wild, complacent in comparison of Notes on the Nidification of *Dacelo gigas*. And, lo! here you are disputing with Johnsonian dogmatism over technical names, arguing spiritedly about matters of procedure, splitting into separate 'camps' on the question of collecting birds and eggs, and even negotiating (some of you) a kind of Seamen's Union 'ticket' in the election of your officers!"

The Pressman paused at a convenient corner. "Alas!" he sighed, "for the shattering of my youthful ideas. 'Birds of a feather,' says the motto on your *Emu*. But, no, you do not flock *together*—not always. Sometimes, I perceive, you bear out what a stumbling foreigner once said: 'Birds of a feather *flock mit themselves!*'"

* * * *

There, reader, is a scrap of dialogue that drifted into mind when the editor of the *Australian Zoologist* suggested that he could find space for a resumé of and critical comments upon the recent congress of the R.A.O.U. at Rockhampton (Queensland), echoes of which had penetrated to Sydney. And now, if so it pleases, let that prelude remain in your mind while some attention is paid to the more amiable portion of the proceedings.

Four States were represented at the congress—the absentees being South Australia and West Australia, curiously enough, the States that made, so to say, the most noise at the elections. All material aspects of ornithology were covered in the attendance, and there was also a sturdy band of some half dozen entomologists, as well as one or two devotees of other studies. The total was rather more than thirty. Accompanied by the Governor of Queensland, Sir Matthew Nathan, we arrived at Rockhampton on the afternoon of Tuesday, October 14, and were tendered a civic reception by the Mayor and aldermen. That reception was an earnest of the hospitality to follow during the ensuing three or four days in the capital of Central Queensland. Numerous outings were sandwiched between sessions of congress, and all of these made capital enjoyment. Lectures, too, were given between whiles, chiefly under the auspices of the virile Central Queensland Native Birds Protection Association.

Congress was opened by Sir Matthew Nathan in an address that would have done credit to the president of any natural history society in Australia. As a comparative newcomer, he referred first of all to the peculiarity of the Australian fauna as contrasted with that of other lands. Then he went into some of its chief points of interest, from which it was an easy transition to a sturdy championship of the work of the Great Barrier Reef Committee, of which he is president and a vital force. One result of this address was that members later, when the congress was continued at camp, carried a motion tendering fraternal greetings to the Great Barrier Reef Committee, congratulating it upon the work already accomplished, and appointing five Queensland ornithologists to co-operate with the committee in working out the ornithology of the Reef.

The address of the retiring president, Dr. Leach, was on a purely "domestic" subject, dealing as it did with the history of the naming of Australian birds. This synchronised with the presentation of a progress report by the committee which has been engaged for several years on the preparation of a second edition of the official Check List of Australian birds. Both technical and popular nomenclature, as well as the distribution of our bird-life, have been subjected to drastic revision in the course of the operations of this committee, and it is hoped that finality will be reached when the edition finds its way into print.*

Dr. Leach, who has infused a great amount of energy into his work for Australian ornithology, was elevated by congress to honorary membership of the Union.

Certain points in relation to the conduct of *The Emu,* the quarterly journal of the R.A.O.U., caused animated discussion. Mr. Alexander commenced by objecting strongly to money donated for the Coloured Figure Fund being used for general purposes; and other members expressed the views of their States in protesting against photographic reproductions in this well-illustrated journal being grouped or reduced.

Conservation laws, of course, came under general review again. The situation in New South Wales was discussed first, after which some attention was paid to a new law in Queensland. Framed chiefly to regulate the trapping industry—opossum hunting in Queensland has grown into a big enterprise—it affects birds in one respect; that is, the Government now has power to proclaim sanctuaries over private lands, irrespective of whether the owner agrees or not. Congress carried a resolution expressing approval of the establishment of reservations for native fauna, and urging that these should be established in inland areas, as well as in the coastal districts.† Another resolution bearing on this subject was one recommending that the sale and use of the pea rifle should be prohibited throughout the Commonwealth. Further discussion centred upon reports dealing with the operations of the State committees who advise the Minister for Customs relative to the export of native fauna. Dr. Leach suggested that an effort be made to have these committees work in unison. Other members desired that efforts be made to locate an apparent leakage in the restrictions. It seemed to them that fauna was being taken out through Western Australia.

Another objective to which congress decided to set its hand was the procuring for Australia of the great ornithological library of Gregory M. Mathews, England. It was mentioned that this invaluable collection of books could be secured for £3,000.

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*A devout hope, and an end devoutly to be wished, but *quot homines, tot sententiae* is still a live proverb, though couched in a dead language! Ed.

† Since then the Commonwealth Government has announced the establishment of two reservations in the Northern Territory, one in Coburg Peninsula, and one in the McDonnell Ranges.

Usually, the election of officers of the R.A.O.U. is an uneventful business, a decorous business. This time it was neither. Some amusement had been caused when the voting papers appeared by the fact that two South Australian members had largely monopolised the nominations. Not content with selecting nominees in their own State, they had invaded the whole Commonwealth in an orgy of energy, and nominated candidates for every State. Inasmuch as very few members in New South Wales or Queensland knew the nominators; and as, moreover, we realised that the nominators scarcely knew one of the men whom they were honoring, we attached no importance to this unique excursion. We merely ascribed the proceeding to an excess of zeal and a lack of courtesy, and let it rest at that. But when the voting numbers went up at the congress we found that the whole of those nominated by New South Wales and Queensland members for their own States were defeated!

The presidency, not being the concern of a particular State, does not enter into this consideration. What did matter was the rejection of the nominees of the N.S.W. Section for its own officers (vice-president and members of Council), and the rejection of the two Brisbane nominees whom the State Secretary there had looked to for colleagues. Worse still, this extraordinary vote had resulted in New South Wales, with 133 members, securing only one representative on the Council, while Western Australia, with 15 members, secured three seats! Other inequalities need not be mentioned after that.

The cause, of course, is obvious: a "ticket" was worked for certain ends. That much was made plain by the nature of the voting. A "ticket" in the Ornithologists' Union! That, surely, is the crudest jest that ever was perpetrated in any society of the kind in Australia,—so crude and such a jest that members of the congress scarcely knew whether to laugh (on their own part) or swear (on behalf of the Union). Anyway, they reached a quick decision to try to rescue an honorable society from a menace; they unanimously carried a motion, sponsored by Mr. Barker (Queensland) and Dr. Chenery (N.S.W.), for an alteration of the rules to provide that in future each State and New Zealand should nominate and elect its own officers of the Royal Australasian Ornithologists' Union, and that the representation should be according to the strength of membership in the respective States.

After all, though, apart from the question of principle—the natural irritation aroused among earnest naturalists when encountering such "political" methods—no great harm has been done by these elections. For the fact is that the gentlemen of the "block" had no one to offer for the key position, to wit, that of editor of *The Emu*. One hesitates to think how much sleep they would have lost had that position come to Sydney! However, we did not do anything quite so cruel as that, but appointed Mr. W. B. Alexander, M.A., of Brisbane, while the chairman and hon. secretary of the N.S.W. Section were added to the Printing Committee.

Then, when the congress was resumed at the camp-out later (with Mr. Alexander in the chair) we offered some of the new Council food for heavy thought by carrying two resolutions in particular. The first one had an international significance, in that it declared disapproval of the International Museum of Comparative Oology, Santa Barbara, California, and advised members of the R.A.O.U. that they should not be members of that body. The sponsors of that motion were Dr. Chenery (N.S.W.) and Mr. H. G. Barnard (Queensland), both of whom have collected birds and eggs, but always rationally. The second resolution declared that the congress set its face against the indiscriminate collecting of birds and/or their eggs, instructed the Council to notify every member of the R.A.O.U. that in no case should collecting be carried on without a permit, and

recommended that a member desiring such permit should seek it through the secretary of the R.A.O.U. in his particular State.

Does it seem that those decisions should have been mentioned earlier, among other congress business? Well, the point is they have been held back until this stage for a good reason—behind them lies the chief issue that operated in those lamentable elections. Consider this: Nearly two years ago Mr. E. Ashby, a South Australian veteran, wrote in *The Emu* a vehement championship of "collecting," including in his case a plea for the encouragement of bird-killing (for skins) among boys. Immediately after that Mr. Ashby lost his seat as a vice-president of the R.A.O.U., the first time in history that such an officer had been unseated. This happening probably did not worry Mr. Ashby himself so much as it did others who, in a rather less coherent manner, share his beliefs. Obviously, something had to be done. That vote had been a straightforward one, carrying no solicitations; therefore, a new method was necessary—a commendable method if possible, maybe, but a new method anyway! There you have a reason for the fact that the Council of the R.A.O.U. now carries, with certain very worthy exceptions, a big batch of bird and/or egg collectors; for the fact that the leaders of ornithological opinion in New South Wales and Queensland had their nominees for their own States rejected, and for the fact that a severe blow was thereby struck at the federal nature of the R.A.O.U. Incidentally, it should be observed that the elections in question have no effect on the N.S.W. Section as such and as a Section of the R.Z.S. of N.S.W. Here, we elect our own officers, and the loss of our men on the Council of the federal body is a loss to that Council, not to us.

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Leaving congress matters now, let us look briefly at the general position of this "collecting" argument. Comment is advisable, not to say necessary, since the whole of the current number of *The South Australian Ornithologist* (Vol. 7; Part 8) is given over to a championship of private collecting; there is not one line devoted to the other side of the case, and yet it is announced that the editorial committee have decided to open only "the pages of one number" to the subject. In that prefatory note, too, it is hinted that *The Emu,* at the time of last year's discussion, did not give the collectors all the space they merited,—this in face of the fact that Mr. Ashby alone was allowed the right of reply. Such large capacity for loftily ignoring the other fellow is worthy of a better cause.

Some of this matter in the *Ornithologist* is sound argument, but there is also a good deal of rubbish; and for the most part it is laboured special pleading. To begin with, Mr. Ashby's first *Emu* article is reprinted; then follow several pages of matter reproduced from writings by Dr. Grinnell, of America; after which are given the views of certain selected members of the R.A.O.U. It is not necessary to traverse all the points raised; a few comments will suffice.

Firstly, it should be made clear that no Australian naturalist desires to prohibit collecting of fauna. What discreet people do object to is the amassing of skins for no worthy purpose, and in many cases quite illegally. We say that wild birds are as much part of the community life as are flowers in Botanical Gardens; and there is a nasty name to apply to people who help themselves to such flowers just because they desire them for their own property. Further, we say that when it does become necessary to collect birds (or eggs) those specimens should be taken only for a definite, disinterested purpose, in the public interest. A very reasonable limit, is it not?—yet it excludes men who shoot birds at random, men who stow skins or eggs away where they cannot be seen, men who lack either the broadness or the intelligence to write up material collected, and men who aim at selling such collections to the highest bidder. These

deficiencies, alas, are distributed among certain private collectors in Australia, and, judging by the noise being made abroad, among collectors in Britain and America as well.

The latter reference recalls that Dr. Grinnell admits in a letter to Mr. Ashby that the "sentimentalists" are overwhelmingly in a majority in the United States. Accordingly, it will suffice to suggest to that gentleman that he can very well confine his propaganda to his own land, and not waste energy in throwing adjectives into a country where (so the *Ornithologist* says) there is already more pro-collecting material than can be printed. Here, too, it is necessary to join issue with Mr. A. J. Campbell, of Melbourne, who quotes an American opinion relating to collecting and says: "What applies to America is surely good enough for Australia!" While admiring certain phases of American life as much as anyone else, I decline to subscribe to the idea that anything that country (or any other country) chooses to do is necessarily good enough for Australia. (But if we really must follow America, remember Grinnell's confession that anti-collectors, or people who would have these things done decently, greatly predominate there!) Why, indeed, should Mr. Campbell follow anyone? His work is good enough to stand by itself, and he is one of the few private collectors locally who has put his material to really educative use.

Much the same may be said of Mr. Robert Hall, whose name also appears among contributors to the *Ornithologist*. Mr. Hall, by the way, comments upon the fact that Mr. Ashby was refused a permit to shoot birds in N.S.W. a few months ago. To avoid misapprehension on this point, it should be said that the visiting South Australian did not consult any of the local officers of the R.A.O.U. on this matter, and it was scarcely to be expected that departmental officers would grant a permit to a man unknown to them. Personally, I knew nothing of the matter until Mr. Ashby had left this State; but what I did and do know is that Government departments are getting very shy of private collectors generally. Indeed, there have been cases in which too much strictness has been used—due, so the departmental officers say, to the methods of collectors themselves. This means, of course, that reckless bird-killers are hindering the work of better men. If all the collectors of Australia had the fairness and intelligence of Mr. Hall and Mr. Campbell, there would, one imagines, be little for either governments or genuine naturalists to worry about in this respect. But such, I repeat, is far from being the case.

If an instance bearing out this latter contention is needed, one has only to read the *S.A. Ornithologist* contribution of Mr. J. N. McGilp, of South Australia. "The camera," says he, "accounts for the death of more birds than the collector." Excellent, as an example of unconscious humour! Richer still is the plaint that observation without specimens may lead one astray, as in a Tasmanian case where he (McGilp) "listed a certain bird, only to be proved unreliable by a resident of the district." Could unwitting frankness go further? He was not, be it marked, proved merely to be in error, but unreliable. After that, it is scarcely necessary to inquire how much better off ornithology would be if a specimen of that bird had been taken—in a district where a *reliable* observer had previously been at work. But Mr. McGilp has something more revealing still to say: "I'll undertake to hand my collection over to any person or institution that will give me one-fifth of what I have actually spent in hard cash in my endeavour to get the material." See how the *S.A. Ornithologist* is brought to the level of a trade journal by unwittingly giving a free advertisement to a man who is willing to *sell* a collection! How unfortunate, though, that a Tasmanian naturalist put forward a case in which the owner of that collection was "proved unreliable!"

There are other whimsicalities in the paper under notice, but citations must

cease. Broadly, the main arguments of the writers are that collectors make discoveries—as though anyone ever denied this of good collectors—and that the ravages of collectors are a mere detail to the destruction wrought by Nature. On this latter point, Mr. T. A. Coward, the well-known British ornithologist, observes in the *Nineteenth Century* that the collector destroys where he has no right to destroy. "So long as man leaves the environment in Nature's care, the proportions will be static, constant, but any human interference will create a greater drain. . . Thus, the collector goes beyond the dictates of Nature." Even so. The short-sighted collector, indeed, attempts to set up a dictatorship of his own. Because natural agencies wipe out many birds, he, it would seem, has a perfect right to do the same! Storms and droughts he concedes to be the "Act of God." And almost he would have us believe that promiscuous collecting is in the same category!

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Well, I have wandered somewhat from the point where we began. But now, reader, you have an idea of how the land lies in Australian ornithology—of the position that caused an amused Pressman to wonder if "Birds of a feather flock mit themselves." You know, too, why New South Wales and Queensland had their R.A.O.U. officers selected for them by an "outside" coterie. And you may conclude how much the welfare of an admirable society is being endangered by such anti-federal methods, no less than by the indiscretions of a few collectors, whose work would be infinitely more useful if their present presumption and assumptions were replaced by a spirit of sweet reasonableness. However, it may be that, in the course of time, tolerance and clear thinking will sway the behaviour of both collectors and "sentimentalists"; then, surely, bird life and bird study will be viewed in proper perspective, and it will be possible to say in truth of the ornithologists and nature-lovers of Australia, "Birds of a feather flock together!"

Note: Those of our readers who are not familiar with the famous "Resolutions" which have given rise to so much energetic disputation, may be surprised to find how absolutely they are in consonance with the objects of both the R.A.O.U. and R.Z.S. as expressed in their respective memorandums of Association. Let me quote the latter first: "To *protect, preserve,* and *study* the birds (or indigenous and introduced animals) of Australia." The Resolutions were:—

"1. That recognised ornithologists, pursuing some definite course of research, should be allowed to continue to collect specimens under statutory permit, with a view to the ultimate donation of such specimens to a public institution.

"2. That permits be granted to special research students, limited to the species to be studied, and to the number of specimens to be taken.

"3. That promiscuous collecting, or the formation of any new collection, be discountenanced, and that any collectors, other than those coming under recommendation No. 1, be advised to donate their collections to some recognised public institution.

"4. That any member found guilty of collecting without a permit or in a sanctuary, or of any other breach of the Statutes relating to Bird Protection, shall be dealt with under the Articles."

These were to be regarded as an expanded object or aim of the Union, as briefly set out in the Memorandum of Association. They could not have the force of law, as that is already provided for by Statute. The whole trend of the "collecting" propaganda is to advocate the repeal or amendment of Statutes which all right-thinking naturalists have urged the various State Governments to enact! EDITOR.

SOME CENTRAL QUEENSLAND BIRDS.

By H. Wolstenholme.

Many interesting birds were observed during the period of the R.A.O.U. 1924 Congress and Camp-out in Queensland. The Congress was held at Rockhampton, from which place various outings were made. Yeppoon, a seaside resort, was visited also on the way to the camp at Byfield—a small settlement of banana growers with plantations reaching into the scrub of the hillsides. These places being within the southern end of the northernmost avifaunal subregion of Australia or, more correctly, perhaps, within the area where this and the adjoining southern subregion overlap each other, members were on the look-out for northern species, and, though they saw no Flycatcher from the north, they were pleased to find at Byfield the northern Scrubfowl (*Megapodius reinwardt*), and at Yeppoon the little Sunbird (*Cyrtostomus frenatus*) of the Tropics. And there were in plenty such birds as Spectacled Flycatchers (*Monarcha trivirgata*); Orange-backed Wrens (*Malurus melanocephalus*); and Rufous Shrike Thrushes (*Colluricincla megarhyncha*); species which dwindle out after reaching the coast of New South Wales. Some of the more interesting of the birds observed are mentioned in the following notes:—

Mound-builders (*Megapodiidae*), Scrubfowl (*Megapodius reinwardt*) and Brush Turkeys (*Alectura lathami*) were both seen at Byfield, but not many. They are, however, in sufficient numbers to do some damage to the banana bunches on the trees by eating a few bananas of each bunch; the turkey being the more destructive of the two. Many nesting mounds were shown us. Some of the Scrubfowls' mounds were very large—perhaps ten feet high and forty feet round the base—and pointed. They are used and added to each year. The birds themselves are difficult to see, and it was only by going out with a settler and trained dogs very early one morning that any were seen. The dogs cause the birds to leave the ground and sit quietly in the low branches of the trees. The turkey mounds were smaller and less conical. A few members had a good view of a turkey that was cornered by a wire fence, and did not take to its wings till we were close upon it.

Pigeons and Doves (*Columbiformes*). Pigeons were very plentiful. At daybreak one morning at Byfield we went to the head of Polka Creek and heard a wonderful pigeon chorus from the hills surrounding us a little way off, though we could not see the birds. The species noted about here were three Fruit-pigeons:—Red-crowned Pigeon (*Ptilonopus regina*), Purple-crowned Pigeon (*Ptilonopus superba*) and Woompoo (*Megaloprepia magnifica*). Of these the first-named (Swainson's) was the most plentiful, and two nests were found containing each one egg. The White-headed Pigeon (*Columba norfolciensis*) and Pheasant Pigeon (Brownie) (*Macropygia phasianella*) were also there.

At Yeppoon the Bar-shouldered Dove (*Geopelia humeralis*) was in great

numbers, and their call, "Hop off-hop off," was continually heard in the strip of bush between the mangroves and the road, and Swainson's Fruit-pigeon was here, too, and the Peaceful Dove (*Geopelia placida*).

Swamp Birds. Rockhampton has many swamps and lagoons in its neighbourhood. We visited first the lagoon at the Botanical Gardens, and the large mere in front of "Gracemere" homestead, and it took some time to identify the various water birds. There were representatives of most swamp bird families, including—Coot (*Fulica atra*), White-headed Stilt (*Himantopus leucocephalus*), Royal Spoonbill (*Platalea regia*), Glossy Ibis (*Plegadis falcinella*), Darter (*Anhinga novae-hollandiae*), many female birds showing the light coloured neck, Egrets (large and small), Ducks, 6 species (including the 2 species of Whistlers), Herons (3 species), Swan, Pelican, Cormorants, Plover, Dotterels, etc.

Before breakfast one day we went out to a swamp that contained the nest of a pair of Brolgas (*Megalornis* (*Antigone*) *rubicunda*). It was a small swamp and the water not deep, and we could without inconvenience wade out to the middle where the nest was situated. It consisted merely of little bits of dried reed or other swamp vegetation spread about in a round patch on a small piece of soil forming a tiny island just bigger than the nest. There were two eggs—one elongated in shape, the other shorter and rounder. A bird was sitting on the nest on our arrival. As we approached, the two birds retired slowly to the further shore of the swamp and did some very graceful dancing. At times a bird would leap right off the ground with both feet well in the air. There were many Egrets, Herons and Ibis on the shores of this swamp. The last outing from Rockhampton was to Fitzroy Vale—to the Goose Swamp, so-called because Pied Geese (*Anseranas semipalmata*) are usually to be found there. It was a large swamp, bright green in appearance, the reeds and other plant vegetation almost entirely covering the surface of the water. In addition to nearly all the birds seen on the previously mentioned swamps there were here:—Swamp Hens (*Porphyrio melanotus*) in great numbers; Grebes, the two small species; Marsh Terns (*Chlidonias leucopareia*); Lotus-birds (*Jacanas*), (*Irediparra gallinacea*), a few pairs only, stalking about among large blue Waterlily flowers, and there near the centre of this part of the swamp were the Pied Geese, by the hundred. We saw their black and white plumage from afar as we came along. There were probably a thousand of them (that at any rate was the lowest estimate made), and they appeared to be feeding—very quietly. Then there would be a little stir and some would rise, a few only at first, followed slowly by more and more amid a wonderful *crescendo* of whirring wings and cackling calls until the whole flock was well aloft—but only to settle down to quietness again, a few at a time with a corresponding *diminuendo* of sound, not far from where they rose.

Sea Birds. Few sea birds were seen, though a day was spent in visiting Keppel Island from Yeppoon. A Wedge-tailed Shearwater (*Puffinus pacificus*) was seen and a Lesser Frigate Bird (*Fregata ariel*). On the shores of the island there were Crested Terns (*Sterna bergi*); Reef-Herons (*Demigretta sacra*); Pied and Black Oystercatchers (*Haematopus ostralegus* and *H. unicolor*); Sea-Curlews (*Numenius cyanopus*), and other birds. The Shoreplover, too (*Orthorhamphus magnirostris*) was seen on the island.

Stork *Oiconidae*. A single Jabiru (*Xenorhynchus asiaticus*) was seen between Yeppoon and Byfield.

Birds of Prey. *Accipitriformes*. Many of the Eagle family were seen in various places. The White-headed Sea-eagle (*Haliastur indus*) of northern coasts was plentiful about Yeppoon. Its white and bright chestnut plumage make it a handsome bird. It is smaller than the White-breasted Sea-eagle (*Haliaetus leucogaster*)—also seen—which is well known further south. The

white-headed bird likes mangrove-fringed shores and the mouths of tidal creeks. Many Whistling Eagles (*Haliastur sphenurus*) were seen from the launches on a trip up the Fitzroy River and birds going to their nests in the high timber on the banks. Grey Goshawks (*Astur novae-hollandiae*) were observed at Byfield; also Crested Hawks (*Baza subcristata*), including a pair of birds at a nest. On Keppel Island, which was visited from Yeppoon, a few Ospreys (*Pandion haliaetus*) were seen, and an old nest.

Owls *Strigidae*. The Rufous Owl (*Ninox rufa*) of the north was seen on two occasions at Byfield. A Boobook Owl (*Ninox boobook*) (and its nest) was seen on Keppel Island.

Parrots and Cockatoos (*Psittaciformes*). Very few of these were observed. Excepting Scaly-breasted Lorikeets (*Trichoglossus chlorolepidotus*) and Blue Mountain Lorikeets (*Trichoglossus moluccanus*), no parrots were seen, but one or two Redwing and King Parrots (*Aprosmictus erythropterus* and *A. scapularis*) on the way to Byfield, also an odd Pale-headed Rosella (*Platycercus adscitus*). A small flock of Red-tailed Black Cockatoos (*Calyptorhynchus banksi*) was seen and a few White Cockatoos (*Cacatua galerita*). We were informed that at times the White Cockatoos are at Byfield in very large numbers.

Kingfishers (*Dacelonidae*). We saw many Kingfishers, small and large, the most plentiful species being the pretty Forest Kingfisher (*Halcyon macleayi*). Of this species we found a few nesting holes all in termite nests in trees. The Blue-winged Kookaburra (*Dacelo leachi*) was the most interesting of the Kingfishers and was seen about Rockhampton and Yeppoon. The silvery blue of the wing and the rich blue of the tail (especially of the male) when the bird is in flight, is very noticeable. The head is light coloured, faintly streaked with brown. The note is simply a kind of loud bark.

Rainbow Birds (Bee-eaters). (*Merops ornatus*). These birds were seen in all the places we visited and sometimes going in or coming out of their nesting burrows. In some sandy soil at Rockhampton Gardens, burrows were made into flat ground. At Yeppoon there were burrows in banks not far above the reach of high tides. A burrow here into which a bird had gone was found to be nearly four feet deep.

Cuckoos. (*Cuculiformes*). Pallid Cuckoos (*Cuculus pallidus*) and Square-tail Cuckoos (*Cacomantis pyrrhophanus*) were heard calling at different places, but never a Fan-tailed Cuckoo (*Cacomantis flabelliformis*). The Rufous-breasted Bronze Cuckoo (*Lamprococcyx russatus*) was seen a few times. This bird deposits its bronze eggs very frequently in the nests of *Gerygone*, of which there are several species in North Queensland. Koels (*Eudynamis orientalis*) were continually heard. The "Cooee" was the usual early morning and evening call, and the "Woo woo woo woo woo" was used more during the way. Screeching Channel-birds (*Seythrops novae-hollandiae*) were heard and seen flying over and Coucals (*Centropus phasianus*) were very common, especially at Yeppoon.

Pittas (*Pittidae*). The Noisy Pitta (*Pitta versicolor*) was heard sometimes but seen once only. We had hoped to see more of it.

Flycatchers (*Muscicapidae*). A good many of the Flycatcher family were seen, but none of the northern forms that it was thought might possibly be found this far south. The Spectacled Flycatcher (*Monarcha trivirgata*) was very common—a brightly coloured bird with no striking note. Two pretty moss nests were found. The rare White-eared Flycatcher (*Monarcha leucotis*) was seen, and a parent bird feeding young. One nest only of this species has been recorded, and there is as yet no record of the eggs. The Black-faced Flycatcher (*Monarcha melanopsis*) was observed occasionally only; the Rufous Fantail (*Rhipidura rufifrons*) once only; the Grey Fantail (*Rhipidura flabellifera*) not

at all. The only Robin seen was the Northern Yellow Robin (*Eopsaltria magnirostris*).

Rufous Shrike Thrush. (*Colluricincla megarhyncha*). This smaller thrush was plentiful and its beautiful "wot, wot" note often heard in the scrub bordering on the mangroves at Yeppoon. Two nests were found in small shrubs, each containing three eggs, white with brown spots.

Cuckoo-shrikes (*Campophagidae*). Nearly all the caterpillar-eaters were seen. The large black-faced bird (*Grauculus novae-hollandiae*) had a nest near the camp, and at the same place a small flock of little Cuckoo Shrikes (*Grauculus robustus*) was seen and their peculiar notes heard which end with a kind of "fizz" sound. The fine barring of the underparts, tail to bill, of the Barred Cuckoo Shrike (*Grauculus lineatus*) was well seen at Olsen's Caves, Rockhampton, where a few birds were found. The two *Lalages*, the varied and the white-shouldered (*Lalage leucomela* and *Lalage tricolor*) were seen, and their nests found. The former, which is the larger, just comes into the north-east corner of New South Wales and, unlike the latter bird (which is well known further south), likes semi-scrub country. It was common at Yeppoon. The Great Caterpillar-eater (*Edolïsoma tenuirostris*) was heard every day in the timber at Byfield, but not seen as a rule unless the call was followed up.

Figbird (*Sphecotheres vieilloti*). This is one of the familiar birds of coastal Queensland, and it was seen very often, not only in the bush, but also close to dwellings and even in the streets of Rockhampton, where in a figtree near the Fitzroy River a pair of birds were making a nest. The male bird is yellowish-green with dark head and tail, and very conspicuous red skin round the eye. The female is brown, has not the red on the face, and is marked underneath like the Oriole (*Oriolus sagittatus*). The birds are about the size of the Oriole, and their chief notes appear to be a mixture of chirps and chatter.

Warblers. *Gerygones*. Two *Gerygones* were of particular interest. The Sweet-singing Mangrove Warbler (*Gerygone cantator*)—well known in Brisbane, but not much further south—was seen and heard among the mangroves at Yeppoon. Still more interesting was the Yellow Warbler (*Gerygone flavida*) which also was plentiful at Yeppoon, as well as about Rockhampton. Ornithologists in the past have been led into errors about this species, partly owing to the bird (both sexes) being similar in appearance to the female bird of a more northerly species called *Gerygone personata*, the male of which species has a dark throat. One result of this trip has been to correct these errors and to confirm beyond doubt the validity of the *Flavida* species. Nests were found, in some cases hanging beside a wasp's nest. One nest contained a bronze coloured cuckoo's egg, almost without doubt that of the Rufous-breasted Bronze Cuckoo (*Lamprococcyx russatus*). The nest is of the hanging *Acanthiza* type, heavily hooded, and with a long thin tail decorated with brown wood-borings.

Orange-backed Wren (*Malurus melanocephalus*). This bird was very often seen. It was about the Rockhampton Botanical Gardens and Mr. Archer's lovely garden at "Gracemere," and at Yeppoon was particularly common in the bushes beside the coast road. One would hear *Malurus* warbles and see among the warblers the male bird, not with blue plumage (which the southerners would expect), but with head and neck velvety black, which colour catches the eye more quickly than the orange of the back. The females are light brown in colour. Some brown birds were seen with orange backs—apparently young males. The warble was like that of the Blue Wren (*M. cyaneus*), but less animated. No other *Malurus* was seen anywhere.

Wood Swallows (*Artamidae*). Three northern species were seen. The White-breasted Wood-Swallow (*Artamus leucorhynchus*) was plentiful, and there was a nest in a palm at Rockhampton. The Grey-breasted and also the Little

Wood-swallows (*A. hypoleucus* and *minor*) were also seen a little way out of the town.

Whip-bird (*Psophodes olivaceus*). It is worth recording that, though we were in many scrubs, which, if in New South Wales or South Queensland would have contained these birds in numbers, we rarely heard their notes.

White-headed Sitella (*Neositta leucocephala*). Little flocks were sometimes seen in the timber. Head and neck are all white. Rufous band on wing like the Orange-winged bird (*Neositta chrysoptera*) and same note.

Black-headed Pardalote (*Pardalotus melanocephalus*). This bird was fairly plentiful about Rockhampton.

Sunbird (*Cyrtostomus frenatus*). Perhaps the most interesting of all the birds we saw was this gay and active little sprite of humming-bird appearance. It inhabits the coastal districts of tropical Queensland. We were fortunate in seeing birds at Yeppoon which must be about their "furthest south." Their plumage is bright yellow below and yellowish-green above, the male bird's neck and chest being of a rich metallic blue colour. Their bill is large and long, like the Spinebill Honeyeater's, and they have that bird's rapidity of movement and habit of hovering beside a blossom or clinging to it while extracting the nectar. They are fond of the flowers of the red Hibiscus and of the Paw-paw trees, and seem to like living close to dwellings. We saw a nest hanging from a piece of wire in the verandah of an unoccupied cottage at Yeppoon—a long fragile-looking nest, light in colour, and with a side entrance. The female bird was completing the lining of the nest with white downy material, the male singing lightly close by.

Honeyeaters (*Meliphagidae*). Considering what a large family this is, few species were observed. White-throated Honeyeaters (*Melithreptus albogularis*) —very like *M. lunulatus,* but no vermilion round the eye—were seen dipping into the water of Fairy Bower Creek, Rockhampton, one hot day. Scarlet Honeyeaters (*Myzomela sanguineolenta*) were numerous and the male birds constantly to be heard singing along the creek near the camp at Byfield. Another bird of this genus, the Dusky Honeyeater (*M. obscura*) was very plentiful at Yeppoon—a very brown bird. They were very lively and noisy in some Lilly-pilly (*Eugenia*) trees. Another quietly coloured small Honeyeater, the Brown Honeyeater—*Lichmera* (*Stigmatops*) *indistincta*—was perhaps the species of this family most often seen. It is a fine singer and its loud and cheerful note was heard in most places we visited. Varied Honeyeaters (*Meliphaga versicolor*) were seen in numbers on Keppel Island. This seems to be a common bird on the coastal islands of North Queensland. Strangely none was seen on the mainland. It has a good loud note. Of the larger Honeyeaters two Leatherheads (*Philemon corniculatus* and *P. citreogularis*) were often seen and still more plentiful was the handsome Blue-faced Honeyeater (*Entomyzon cyanotis*). A pair of these had their nest over one of the tents at Byfield. This was one of their own pendulous nests and not made on the old nest of another species, as is often the case.

Finches (*Ploceidae*). Not as many finches were seen as might have been expected. Banded Finches (*Steganopleura bichenovii*) were the most common. Red-browed Finches (*Aegintha temporalis*) and Black-throated Finches (*Poephila cincta*) were also seen.

Spangled Drongo (*Chibia bracteata*). This bird was seen and its harsh note heard in the timber. Not a great many were noted.

Pied Butcherbird (*Cracticus nigrogularis*). This bird was seen wherever we were and nests found. Its notes are loud, rich and clear. It is one of our greatest song-birds.

Altogether over 180 species were identified and nests (this year's) of 42 species were seen.

CAPTAIN COOK'S KANGAROO.

By Tom Iredale and Ellis Le G. Troughton.
(Contribution from the Australian Museum.)

In submitting the following notes upon the identity of Captain Cook's Kangaroo it is important to emphasise that, contrary to general belief, Captain Cook did not observe a kangaroo at Botany Bay.

We are indebted to Mr. J. J. Fletcher, M.A., B.Sc., for valuable comment, and several references, including the following extract from a modern book, "Britain's Heritage of Science," by Schuster and Shipley, two very famous English naturalists, wherein the popular fallacy is maintained—p. 241. "Banks was a wealthy man, and was able to indulge his passion for travelling. . . . . Banks left England in August, 1768, on Captain Cook's *Endeavour*. The scientific part of the Expedition was financed by Banks; and he was accompanied, not only by Dr. Solander, but by two artists and two attendants. It would take too much space to dwell upon that remarkable voyage. Banks was collecting, not only plants, but animals and noted, as an ancient writer said, "ye beastlie devices of ye heathens." At a spot they christened *Botany Bay,* owing to the wealth of plant-life in the district, *kangaroos were observed for the first time.*"

Regarding the above it is of interest to note that Fletcher pointed out twenty years ago (Proc. Linn. Soc. N.S.W., xxx., 2, 1905, p. 223) that Solander's Journal would doubtless reveal something regarding the kangaroo; he also referred to the fact that all Captain Cook's kangaroos were killed at the Endeavour River, Cooktown, and expressed the hope that attempts would be made to follow the matter up.

Our endeavours to ascertain the identity of the kangaroo, actually secured at Cooktown, have disclosed facts which appear to foreshadow complications as involved as any hitherto encountered by us.

As Hawksworth's account of Captain Cook's voyages is well known, we here quote the items as seen in Captain Cook's Journal and Sir Joseph Banks's Journal, from which Hawksworth framed his work. The first indication of such an animal appears on p. 244 of Wharton's edition of the former, only issued in 1893, where, reciting the doings at Botany Bay on May 1st, 1770, Cook wrote: "In the woods between the Trees Dr. Solander had a bare sight of a Small Animal something like a Rabbit, and we found the Dung of an Animal which must feed upon Grass and which, we judge, could not be less than a Deer, we also saw the Track of a Dog, or some such like Animal." This is the complete account of the Botany Bay Kangaroo, and we must now travel north until the Endeavour is beached on the spot where Cooktown now stands, continuing Cook's narrative again, p. 280, June 23rd, 1770: "One of the Men saw an Animal something less than a Greyhound; it was of a Mouse Colour, very slender made, and swift of Foot." Page 281, June 24: "I saw myself this morning a little way from the Ship, one of the

Animals before spoke of: it was of a light mouse Colour and the full size of a Grey Hound, and shaped in every respect like one, with a long tail which it carried like a Grey Hound; in short, I should have taken it for a wild dog, but for its walking or running, in which it jumped like a Hare or Deer. Another of them was seen to-day by some of our people who saw the first: they described them as having very small Legs, and the print of the feet like that of a Goat: but this I could not see myself because the ground the one I saw was upon was too hard, and the length of the Grass hindered my seeing its legs." Page 287, July 14: "Mr. Gore, being in the Country, shott one of the Animals before spoke of: it was a small one of the sort, weighing only 28 pound clear of the entrails: its body was long: the head, neck and Shoulders very Small in proportion to the other parts. It was hair lipt, and the Head and Ears were most like a Hare's of any Animal I know: the Tail was nearly as long as the body, thick next to Rump, and Tapering towards the End: the fore Legs were 8 Inches long, and the Hind 22. Its progression is by Hopping or Jumping 7 or 8 feet at each hop upon its hind Legs only, for in this it makes no use of the Fore, which seems to be only design'd for Scratching in the ground, etc. The Skin is covered with a Short hairy furr of a dark Mouse or Grey Colour. It bears no sort of resemblance to any European animal I ever saw: it is said to bear much resemblance to the Jerboa, excepting in size, the Jerboa being no larger than a common rat." Page 291, July 27: "Mr. Gore shott one of the Animals before spoke of, which weighed 80 lbs. and 54 lbs. exclusive of the entrails, Skin, and head; this was as large as the most we have seen."

After leaving the place, Cook epitomised the natural history, writing, p. 294: "Besides the Animals, which I have before mentioned, called by the natives Kangooroo, or Kanguru. . . . . The Kanguru are in the greatest number, for we seldom went into the Country without seeing some."

Such are Captain Cook's notes written at the time and obviously made up from the Naturalists' conclusions as hereafter shown. Banks' Journal was edited by Hooker and published in 1896 and the account there written shows how much Cook is indebted. Page 267, May 1st, 1770, Botany Bay: "We saw one quadruped about the size of a rabbit. My greyhound just got sight of him, and instantly lamed himself against a stump which lay concealed in the long grass. We also saw the dung of a large animal that had fed on grass, much resembling that of a stag; also the footprints of an animal clawed like a dog or wolf, and as large as the latter, and of a small animal whose feet were like those of a polecat or weasel." Page 282, June 23rd, Cooktown: "The people . . saw an animal as large as a greyhound, of a mouse colour, and very swift." Page 282, June 25th: "I have had the good fortune to see the beast so much talked of, though but imperfectly; he was not only like a greyhound in size and running, but had a tail as long as any greyhound's: what to liken him to I could not tell, nothing that I have seen at all resembles him." Page 284, July 6th: "We saw three of the animals of the country, but could not get one." Page 285, July 7th: "Saw four of the animal's, two of which my greyhound fairly chased: but they beat him owing to the length and thickness of the grass, which prevented him from running, while they at every bound leaped over the tops of it. We observed, much to our surprise, that instead of going upon all fours, this animal went only upon two legs, making vast bounds just as the jerboa (*Mus jaculus*) does." Page 287, July 14th: "Our second lieutenant had the good fortune to kill the animal that had so long been the subject of our speculations. To compare it to any European animal would be impossible, as it has not the least resemblance to any one I have seen. Its forelegs are extremely short, and of no use to it in walking; its hind

again as disproportionately long: with these it hops seven or eight feet at a time, in the same manner as the jerboa, to which animal indeed it bears much resemblance, except in size, this being in weight 38 lbs., and the jerboa no larger than a common rat. 15th: The beast which was killed yesterday was to day (p. 288) dressed for our dinner, and proved excellent meat." Page 291, July 27th: "This day was dedicated to hunting the wild animal. We saw several, and had the good fortune to kill a very large one weighing 84 lbs." Afterwards "Having now, fairly passed through between New Holland and New Guinea," a summary of the Natural History is given, and p. 301—"Quadrupeds we saw but few, and were able to catch but few of those we did see. The largest was called by the natives *kangooroo*: it is different from any European, and, indeed, any animal I have heard or read of, except the jerboa of Egypt, which is not larger than a rat, while this is as large as a middling lamb. The largest we shot weighed 84 lbs. It may, however, be easily known from all other animals by the singular property of running, or rather hopping, upon only the hind legs, carrying its forefeet close to its breast. In this manner it hops so fast that in the rocky bad ground where it is commonly found, it easily beat my greyhound, who, though he was fairly started at several, killed only one, and that quite a young one."

These are the original accounts from which the common description is drawn up, and two points stand out prominently. These were pointed out to us by Mr. Charles Hedley, now Scientific Director of the Great Barrier Reef Investigation Committee, who initiated this inquiry by explaining that the Great Sydney Kangaroo was unlikely to live at Cooktown. The thanks of science are due to Mr. Hedley for his most interesting suggestion that a correct interpretation of the identity of Captain Cook's Kangaroo had never been attempted.

It will have been observed that Cook mentioned Solander in one place, and then never either Banks or Solander again. Banks used the first person singular in his Journal, including Solander's observations with his own, without acknowledgment. However, by reading between the lines it is apparent that it must have been Solander's suggestion that it was like a Jerboa. Hawkesworth's account deals with the young mentioned above, giving the measurements from Cook's Journal, as forelegs 8 in., hind legs 22 in., and weight 38 lbs. A figure is given (Cook's Voyages, vol. iii., 1773, p. 577, tab. xx.) which is here reproduced, and the animal is placed on rocky ground, such as described above as its habitat.

Sydney Parkinson, draughtsman on the Endeavour's voyage, gives the following account (A Journal of a Voyage to the South Seas, 1773, pp. 145-6), to which Mr. J. J. Fletcher very kindly drew our attention:—"and an animal of a kind nearly approaching the mus genus, about the size of a grey-hound, that had a head like a fawn's; lips and ears, which it throws back, like a hare's; on the upper jaw six large teeth; on the under one two only; with a short and small neck, near to which are the fore-feet, which have five toes each, and five hooked claws; the hinder legs are long, especially from the last joint, which, from the callosity below it, seems as if it lies flat on the ground when the animal descends any declivity; and each foot had four long toes, two of them behind, placed a great way back, the inner one of which has two claws; the two other toes were in the middle, and resembled a hoof, but one of them was much larger than the other. The tail, which is carried like a grey-hound's, was almost as long as body, and tapered gradually to the end. The chief bulk of this animal is behind; the belly being largest, and the back rising towards the posteriors. The whole body is covered with short ash-coloured hair; and the flesh of it tasted

like a hare's, but has a more agreeable flavour." A pencil drawing of the animal described by Parkinson is probably preserved in the British Museum of Natural History, though we are unable to refer to it at this time.

At once such a strange animal received scientific names, Zimmermann and Erxleben both in 1777 calling it *Jerboa gigantea* and *Jaculus giganteus* respectively, simply basing the names on the description and figure given in Cook's Voyages of the small animal killed at Cooktown. Apparently no one has ever critically examined this figure as it is obviously not based on the species local to Sydney.

In endeavouring to arrive at a definite conclusion Iredale wrote to the British Museum where the original descriptions prepared by Solander are preserved. Through the kindness of Mr. Francis J. Griffin, of the Natural History Library, South Kensington, Iredale has received a complete copy of the M.S.S. account written by Solander, and as this is very important we reproduce it here.

KANGURU. *Dentes Primores* superiores vi, approximati. Inferiores ii., magni, porrecti.

Laniarii nulli.

Molares iv utrinque a primoribus remotissimi.

Pedes antici brevissimi (5 dactyli).

postici longissimi (3 dactyli: digito intimo biunguiculato).

Saliens. KANGURU. *Novis Hollandis.*

Habitat in *Nova Hollandia.*

In multis convenit *Mure longipede* Linn. et *M. Jaculo* Linn. xiv antea genere illis conjungi queat. ob . . . . Dentes primores superiores diversissimos; his etjam ab omnibus aliis Gliribus discrepat.

Saliendo ambulat, saltus longissimos praecipue inter saxa faciens, solis pedibus postici incedens.

Vegetabilibus victitat, uti e stercore et contentis intestinorum judicare licuit, stercus *Cervi Dama* Linn. non absimile est. Pedes antici pro fodiendo inserviunt.

Caput. (Cervi Damae junioris simillimum), oblongum, ante oculos angustatum; *Rostrum* breviusculum, parum compressum; apice inter nares nudum ibique cute aterrima rugulosa vestitum.

Labium superius bipartitum, clausum, gibbosiusculum.

Labium inferius acute emarginatum, superior brevius, unde os fere sub medio rostri.

Narium foramina flexuosa (fere uti), aperta.

Mystaces utriusque Labii copiosi, pluribus ordinibus dispositi, nigricantes; supremi labii superioris longiores.

Setae, supra and infra oculos; superiores longiores, copiosiores.

Oculi mediocres. *Iris* brunneo-fusca; *Pupilla* e caeruleo-nigra.

Auriculae ovato-oblongae, obtusae, erectae, basi coarctatae, simplices, pilosae, capite (1/3) breviores.

Lingua lata, obtusa, glabra, mollis.

Dentes primores superiores Incisores sex, approximati, lati; Primum par leviter bilobum; secundum integrum; tertium latius crassiusque, bilobum: lobis anticis minoribus.

Laniarii nulli.

Molares et primoribus remotissimi quinque utrinque, *inferiores* duo, magni, porrecti, lanceolati, acuti, intra lato et obtuse carinati.

Obs. Par intimum Molarium diu intra alveolos suos latitat, in junioribus non discernendum.

Collum breve, angustum.

Truncus obovatus, antice valde attenuatus.

Dorsum teretiusculum, postice latum. *Regio lumborum* magna. *Pectus* angustatum.

Abdomen convexum, magnum.

Pedes antici brevissimi, rostrum vix adtingentes, angusti.

Digiti quinque, sub aequales antrorsum versi, unguiculati.

Unques lanceolati, acuti longi, robusti, subtus-concavi; nigri.

Pedes postici longitudine fere corporis.

Femora crassa.

Tarsi longi, subtus nudi et cute atra verruculosa tecti.

Digiti tres:

exterior brevissimus, crassus, ungue brevi, crassiusculo armatus.

medius maximus, reliqui quintuplo major, porrectus,—ungue crasso, obtuso praeditus.

interior longitudine exterioris, sed angustior, apice bifidus, ideoque instructus unguibus duobus, lanceolatis, acutis.

Cauda longissima, vix corpore brevior (ad aures enim illa reflecti potest), teres, aequaliter pilosas basi valde crassa, sensim angustata; primum porrecta, dein parum declinans, apice leviter and arcu lato recurva.

Scrotum exertum, inter femora pendulum.

Penis sub cauda retrospiciens, Praeputio crasso, exerto cinctus.

Vulva et *Meatus urinarius* communem cum ano habent aperturam.

Anus supra penem, sed quasi ex eodem orificio, proprio tamen sphinctire cinctus.

Regio mammarum sub postica parte abdominis (in juniore tantummodo visa), nuda erat, mammis nondum exertis.

Color totius animalis cinereus; auriculae obscuriores.

Hirsuties per totum corpus aequalis.

Magnitudine ratione aetatis ad modum variat.

Femina junior forte unius anni et semis octo librarum pondere erat; Mas forte bi- vel triennis viginti et quatuor, librarum, Mas adultus octoginta libras pondebat.

Mensura maris biennis hoc erat.

Corporis totius	28 unc.
Cauda	26 unc.
Capitis	6
Auricularum	4
Pedum anticorum	8½
„ posticorum	22

Kanguru *Novis Hollandis.*

This excellent description, in our opinion for reasons enlarged upon below, establishes beyond all reasonable doubt that Captain Cook's Kangaroo was not the Great Grey Kangaroo (*Macropus giganteus*) of southern Queensland, New South Wales, and other States. An analysis of the characters of Cook's Kangaroo given in Solander's M.S. description quoted above, supports our conclusion in a very definite manner as follows:—

The description says that the rhinarium between the nostrils is naked, and that the 3rd incisor is bilobate, whereas two of the essential diagnostic characters of the Great Grey Kangaroo are the hairy rhinarium, and the two external notches on the 3rd incisor, which render the tooth trilobate. So distinctive of the Great Grey Kangaroo are the two latter characters that their absence in Cook's animal leaves no doubt that the two are not synonymous.

In the absence of original specimens or any material from the Cooktown area, the identity of Cook's species must remain a matter for conjecture. However, we venture to point out hereunder, that the weight of evidence suggests a form of the *robustus* series, a possibility to which we intend to refer at a later date upon examination of material which we are now endeavouring to acquire.

Solander's description of the rhinarium as naked between the nostrils and covered with very black, rough skin, is typical of the *robustus* type. He also describes the 3rd incisor as bilobed, with the anterior lobe very much smaller, thus implying that the notch or groove is decidedly anterior in position; both the single notch and its situation are also typical of *robustus*. Though the specimens examined by Cook were apparently not fully grown, the measurements given by Solander are not incompatible with those of a medium sized Wallaroo, the full-grown of which average considerably smaller than the Great Grey Kangaroo. The ear measurement, while making allowance for different methods of taking it, shows the ear to be proportionately very large, a feature also typical of *robustus*. Furthermore the figure and the rocky habitat described in the Journals, all indicate an affinity with the Wallaroo; Banks described the habitat as "in the rocky bad ground where it is commonly found," while Professor Wood Jones has recently described the Wallaroo's habitat as "of the high, rock strewn ranges" as opposed to the country "characterised by dense scrub and open glades" frequented by the Great Grey Kangaroo.

The colour of Cook's specimens was variously noted as "mouse colour," "dark mouse or grey colour," "of a mouse colour," and in Solander's description as "cinereus" for the general colour. It is noteworthy that Solander, in his very able description, makes no mention of the brown element found in the colouration of the Great Grey Kangaroo, and that the ashy or mouse colour of Cook's specimens is more reconcilable to the Wallaroo's general colour than to that of any other larger form local to the Cooktown area.

Appreciating the serious consequences attaching to the disturbance of names happily established by long precedent, while pointing out the apparently indisputable fact that the kangaroo observed at Cooktown was not the Great Grey Kangaroo, we have conceived it wise to make no premature decision as to its real identity.

It was quite natural that the first settlers at Port Jackson should regard their animal as the same as Cook's now famous beast, but even in Phillip's Voyage (p. 104) we read: "The largest kanguroo which has yet been shot weighed about one hundred and forty pounds. But it has been discovered that there are two kinds, one of which seldom exceeds sixty pounds in weight; these live chiefly on the high ground; their hair is of a reddish cast, and the head is shorter than in the larger sort."

Hunter in White's Journal (p. 292) notes "This animal (probably from its size) was the principal one taken notice of on this island; the only parts at first brought home were some skins and sculls (sic); and I was favoured with one of the sculls from Sir Joseph Banks." This is an important statement, which also seems to have been overlooked, as the skull probably exists to-day in the Museum of the Royal College of Surgeons.

Pennant also, in his history of Quadrupeds, gives an account prepared from Solander's Manuscript by favour of Banks with whom Pennant was very friendly. In the third edition, 1793, the only one available here, the information from Phillip's Voyage is added, but in the earlier edition the whole account must be from Banks.

Realising that the diagnostic characters of Cook's Kangaroo may be applicable to several forms of *Macropus*, we have refrained from a drastic interference with nomenclature, so that the present arrangement may stand, pending added proof of our conclusion that the Cooktown animal was not the Great Grey, but a smaller form, most probably of the *robustus* series. We also feel that this treatment of the problem will meet with the approval of the older school of conservative workers, though we anticipate a definite rearrangement in the near future. The preparation of this paper has been actuated by the desire to present all the information available for the benefit of those interested, at the same time deprecating any premature or needless confusion, pending additional data which we will endeavour to obtain for future publication.

PARASITISM IN SOME OF THE LOWER ANIMALS.

By Gilbert Whitley.

(By permission of the Trustees of the Australian Museum.)

Many diseases are caused by parasitic "worms" and "germs" and, since diseases are better prevented than cured, it is necessary for the public to realise the necessity for dealing with these enemies before they can obtain a foothold. The importance of eating well-cooked, clean food cannot be too strongly emphasised, and the age-long war against insects which carry disease should be waged as ruthlessly as ever. Intimacy with pets such as cats and dogs is often the cause of hydatids, and hygienic supervision should be maintained over all domestic animals as much as possible for their own welfare, as well as for that of their masters. The proper disposal of sewage is another important factor for the reduction of diseases caused by the lower animal parasites. Migration and the introduction of men and animals into new areas should also be considered from the parasitological standpoint. In these ways, diseases could be minimised and these precautions, combined with researches in other branches of science, would, in time, make the world safer for human habitation, and healthier and happier races of men and stock would result. The old wasteful methods of natural selection (whose efficacy, however, none can deny) would then give place to the new "artificial selection" and the Age of Man would attain a greatness unrivalled by any that has preceded it.

The cuckoo which places its egg in another bird's nest, the young mussels which live in the skin or gills of certain freshwater fishes, the bag-like Sacculina which attaches itself to a crab to absorb its vital juices, and the human being who lives at the expense of his friends are all examples of parasites, and serve to show that parasitism, the act of living at the expense of another creature to its detriment, is widely spread in the animal kingdom. Parasites may be broadly classified into three main groups: commensals, which share tables with their hosts without harming them in any way; symbionts, which live in still more intimate co-relationship with their hosts, so that mutual benefits usually result; and true parasites, which cultivate themselves entirely at the expense of their hosts without giving any benefits in exchange. These three groups merge one into the other so that it is difficult at times to assign a given parasite to any one of them. Parasitism, besides being widely in vogue in the animal kingdom generally, has a myriad disciples among the animalcules and flatworms (Protozoa and Platyhelminthes) which form the subjects of this article. These parasites may be broadly divided into two groups: external parasites, known also as ectoparasites or epizoa; and internal parasites, endoparasites or entozoa.

Mere fixation to the exterior of an animal can hardly be termed parasitism, though the sedentary visitor may get beneficial transport without exerting itself, yet this habit is evidently the first step taken by a free form which is destined

to evolve into an ectoparasite. Innocuous creatures like the Vorticellae and Amoebae found on the limbs of marine animals are examples of this type among the Protozoa, whilst the Temnocephala and certain Turbellaria afford parallel cases in the Platyhelminthes. It is well known that an organ which is not used tends to degenerate, so that the first thing which happens to an animal which relies upon another for transport is the deterioration of its locomotor organs. The cilia, legs, and such structures give place to stalks, suckers, hooks, or other organs of adhesion or attachment. The Triclad parasite of the freshwater Tortoise (*Chelodina longicollis*) has lost its cilia and evolved posterior suctorial discs. The young *Vorticella*, after attaching itself, loses its posterior band of cilia and grows a stalk there instead. These harmless examples, however, are linked up by a series of intermediate forms with ectoparasites which are very harmful to their hosts. It is conceivable that some primitive ectoparasite became affixed to its substratum in such a way as to derive nourishment therefrom, eventually becoming injurious to its host. Such a form as *Ichthyophthirius* may have evolved in this way. *Ichthyophthirius* is a ciliate infusorian which burrows into the epidermis of fishes. It forms a cavity for itself by displacing the cells of its host around it, and rotates therein by means of its cilia, which it retains throughout life. In addition to the harm the parasite itself does, bacteria may enter the wounds it forms and introduce toxins.

The change from a temporarily or permanently affixed animal to an ectoparasite is slight compared with the change from an ectoparasite to an endoparasite. Yet internal parasites must have evolved from epizoic or else free-living forms. This change may have come about in many ways, upon which we, in our present state of knowledge, can only theorise. The host of a primitive ectoparasite may have been eaten habitually by another animal, and the ectoparasites, being transferred to the stomach of a new host, may have been able to adapt themselves to their new environment. Or again, the external surfaces of their hosts having become overcrowded or unsafe in some way, the pioneering ancestors of modern entozoa may have sought shelter in the buccal cavities of their hosts. This habit is far from unknown in animals, since there is a considerable protozoan and, in some cases, metazoan, fauna in the mouths of many animals. A long series of evolutionary changes would have to take place in both host and parasite before the wonderful mutual relationships met with to-day in many entozoa became finally perfected. For a lowly protozoan, a change from external environment to internal would not be so severe as it would be for the more highly specialised flatworm. How endoparasites have solved the problem is not known; the process must have taken a long time, because the hosts would naturally have revolted against this invasion and would have tried to eject the parasites or to destroy them. If these measures failed, the hosts would either have had to tolerate the parasites or die. On the other hand, the parasites had to cope with and overcome the difficulties put in their way by their hosts or else would have ceased to exist. Parasites of the alimentary canal probably evolved into parasites of other internal organs through wounds in the walls of the host's intestine. Carried by the blood-stream, they either lived therein, or became suited for life in special organs such as the liver. Another invasion of internal parasites may have entered through air-passages and skin-wounds into their hosts. There are harmless and harmful endoparasites as well as ectoparasites. For instance, *Entamoeba coli* feeds on bacteria and other micro-organisms in the intestine of man and probably does more good than harm by its scavengering activities. Its relative, *Entamoeba histolytica*, on the other hand, is a dangerous parasite which feeds on the epithelial cells of its host,

thereby not only causing dysentery in man, but becoming carried in the blood-stream to other organs of the body. The step from a harmless entozoan like *Entamoeba coli* in man or *Lophomonas* in the cockroach to a form which feeds on its host's food so as to weaken it is a small one, and but a preliminary to the evolution of the habit of becoming attached to, and perhaps devouring, the epithelial cells of the host, as do the Gregarines and many Trematodes and Cestodes.

As a result of this long process of mutual adjustment on the part of host and parasite, animals eventually tend to become immune from the diseases caused by their parasites, which are kept in check. Though a stronger race of hosts may be evolved by the "survival of the fittest," as a result of the stock being parasitised, the parasites themselves have to pay a price for the sheltered life they enjoy. The more comfortably settled the parasite is, the more its organs degenerate, until only the absolute essentials for living and perpetuating the species remain. The best example of degeneracy in a parasite is the Crustacean *Sacculina*, but since that is beyond the scope of this article, the tape-worm will be selected as an illustration instead.

The adult tape-worm has no organs of locomotion whatever. It has suckers, or hooks, or both for attaching itself to its host's intestinal walls. The tape-worm has no mouth, no stomach and, therefore, no digestive apparatus. Such organs would be luxuries in a creature which lives bathed in food already digested for it, so the tape-worm simply absorbs its nourishment through its general body-surface by osmosis. The body-surface is consequently very extensive and porous; it is also supported by very contractile muscles and the undulating movements of living tape-worms probably resist the peristaltic motions of the host's intestine, which might tend to expel the parasites in spite of their suctorial or hooked attachment. The tape-worm is without eyes or organs of special sense, these likewise being useless to a creature in such an environment.

Although so lacking in the things usually considered to be essential to the enjoyment of life, the degenerate tape-worm cannot fail to impress one with its wonderful adaptations to its parasitic existence, and one of the most wonderful of these is its capacity for perpetuating its race. The body of a tape-worm such as *Taenia*, consists of a large number of segments which grow from the attached head end and become larger posteriorly. In them, the hermaphrodite reproductive organs develop. At first, the male organs predominate, the testes forming sperms which are stored in special vesicles of another segment either of another tape-worm or of the same individual, or a segment may even impregnate itself. When the male elements have been shed, the female organs replace the male in each segment, the fertilised ova passing into the growing uterus. The ripe segment finally drops off the tape-worm, full of developing embryos, and is ejected by the host animal with its faeces. Since the chances are overwhelmingly against the taking up of a deposited egg by a suitable host, the prolificacy of the tape-worm is justified.

Since reproduction is essential to the perpetuation of a species, great modifications, not only in the sexual organs themselves, but also in the embryos and larvae are commonly met with in flatworm parasites. Hermaphroditism and great productiveness is the rule amongst these animals, and self-impregnation in some forms is of frequent occurrence. The Protozoa, of course, have not differentiated along the lines of sex very much, but their adaptations for continuing their species are of necessity just as successful as those of higher animals. A favourite method with members of the exclusively parasitic class Sporozoa is to spread rapidly over a host by the repeated division of one animal into many sporonts which are forms capable of being transferred to a fresh host. When

taken up by an intermediate host, these sporonts give rise to gametes or so-called males and females, which fuse in a manner similar to the ova and spermatozoa of higher animals to form zygotes. The latter also give rise to still more individuals by encysted spore-formation, the resultant young being capable of infecting the primary host again.

From the above, it will readily be seen that it is necessary for the survival of the species that the parasite, having found its host, should grow to maturity and arrange for its descendants to be transferred to another host, since it is obvious that one host cannot serve a species of parasite indefinitely. The mode of transference from one host to another is usually effected by active migration on the part of the external parasite or, more usually, its young in the more primitive types of parasites. Other forms solve the problem by being carried from one host to another by an intermediate host. A somewhat primitive method of transference by this means is displayed by some entozoa. These parasites remain in their host whilst it is eaten by another animal, finally becoming liberated in the intestine of the latter. Here they resist the action of digestive juices and are finally ejected with the faeces. The parasites are later eaten again by their primary hosts. This is probably how the sporozoan parasite (*Monocystis*) of the earthworm is spread. Infected worms may be eaten by birds, whose faeces are eaten along with earth, mould and such like by other earth worms.

The blood-parasites, such as the Haemoflagellates and the Haemosporidea are carried by blood-sucking invertebrates such as leeches, or mosquitoes and fleas. Some protozoan parasites become intranuclear parasites in Amoebae, which form their intermediate hosts. The larvae of Cestodes are swallowed by invertebrate or vertebrate intermediate hosts, in which they develop into cysticercoids and cysticerci (bladder worms which may cause hydatids) respectively; eventually, the intermediate host may be devoured by the final host, in which case, the adult form is reached. In the Trematoda, the well known life-history of the Liver Fluke, *Fasciola,* is typical of the methods of employment of intermediate hosts in that class.

Those parasites which do not make use of secondary hosts adopt other ruses, a few selected examples of which will be quoted here. Protozoan entozoa, such as the Entamoebae, have an encysted resting period external to their hosts, during which they may be carried by wind, water or some other agent to a fresh host. Some of the Myxosporidea wait until the host which they have killed disintegrates, when they are set free; others of the same group give rise to ulcers which burst and liberate their young. *Nosema,* another Myxosporidean, causes silkworm disease, and may be transmitted in two ways: firstly, by a silkworm eating the faecal matter of another silkworm on the leaves upon which it feeds, and, secondly, by the spores of the parasite entering the ovaries of the adult female moth, infecting the ova so that the next generation of silkworms is born with the disease.

From medical and veterinary standpoints, the study of Parasitology is of enormous importance, since parasites are often the cause of disease when they multiply too rapidly in animals. The study of life-histories and intermediate hosts is an essential and often difficult part of this work. The tendency in Nature is to cause host and parasite to become adapted one to another, in some cases to such an extent that a specific parasite only exists on or in a single species of host, but in man and his domesticated animals, which are more or less exempt from natural selection, disease is quite common and dire results may follow the introduction of a new parasite.

The Trypanosomes of African wild game furnish excellent examples of

parasites and their relationships with their usual and unusual hosts. The jungle animals have become tolerant of the Trypanosomes found in their blood, but domestic cattle introduced into South Africa have not acquired this faculty; when they or their human masters become infected with the parasites, through the agency of the tse-tse flies, they soon succumb to the evil effects the parasites produce. The separation of the wild game animals and their parasites from their relatives in other parts of the world has lasted so long that they are now "reservoir-hosts" of those Trypanosomes which are so deadly to their less hardy congeners.

Another feature arising from the distribution of hosts applies more to animals which are potential intermediate hosts of parasites. The malaria parasites (*Plasmodium*) are spread by a single genus of mosquitoes (*Anopheles*), which act as intermediate hosts. Anopheline mosquitoes are, however, sometimes found in districts in which malaria is unknown. If one of these mosquitoes were to suck the blood of a malaria patient, the disease would in all probability become endemic in a hitherto unaffected area.

Many diseases, the causative organisms of which have not yet been discovered, are doubtless caused by animals which are ordinarily regarded as harmless, but which really act as intermediate hosts. Thus, although the common flea (*Pulex irritans*) has not been proved to be an intermediate host of any pathogenic parasites, it might in all probability become one and cause the transference of blood-parasites much in the same way as the rat-fleas carry plague.

Pathogenic parasites weaken their hosts either by devouring or harming their tissues, or by producing toxins of a poisonous nature. The affected host either counters by elaborating antitoxins in its blood to neutralise the toxins of the parasite or to kill the parasite itself, or else devours the invader by means of the white blood-corpuscles (phagocytosis). These thrusts and parries continue until immunity from the disease caused by the parasite is acquired, mainly because of the adequate production of antitoxins. Man invents antitoxins by inoculating animals such as monkeys and horses with the parasites or their poisons in small doses and collecting the antitoxin-containing serum. Patients are then inoculated with this serum and may then acquire immunity. In disease caused by worms, anthelminthics such as herbs which have a purgative effect or poisons which kill the worms without harming the host are usually employed, generally after a period of fasting on the host's part in order to weaken the worms.

NOTES ON AUSTRALIAN DIPTERA WITH DESCRIPTIONS OF THIRTEEN NEW SPECIES.

By J. R. Malloch.

(*Communicated by E. W. Ferguson.*)

Family Muscaridae.

Subfamily Phaoniinae.

Genus Dichaetomyia Malloch.

The Australian species of this genus which I have seen are largely or entirely yellow in colour. Some of the species extend their range into New Guinea, but so far as I know none occur in the southern parts of Australia, in Tasmania or New Zealand. Under certain of the species I discuss their relationships and identities, but only an examination of the type specimens of some of Stein's species described under *Mydaea* will definitely decide the question of specific names.

There are two or three rather clearly defined groups amongst the Australian species. Three of the species may be separated from all the others by the character of the hairing of the scutellum. In these species the minute black hairs descend to the lower margin of the sides of the scutellum and well below the level of the strong marginal bristles, while in the other species these hairs are discontinued at or very close to the bases of the bristles. The three species in this first section, i.e., with lateral scutellar hairs, may be separated as follows:

Key to species.

1. Males 2
   Females 4
2. Thorax with 2 + 3 dorsocentral bristles; mid femur with a series of four or more black bristles on basal third of anterodorsal surface, which are quite conspicuous; hind femur with rather dense black setulose hairs on median third of ventral surface which become longer apically, the anteroventral bristles very long from near base to near apex, their tips hair-like; fore tibia with usually an anterodorsal and an anteroventral bristle near middle .. .. *rigidiseta* Stein
   Thorax with 2 + 4 dorsocentral bristles; mid femur without distinct anterodorsal bristles at base; hind femur not armed as above 3
3. Fore tibia with at least one median bristle; hind femur swollen near base, the swollen part with dense erect short black hairs which are flexed near the apices, a stout black thorn about one-third from apex on posteroventral surface which is much longer than the diameter of femur, directed obliquely forward, and has its tip bent .. .. .. *armata* Stein
   Fore tibia unarmed at middle; hind femur normal, with a series of bristles

on basal half of posteroventral surface and another on apical half of anteroventral surface .. .. *setulifera* Stein

4. Thorax with 2 + 3 dorsocentral bristles .. .. *rigidiseta* Stein
   Thorax with 2 + 4 dorsocentral bristles 5
5. Fore tibia with one anterodorsal and one posterior bristle near middle .. .. *armata* Stein
   Fore tibia without median bristles .. .. *setulifera* Stein

Dichaetomyia rigidiseta (Stein).

Termes. Fuzetek, vol. 23, 1900, p. 139 (*Mydaea*).

This species agrees very well in colour with *armata* Stein which I redescribed in a previous paper on Australian Diptera. Structurally it agrees also, but the characters listed in the above key will readily distinguish it. Both of these species are much more slender than is *setulifera,* the abdomen being more elongate especially, and the bristles on apical tergites are much stronger. The eyes are more widely separated above also. All three species have the hypopleura with some microscopic black hairs in two groups, one below spiracle and the other near lower posterior angle.

Length, 7-8 mm.

Originally described from New Guinea in the female sex only. I have before me one female from Hamilton, and a male from Eidsvold, Queensland. I have no doubt these specimens are referable to Stein's species, the female agreeing in every particular with his description. I suspected this was the same as *armata* until I received the male.

Dichaetomyia armata Stein.

I have previously given a description of the male of this species. The female may be distinguished by the characters listed in the above key.

Before me there are a number of both sexes from New South Wales, Queensland, and New Guinea.

Dichaetomyia setulifera Stein.

This species agrees in structure and chaetotaxy with the typical form of *quadrata* Wiedemann, an oriental species which is very widely distributed, but the entire thorax is rufous yellow except a small spot below wing base, and the grey pruinescence gives the dorsum a trivittate appearance when it is viewed from behind. Palpi and antennae yellow. Abdomen frequently entirely yellow, but more usually more or less darkened apically. The armature of the hind femur is the same in *quadrata* as in the species under review.

Length, 6.5-8 mm.

Localities, male, Hamilton, Queensland, January, 1890; 6 males and 3 females, Cairns, Queensland; 3 females, Gordonvale, Queensland; 1 male, Hamilton, Queensland.

It is possible that this species, which was originally described from an Australian specimen in a paper on African species, is merely a variety of *quadrata* but it is so constant in colour and so uniformly different in this respect from the typical form of that species that I have no hesitation in retaining its distinct specific status.

It appears pertinent to note that there is a variety of *quadrata, lineata* Stein, in which the postsutural dorsocentral bristles are invariably three in number. It is my opinion that this form is a distinct race or species. It does not occur, nor does *quadrata,* in Australia, though the latter is found in New Guinea.

The second group contains a few species that conform more closely to the general run of those found in the Orient and in Africa. There are some of them, however, which have the eye facets in the males very strikingly enlarged on the upper half, the largest of the facets being equal in size to the anterior ocellus. In these species the frons is reduced to a mere line, consisting of the contiguous orbits, the interfrontal stripe being entirely obliterated on all but the anterior margin. This group is, however, not clearly delimited as there is one species in which the facets are not very noticeably enlarged and which has the interfrontalia also obliterated, while another has the eyes practically normal and the interfrontalia distinct on the entire length of frons. As in the great majority of the Oriental species of the genus there are few striking specific characters one must resort to minute details for distinguishing the species. These however appear to be quite constant and with a little practice one can readily distinguish the species. I present a key for the identification of those species already known to me.

Dr. E. Bergroth some years ago described a species, *Spilogaster fuscitarsis*,* which may be referable to this genus. Unfortunately he informs me that the type specimen has been destroyed, and as without it it is impossible to definitely establish the identity of the species, I fear it will have to be considered as without status. From the description it appears to be similar to *setulifera* and *armata*, both of which have the thorax more or less distinctly vittate, but neither of these species has the palpi and tarsi fuscous, which would appear to justify us in regarding them as distinct from *fuscitarsis*. There are also some yellow species in other genera, some of which agree more or less closely with the description of Dr. Bergroth's species. I append the description as given.

"SPILOGASTER FUSCITARSIS n.sp."

"Luteo-ferruginea, dorso thoracis vittis tribus albescentibus notato, callo humerali etiam levissime albido-pruinosulo, segmentis duobus ultimis dorsalibus abdominis plaga magna communi nigra praeditis. Caput cinereo-argenteum, vitta frontali nigricante, proboscide et palpis fuscis, antennis luteo-ferrugineis, articulo ultimo apicem versus fuscescente, seta longe plumosa, fusco-nigra, basi flavida. Thorax macrochaetis postsuturalibus quattuor instructus. Alae leviter cinerascentes, venis anterioribus flavescentibus, posterioribus fuscescentibus, vena transversa postica undulata; squamae luteo-ferrugineae. Pedes luteo-ferruginei nigro-setulosi et pilosi, tarsis fuscis, tibiis posticis medio seta una rigida exserta instructis. Long. female, 9 mm." Central Queensland.

Key to species.

1. Males 2
   Females 8
2. Hind femur with four or five long black bristles on apical third of anteroventral and posteroventral surfaces which are much longer than diameter of femur .. .. *terraereginae* sp.n.
   Hind femur without long bristles on apical third of posteroventral surface 3
3. Basal half of posteroventral surface of hind femur with a series of long fine bristles, some of which are longer than the diameter of femur; facets of upper half of eye very conspicuously enlarged .. *megophthalma* sp.n.
   Basal half of posteroventral surface of hind femur without distinct bristles, or if any are present they are not nearly as long as diameter of femur 4

*Stett. entomol. Zeit., 1894, p. 74.

4. Thorax with four pairs of equally strong postsutural dorsocentrals 5
   Thorax with three equally strong pairs of postsutural dorsocentrals and with or without a much weaker anterior pair of postsutural setulae . 7
5. Hind femur with at most three or four anteroventral bristles on about the apical third; the uppermost hairs of the pteropleural group brown or fuscous .. .. *rufa* Stein
   Hind femur with six or seven anteroventral bristles, the basal one close to the middle of femur; all the pteropleural hairs yellow 6
6. Facets of the upper half of eyes rather abruptly enlarged centrally; frontal orbits contiguous, obliterating interfrontal stripe .. .. *flavohirta* sp.n.
   Facets of eyes gradually enlarged in the normal manner; frontal orbits narrowly separated by a black interfrontal stripe .. .. *luteohirta* sp.n.
7. Thorax with three pairs of long postsutural dorsocentrals .. .. *apicalis* Stein
   Thorax with three pairs of long and one pair of very short postsutural dorsocentrals .. .. *impar* Stein
8. Thorax with four strong pairs of postsutural dorsocentral bristles 9
   Thorax with three strong or three strong and one very weak short pair of postsutural dorsocentral bristles 10
9. Pteropleural hairs all yellow, those on prosternum concolorous .. .. *flavohirta* sp.n.
   .. .. *luteohirta* sp.n.
   Pteropleural and prosternal hairs largely or entirely fuscous .. .. *megophthalma* sp.n.
   .. .. *terraereginae* sp.n.
   .. .. *rufa* Stein
10. Postsutural dorsocentrals consisting of three long pairs which are equally distant and the third (anterior) pair of which is much in front of the anterior intra-alar pair .. .. *apicalis* Stein
    Postsutural dorsocentral bristles consisting of three long and one very short pair, the third pair from hind margin but little in front of the anterior pair of intra-alar bristles .. .. *impar* Stein

Dichaetomyia terraereginae sp.n.

Male.—Rufous yellow, shining. Head fuscous, antennae yellow, third segment largely brown; palpi brownish to fuscous yellow. Thorax with faint white pruinescence anteriorly, the slender vittae visible only from behind. Abdomen with the apical two tergites more or less infuscated. Legs yellow, tarsi hardly darkened. Wings, calyptrae, and halteres yellow.

Eyes subcontiguous, bare, facets normal; interfrontal stripe obliterated in middle; palpi slender. Anterior presutural and postsutural dorsocentral bristles not much shorter than the other pairs; prealar short; hypopleura with a few very fine hairs. Hind femur with about four or five long bristles on apical third of anteroventral surface and some similar bristles on same part of posteroventral surface, only two of which may be present in some specimens.

Length, 5-6 mm.

Type, and allotype, Dawson River, Queensland, 1923 (Bancroft). Paratypes, South Queensland (T. L. Bancroft); Lisarow, N.S.W., January 5, 1915, on human foeces; Coramba-Dorrigo Rd., 1,000 feet, January 31, 1923; Lowanna, E. Dorrigo, January 31, 1923.

Dichaetomyia megophthalma sp.n.

Male.—Head fuscous, face paler, antennae yellow, third segment brownish apically, palpi fuscous. Thorax yellow, the grey pruinescence when viewed from

behind forming a broad vitta anteriorly which is separated from the outer one on each side by a narrow line mesad of the dorsocentrals. Abdomen yellow. Apices of tarsi very slightly darkened. Wings, calyptrae, and halteres yellow. Fine thoracic hairs yellow.

Frons reduced to a mere line; facets of eyes suddenly enlarged at middle, those of upper half in large part individually as large as anterior ocellus and distinctly wider than frons at middle. Dorsocentrals 2 + 4, all long; anterior intra-alar short. Hind femur with two or three preapical anteroventral bristles, and a series of fine bristles on basal half or more of posteroventral surface some of which are at least as long as diameter of femur; tibiae normal. Fourth vein curved.

Length, 5.5 mm.

Type, Cairns, North Queensland (J. F. Illingworth).

Type in United States National Museum.

Dichaetomyia flavohirta sp.n.

Male and female.—Differs from *terraereginae* in having the antennae paler, and the palpi darker.

The enlarged eye facets are smaller than in preceding species and the transverse division less abrupt; the pteropleural and propleural hairs are yellow and not dark, the mid femur has a few longish posteroventral setulae, and the hind femur has about seven bristles on apical half of anteroventral surface and usually a few short fine bristles at or near middle on posteroventral surface. The thoracic chaetotaxy is the same as in preceding species.

Length, 7-8 mm.

Type, male, allotype, seven male and six female paratypes, Cairns, North Queensland (J. F. Illingworth); one male paratype, Townsville, North Queensland (G. F. Hill).

Type in United States National Museum.

Dichaetomyia luteohirta sp.n.

Male.—Similar to *flavohirta;* differs as noted in the key. The largest of the eye facets are not over one-third as wide as narrowest part of frons and there is no abnormal enlargement anywhere, merely the ordinary gradual increase in size normal to the males of this group.

Length, 7-8 mm.

Type, male, one male paratype, and allotype, Townsville, Queensland (H. Priestly).

Dichaetomyia rufa Stein.

Term. Fuz., vol. 23, pl. 132, 1900 (Spilogaster).

Similar in colour to the preceding species, the antennae usually yellow, palpi fuscous, and apex of abdomen darkened.

The eye facets are rather more enlarged above than in last, but the frons is narrower and the interfrontal stripe obliterated at middle.

Length, 6-7 mm.

A large series from Cairns and Gordonville, Queensland, one from Sydney, and one from the Fiji Islands. Originally described from New Guinea.

Dichaetomyia apicalis Stein.

Tijdschr. v. Ent., vol. 47, p. 103, 1904 (Spilogaster).

One male from Cairns, Queensland, agrees with the description of this

species. It is very similar in all respects to *rufa*, differing in having but three pairs of postsutural dorsocentral bristles.

Length, 5.5 mm.

Originally described from Java.

DICHAETOMYIA IMPAR Stein.

Two males and one female agree with the description of this species.

Length, 6-7 mm.

Localities, Lowanna, E. Dorrigo, N.S.W., January 30, 1923; Hamilton, Queensland, and Maianda, Queensland.

Originally described from Java.

Genus LIMNOPHORA Robineau-Desvoidy.

The group dealt with in this paper consists of those species in which there are some setulose hairs along the sides of the prosternal plate and some microscopic setulae at base of the third vein of the wing. There is considerable variation in the structure of the head in this group, some males having the frons one-third or more of the head width while others have it very narrow. However there is no good reason for the separation of these groups, nor is there any reason why the species with the arista distinctly haired should be separated subgenerically from those which have the arista pubescent or almost bare. The genus as here limited is very widely distributed, occurring in all faunal regions, and the species are, so far as I am aware, always found near bodies of water, some of them at least occurring in the larval stages in running water. I present a key for the identification of the species known to me from Australia, but it is extremely improbable that this is more than a small percentage of the total that occur on this continent.

Key to species.

1. First wing vein with distinct setulae on upper surface; eyes in male separated by about one-third of the head width; thorax with a pair of large subtriangular or subquadrate black spots in front of suture separated by a grey pruinescent area, and another pair of larger spots behind suture .. .. *orthoneura* Malloch

   First wing-vein bare both above and below 2

2. Males 3

   Females 4

3. Frons about as wide as third antennal segment; dorsum of thorax with a large shining transverse black spot in front of suture which covers almost all of disc, and another behind suture; arista short haired .. .. *pulvillata* sp.n.

   Frons about one-third of the head width; dorsum of thorax with three or five dark dorsal vittae; arista almost bare .. .. *divergens* sp.n.

4. Entire frons including orbits opaque deep black, the face and parafacials silvery, the latter sharply differentiated from the frontal orbits at bases of antennae; disc of thorax chocolate brown, the vittae a little darker; abdominal spots fused in centre, leaving only a narrow transverse grey mark on each anterior lateral angle .. *nigriorbitalis* Malloch

   Frons not entirely deep black, the orbits and frontal triangle greyish or brownish pruinescent; disc of thorax without black or brown colour between the dark vittae or spots; abdominal dark spots not fused on entire length of median line 5

5. Arista almost bare; thoracic dorsum with five distinct blackish brown vittae; first posterior cell of wing not narrowed apically .. *opacifrons* Malloch
   Arista short haired; thoracic dorsum with two faint dark spots and a median faintly indicated vitta in front of suture and a faint dark transverse blackish mark behind it; first posterior cell of wing distinctly, though not conspicuously, narrowed apically .. .. *pulvillata* sp.n.

Limnophora divergens sp.n.

Male.—Head black, face, parafacials, and cheeks densely white pruinescent, the two former slightly brassy; interfrontalia black, orbits yellowish grey, triangle brownish pruinescent; occiput grey pruinescent, darker in centre. The five dark thoracic vittae more or less fused at centre in certain lights; pleura and postnotum pale grey, unspotted; scutellum black, a little paler in centre in certain lights. Abdominal tergites 1, 2, and 3 each with a pair of large transverse black spots on hind margins, those on 2 and 3 most conspicuous and separated by a broad wedge-shaped pale grey mark, fourth tergite with a narrow fuscous central line. Legs black, femora not densely pruinescent. Wings hyaline, cross-veins faintly clouded. Calyptrae whitish. Halteres yellow.

Frons one-third of the head width; upper two orbitals sloped over eye and backwards; arista rather thick, with short pubescence; vibrissal angle produced; cheek about as high as width of third antennal segment. Thoracic dorsocentrals 2 + 3, both intra-alars strong. Abdomen narrowly ovate; fifth sternite with a broad shallow rounded emargination. Fore tibia without a median bristle; mid tibia with one posterodorsal and one ventral bristle; hind femur with about three anteroventral bristles on apical half; hind tibia with one anterodorsal and one anteroventral bristle. First posterior cell of wing not noticeably narrowed at apex.

Length, 4.5 mm.

Type, Sydney, N.S.W., November 4, 1923.

Limnophora pulvillata sp.n.

Male.—Head black, orbits and face whitish pruinescent. Thorax shining black, with lateral margins broadly, a narrow fascia on anterior margin of suture which is interrupted in middle, and the posterior half of postsutural region whitish pruinescent; scutellum greyish on sides apically. First visible abdominal tergite black, with a narrow grey hind marginal fascia and a very faint greyish central line; second and third tergites each with a pair of large shining subtriangular black spots which extend the whole length of segments and are narrowly separated in centre; fourth tergite brown, the anterior lateral angles whitish. Legs black. Calyptrae white, slightly brownish apically. Halteres yellow.

Eyes bare; frons at narrowest point about as wide as third antennal segment; longest hairs on arista a little shorter than width of third antennal segment; vibrissal angle not noticeably produced, the single vibrissa very strong, other bristles weak. Thorax with 2 + 3 dorsocentrals, and about four series of weak presutural acrostichal hairs. Abdomen elongate oval, fifth sternite with a large rounded emargination. Fore tibia without a posterior median bristle; mid tibia with one posterior bristle; hind femur with a complete series of rather short, very fine posteroventral bristles and one or two preapical anteroventral bristles; hind tibia with one anterodorsal and one anteroventral bristle; pulvilli long.

Female.—Differs from the male in having the thoracic markings less distinct and with traces of the normal three dark vittae showing through them.

Frons fully one-third of the head width. Legs as in male but the fine posteroventral bristles lacking on hind femur, and but one preapical anteroventral bristle.

Length, 4-4.5 mm.

Type, male, Eidsvold, Queensland, April 16, 1924 (Bancroft). Allotype, Eccleston, Allyn River, February 26, 1921. One female paratype, Mosman, February 4, 1923.

Genus NEOHELINA Malloch.

Generic characters.—Eyes separated by nearly one-third of the head width in both sexes; orbits distinct, each with about seven bristles, the upper one or two on each side in female curved outward over eyes, the others incurved, in male all bristles are incurved; a long pair of bristles between the anterior and posterior ocelli and a shorter pair between the posterior ocelli and the postvertical bristles; antennae short, third segment not much longer than second; arista with moderately long hairs; cheek not over one-fourth of the eye height. Thorax with two presutural dorsocentrals; sternopleurals 1:2; scutellum bare below; postscutellum lacking. Abdomen subcylindrical. Sixth wing-vein falling short of margin of wing; costa ending just beyond apex of third vein. Hind tibia with two posterodorsal bristles; hind tarsus without a ventral basal bristle. Lower calyptra longest.

Genotype, *Neohelina semivittata* Malloch.

There are two species of the genus known to me, one of them being undescribed. I append a diagnosis for their separation.

A. Legs yellow, tarsi fuscous; abdomen yellow, greyish pruinescent, each tergite with an elongate fuscous mark in centre which does not reach hind margin .. .. *semivittata* Malloch

AA. Legs fuscous, tibiae tawny yellow; abdomen glossy brownish black, apices conspicuously tawny yellow .. .. *flavomarginata* sp.n.

NEOHELINA SEMIVITTATA Malloch.

I have seen only the type and paratype specimens of this species, from New South Wales. The description appeared in my series of papers on Exotic Muscaridae, part xii., Annals and Magazine of Natural History, 1924, p. 414.

The species is larger than the new one, measuring 8 mm. in length.

NEOHELINA FLAVOMARGINATA sp.n.

Female.—Brownish black, thorax subopaque, abdomen almost glossy. Second antennal segment and base of third, palpi, apices of abdominal tergites, and the entire tibiae tawny yellow; interfrontalia brownish rufous; thorax with four narrow black vittae, the median pair not continued to hind margin, the laterals interrupted at suture. Wings smoky, apex of first vein and both cross-veins slightly clouded. Calyptrae whitish. Halteres fuscous.

Palpi slender. Thorax with the short hairs quite strong; one or two pairs of irregular presutural acrostichals evident; prealar bristle absent; postsutural dorsocentrals 3 pairs; scutellum flattened above, with four long and one short pairs of marginal, and one subapical pair of discal bristles. Fore tibia shorter than fore tarsus, with two or three short anterodorsal setulae; mid tibia with two anterodorsal and two posterodorsal bristles; hind femur with a few irregular anteroventral and posteroventral bristles apically; hind tibia with two posterodorsal, two anterodorsal and two anteroventral bristles. Costal thorn long, equal to inner cross-vein, the setulae rather pronounced to just beyond apex of

second vein; inner cross-vein beyond apex of first vein and close to one-fourth from apex of discal cell; outer cross-vein at about its own length from inner and fully that length from apex of fifth vein.

Length, 4 mm.

Type and one paratype, Myponga, S.A. (A. H. Elston).

It must be noted that Stein described a species under the name *Limnophora dasyops* in 1910, in volume 8 of the Annals of the Hungarian Museum, page 556. This species is an aberrant one belonging to a group which is very well represented in New Zealand but apparently absent from any other faunal region. I have been trying to work out the relationships of the species of this group for some time and up to the present have not decided what genus they ought to be placed in. Temporarily I have relegated some of them to *Melanochelia,* but some undoubtedly belong near to if not in *Lispoides* which is represented by one North American species. I have *dasyops* from New South Wales.

Genus Myospila Robineau-Desvoidy.

In Europe and North America this genus is represented by the genotype, *meditabunda* Fallen, a black species with paired spots on dorsum of abdomen. The only Australian species already referred to the genus, *flavicans* Malloch, is yellow in colour, and another similar in colour is now before me.

The genus differs from *Dichaetomyia* in having the pteropleura and prosternum bare. The third vein has some setulae at base both above and below, and the fourth vein is curved forward apically; the hind tibia has no strong posterodorsal bristle beyond middle; the prealar bristle is present but small; and the arista plumose.

The new species described herein differs from *flavicans* in much the same manner as does *setulifera* from *armata* and *rigidiseta* in *Dichaetomyia,* the abdomen being much more robust and with less evident bristles.

I present a diagnosis for the recognition of the two species.

A. Palpi yellow; hypopleura with some very fine yellow hairs on upper margin in front of spiracle; one black setula on hind margin of metathoracic spiracle; fourth wing-vein conspicuously curved forward apically .. .. *hypopleuralis* sp.n.

AA. Palpi fuscous or black; hypopleura bare; no setula on hind margin of metathoracic spiracle; fourth wing-vein but little curved forward apically .. .. *flavicans* Malloch

Myiospila hypopleuralis sp.n.

Male and female.—Testaceous yellow, slightly shining. Occiput and frons blackish, frontal orbits and face white pruinescent, occiput grey pruinescent. Thorax not distinctly vittate, with a patch of white pruinescence on anterior margin between the dorsocentrals which is best seen when viewed from behind. Abdomen more or less fuscous brown, sometimes entirely so, the dorsum with greyish pruinescence. Legs yellow. Wings, calyptrae and halteres yellowish.

Frons in male linear, in female about one-fourth of the head width at vertex, not noticeably widened anteriorly, and without cruciate bristles; palpi slender in both sexes. Abdomen more robust than in *flavicans,* the genital segments in female not exposed so that it is impossible to see if there are bristles present. First posterior cell at apex not much more than half as wide as at its widest part.

Length, 8 mm.

Type, Stannary Hills, North Queensland, about 3,000 feet (T. L. Bancroft). Allotype and a paratype of each sex, Cairns, North Queensland (J. F. Illingworth).

This species may possibly be considered as entitled to generic separation from the true *Myiospila* species on the basis of the characters used in the diagnosis herein presented, but there are so many questions of relationships still unsettled in this group that I believe it would be unwise to erect even a subgenus for it.

I have a number of specimens that appear to belong to *flavicans* Malloch, but in the series I find differences of structure that lead me to suppose that there are probably two or more species represented in the material. I hope later to obtain more specimens to enable me to arrive at a decision on this matter.

Subfamily Coenosiinae.

The amount of material in this subfamily which I have does not warrant my treating it comprehensively, my present effort being merely to distinguish two of the genera that occur in Australia and to define two species of each. There are no doubt some more species of each genus present but they are not available to me now.

Genus Coenosia Meigen.

This genus differs from my interpretation of *Caricea* in having the hind tibia with an anteroventral and an anterodorsal bristle near middle, the latter being in all cases higher placed than the former, while in the other genus there is an anterior and an anterodorsal bristle present, both of which are rather closely placed and usually at the same height. I furnish sketches of the two tibiae for reference, see Figure 1.

Fig. 1.

Of *Coenosia* I have two species from Australia, one of which is undescribed. Both have the third antennal segment with a very evident thorn-like tip on upper side, a character not at all common in the genus, and both have also the dorsum of thorax with a broad brown or fuscous mark covering the area between the lines of dorsocentrals, at least posteriorly, which colour is continued over disc of scutellum. This stripe consists of the three fused dorsal vittae normal to most species.

I present a diagnosis for the separation of the species.

A. Tibiae entirely tawny yellow in both sexes; fore tarsi of male slender, when seen from above distinctly narrower than apex of tibia .. .. *acuticornis* Stein

AA. Tibiae yellowish only at bases in male, fore tarsi in same sex distinctly flattened, when seen from above at least as wide as apex of tibia .. .. *latitarsis* sp.n.

Coenosia acuticornis Stein.

Apparently a very common species in Australia, many specimens being before me from various parts of New South Wales, Queensland, and Tasmania. It was originally described from Victoria.

Coenosia latitarsis sp.n.

Male.—This species has the paired dorsal abdominal spots fused as in the preceding species. The only distinctions between the species are those listed in the synopsis, though it is very probable that the hypopygia will furnish some that are not evident in the type specimen, which has the genital organs unexposed.

Length, 3.5 mm.

Type, Bulli, N.S.W., August 25, 1923.

Genus Caricea Robineau-Desvoidy.

I have before me what appear to be two species of this genus. One of these is represented by two males and the other by a number of females. If this material all belongs to one species they represent a sexual colour dimorphism which is not equalled by any other of the numerous species of the genus known to me from other parts of the world. The genus is represented by one species in North America and by the same and possibly one or two other species in Europe; the number of species occurring in Africa is very large. It is a peculiar fact that in North America and Europe the genus *Coenosia* is represented by a very large number of species while *Caricea* is very poorly represented, and the reverse is the case in Africa where *Caricea* abounds and *Coenosia* is almost unrepresented. It will be of interest to discover which genus is most common in Australia.

The adults of both genera occur on flowers and tree-trunks, though many, if not all, of the species are predaceous on small insects.

Diagnosis of species.

A. Legs, antennae, and palpi almost entirely yellow; abdomen with a dorsocentral dark vitta .. .. *subvittata* sp.n.

AA. Legs, antennae, and palpi fuscous, only the tibiae tawny yellow; abdomen with an interrupted dorsocentral vitta and a pair of large subtriangular spots on each tergite from first to third black .. .. *imitatrix* sp.n.

Caricea subvittata sp.n.

Male.—Black, densely pale grey pruinescent. Frons and face in some lights silvery grey; antennae yellow, base of second segment grey; arista black; palpi brown, paler at apices. Thorax slightly darker along the lines of dorsocentrals, but not vittate. Abdomen more brownish on dorsum and with a faint dark dorsocentral line. Legs yellow, tarsi slightly brownish. Wings hyaline. Calyptrae white. Halteres yellow.

Frons one-third of the head width, parallel-sided, orbits poorly differentiated, each with three widely separated bristles and no fine hairs; parafacials distinct on entire length, not as wide as third antennal segment, the latter short, not extending two-thirds of the way to mouth margin; arista with very short pubescence; proboscis slender; palpi normal. Thoracic bristling normal. Abdomen subovate, hypopygium small. Bristles on fore femora long and fine, those

on posteroventral surface not extending to apex; median posterior bristle on fore tibia long; mid tibia with one anterodorsal and one posterodorsal bristle; anterodorsal bristle on hind tibia much longer than anterior one and at almost same height; hind metatarsus about one-third of the length of hind tibia; hind femur with a few very short setulae on basal half, without a preapical bristle on anteroventral surface, and with some bristles on basal half of posteroventral surface the apical one long. Inner cross-vein at middle of discal cell; outer at nearly its own length from apex of fifth vein.

Length, 3 mm.

Type, Mosman, N.S.W., 1.10.1923 (Mackerras).

Caricea imitatrix sp.n.

Female.—Head black, face, frontal orbits, and triangle pale grey pruinescent, interfrontalia slightly greyish; antennae and palpi black. Thorax and abdomen black, slightly shining, with brownish grey pruinescence, the former with three darker vittae, the latter with a narrow dorsocentral vitta and a large subtriangular spot on each side of each tergite, which markings are commonly fused centrally and most readily seen when viewed from behind. Legs black, tibiae varying from brownish to tawny yellow. Wings hyaline. Calyptrae white. Halteres pale yellow.

Antennae not extending to lower third of face, third segment not twice as long as second; arista distinctly pubescent. Scutellum with four equal bristles. Abdominal bristles short. Armature of legs as in last species but the hind femur has about six widely spaced bristles on anteroventral surface and about four longer more widely spaced bristles on posteroventral surface.

Length, 3-4 mm.

Type, and four paratypes, Mosman, two paratypes, Sydney, N.S.W.

The genus *Pygophora* was originally described from Australia by Schiner and of the genus I have seen the genotype and two other species, one of which I am not certain of so far as specific identity is concerned. In my next paper I hope to give a synopsis of the Australian species. The genus *Atherigona* has been placed in this subfamily also but I am now convinced that this is an error and later on I will deal with the Australian species of the genus, some three or four of which are at present known to me. Some species of this last genus destroy forage plants and cereals by boring in the stems.

Subfamily Lispinae.

Genus Lispa Meigen.

In a previous paper I presented a key for the identification of the species of Lispa known to me from Australia. Since then I have received a number of species which are not included in the key and have made a new one which I hope will prove of service to students of the group.

Key to Australian species.

1. Males 2
   Females 8
2. Hind metatarsus fully twice as wide as second segment and but little longer than it, densely black haired below; frons, face, antennae, and palpi densely white pruinescent, the palpi yellowish white; legs black . . . . . *cana* Walker
   Hind metatarsus not noticeably wider than second segment and about twice

as long as it; head parts not coloured as above; legs partly tawny yellow 3

3. Fore femora with two or more series of very short and rather stout spines on the ventral surfaces besides the usual long posteroventral bristles; palpi black; fore tibia without a posterior median bristle. *armipes* Becker

Fore femora with only the long posteroventral bristles below, no short spines 4

4. Mid femur with a rather dense series of short setulose black hairs on the posteroventral surface, most conspicuous and duplicated apically; hind tibia with a series of about eight long erect setulose hairs on apical half of posteroventral surface; abdomen glossy black, with one to four pairs of white spots on sides of dorsum .. .. *eidsvoldica* sp.n.

Mid femur without such a series of posteroventral short setulae; hind tibia not armed as above, and abdomen otherwise coloured 5

5. Palpi slightly and gradually dilated apically; thorax with three or five narrow blackish vittae, the central one generally extending distinctly over scutellum; mid and hind femora each with some widely separated long bristles on anteroventral surfaces; fore tibia without a median bristle; mid tibia with a median posterodorsal bristle; hind tibia without a posterodorsal bristle; first posterior cell of wing not appreciably narrowed apically .. .. *pumila* Wiedemann

Palpi with distinctly spatulate apices; thorax less distinctly vittate, the central vitta not continued over scutellum; first posterior cell of wing very noticeably narrowed apically; hind tibia with a posterodorsal bristle 6

6. Mid tibia with a strong ventral bristle near middle; hind femur with a bristle about one-third from base on posteroventral surface basad of which there are about three long fine ventral bristles; abdominal sternites 3 and 4 appearing black on discs because of a dense covering of very short stiff depressed black hairs; both pairs of presutural dorsocentral bristles long and strong .. .. *xenochaeta* Malloch

Mid tibia without a ventral bristle near middle; hind femur not armed as above; sternites of abdomen not abnormally haired; presutural dorsocentrals short and weak 7

7. Mid and hind femora with long fine bristles on basal half of ventral surfaces, the latter without strong anteroventral bristles .. *weschei* Malloch

Mid and hind femora without long fine ventral bristles, the latter with two strong anteroventral bristles, one just beyond middle, the other near apex .. .. *incerta* sp.n.

8. Fore femur with two or three series of very short stout spines on ventral surfaces in addition to the long posteroventral bristles, one series on at least the apical half of anteroventral surface 9

Fore femur without such short spines, with inconspicuous decumbent hairs and long posteroventral bristles 10

9. Thorax and abdomen densely pale grey pruinescent, the former usually with traces of three narrow brownish vittae, the latter with two pairs of large spots on dorsum which are glossy and subtriangular; palpi fuscous, paler basally; halteres yellow; fore tibia without a median posterior bristle .. .. *armipes* Becker

Thorax and abdomen glossy black on dorsum, the former with traces of two vittae anteriorly and the sides greyish pruinescent, abdomen with a large spot on each side anteriorly and a small central spot on middle of hind

margin of each tergite grey pruinescent; palpi yellow; halteres fuscous; fore tibia with a long posterior bristle beyond middle .. *armata* sp.n.

10. Thorax with one presutural and two pairs of postsutural dorsocentrals, all very long, the anterior postsutural one as near suture as posterior pair is to hind margin; hind tibia with a posterodorsal median bristle; mid tibia with a strong median anterodorsal bristle .. .. .. *uniseta* Malloch

Thorax with two pairs of rather short, or one pair of long and one pair of very short presutural dorsocentrals, and usually two very short and two long pairs behind suture, the anterior of the long pairs much farther from suture than the posterior pair is from hind margin 11

11. Legs entirely black, hind metatarsus thickened, but not so much so as in the male; antennae short, grey pruinescent, not over half the length of face; palpi dilated; first posterior cell of wing not narrowed apically. .. .. *cana* Walker

Tibiae largely or entirely tawny yellow; hind metatarsus not dilated; antennae nearly as long as face, not grey pruinescent 12

12. Hind tibia without a median posterodorsal bristle; fore tibia with or without a median posterior bristle; first posterior cell of wing not appreciably narrowed at apex 13

Hind tibia with a distinct median posterodorsal bristle; fore tibia with a median posterior bristle; first posterior cell of wing distinctly narrowed apically 14

13. Thorax densely grey pruinescent, with three or five narrow darker opaque vittae, the median one evident on middle of scutellum; abdomen opaque grey pruinescent, with a pair of very large shining quadrate black spots on each tergite which are narrowly separated by a median pale grey line; hind femur with an apical anteroventral bristle. *pumila* Wiedemann

Thorax with three broad glossy black vittae, the separating pale lines much less conspicuously white than the lateral margins of mesonotum, the median vitta covering scutellum except on sides; abdomen glossy black, with a pair of round white spots on one or more of the tergites; hind femur with two anteroventral bristles, one near middle, the other near apex .. .. *eidsvoldica* sp.n.

14. Hind femur without strong anteroventral bristles beyond middle; fore tibia with an anterodorsal median bristle .. .. *weschei* Malloch

Hind femur with two strong anteroventral bristles, one just beyond middle and the other near apex, if the former is absent the fore tibia has no median anterodorsal bristle 15

15. Mid tibia with a strong ventral bristle beyond middle .. *xenochaeta* Malloch

Mid tibia without a ventral bristle beyond middle .. .. *incerta* sp.n.

N.B.—In my previous key I included *assimilis* Wiedemann. I am now of the opinion that this species does not occur in Australia. However, the group to which it belongs is in a very unsatisfactory condition and a careful examination ought to be made of the types of *assimilis* Wiedemann and *modesta* Stein as well as some other closely related species to decide how many species names are valid. The species I previously considered as *assimilis*, and possibly the one recorded as that by Stein, is now described under the name *incerta* sp.n.

LISPA ARMATA sp.n.

Female.—Frons black, slightly brownish pollinose, the orbits greyish only at anterior extremities; face, cheeks, and occiput white, almost silvery pruinescent, upper third of latter darker; antennae fuscous, grey pruinescent, apex of second

segment and base of third reddish; palpi tawny yellow. Thorax glossy black on dorsum, with traces of two submedian lines anteriorly and the lateral margins grey pruinescent; pleura whitish pruinescent. Abdomen glossy black on dorsum, with a small spot on centre of hind margin and a large transverse on each side anteriorly on each tergite from second to fourth white pruinescent. Legs black, knees narrowly rufous yellow. Wings smoky. Calyptrae white. Halteres fuscous.

Frons normal; parafacials rather wide, sparsely haired; arista plumose; antennae slender, reaching three-fourths of the distance to mouth margin; cheeks rather narrow; palpi gradually dilated. Thorax with 2 + 3 long strong dorsocentrals; prescutellar acrostichals absent; sternopleurals three. Abdomen narrowly ovate; apical bristles on third and fourth visible tergites long and strong. Fore femur as in *armipes* Becker; fore tibia with a strong posterior median bristle and three long apical bristles; fore tarsus about as long as fore tibia, basal segment rather stout; mid femur with some long fine posteroventral bristles on basal half and some shorter bristles on anteroventral surface, those on apical third forming a series of regular short setulae; mid tibia with a long posterior median bristle and five long apical bristles; hind femur with some irregular long fine bristles on basal half of posteroventral surface and some fine shorter bristles on some part of anteroventral surface, the latter surface with two strong bristles on apical half; hind tibia with one anterodorsal, one anteroventral and four long apical bristles. Third vein slightly undulated apically; first posterior cell not narrowed apically.

Length, 6 mm.

Type, Mosman, N.S.W., 2.4.1923.

Lispa eidsvoldica sp.n.

Male and female.—Frons black, triangle greyish, orbits white pruinescent, as are also the face and cheeks, parafacials and face in male largely olive brown, the parafacials in female with a brownish mark at base of antennae; antennae black, apex of second segment yellowish; palpi yellow. Thoracic dorsum with three broad shining black vittae which are separated by greyish pruinescent stripes of about the same width that are not nearly so conspicuous as the white lateral margins of mesonotum, the median vitta extending over scutellum leaving only a narrow grey pruinescent margin on each side; pleura pale grey pruinescent, with a suffused fuscous vitta above. Abdomen glossy black, sometimes with four pairs of white lateral tergal spots, at times with only the pair on fourth tergite distinct. Legs black, apices of fore coxae, the trochanters, extreme tips of femora, and all of tibiae tawny yellow, coxae and femora grey pruinescent, mid tarsi yellowish at base. Wings hyaline. Calyptrae white. Halteres dark brown.

Frons over one-third of the head width; arista plumose; antennae about two-thirds of the length of face; parafacial narrow, with sparse fine hairs; cheek narrow; palpi abruptly dilated at apices. Thorax with one strong and one very weak pair of presutural dorsocentrals, the short pair sometimes practically absent, and two long and two very short pairs behind suture; presutural acrostichals absent; basal pair of scutellar bristles shorter than apical pair; propleural and stigmatal bristles strong; sternopleurals 3. Abdomen in male cylindrical, fourth tergite covered with dense decumbent short black hairs, in female more ovate and with six genital spines. Posteroventral surface of fore femur with a complete series of bristles; fore tarsi subequal to tibiae, slightly flattened apically; mid femur in male with a comb of short black setulae on

anteroventral surface, most evident apically, and another on posteroventral surface which is dense and duplicated apically; mid tibia with a median posterior bristle; hind tibia with one anterodorsal and one anteroventral bristle in both sexes, in male with a series of long fine erect hairs on apical half of posteroventral surface; hind femur with two anteroventral bristles, one beyond middle and the other at apex. First posterior cell of wing almost imperceptibly narrowed apically.

Length, 5-5.5 mm.

Type, male, allotype and two female paratypes, Eidsvold, Queensland; one female paratype Marwood, Mackay, Queensland; one male paratype, much broken; Hughenden, Queensland. Last specimen in United States National Museum.

In most particulars this species is similar to *leucospila* Wiedemann, both sexes of which are before me from Formosa. But the latter is a more brownish grey species, with usually no part glossy black, the pleural dark stripe is absent, and the abdomen has a greyish lateral continuous stripe instead of spots on each side in the male, and the abdomen is brownish grey with dark paired spots on dorsum in the female.

Lispa assimilis Wiedemann.

This species has been recorded from Australia by Stein. It belongs to a group which has the first posterior cell of the wing very distinctly narrowed at apex, containing, besides several extralimital species, three Australian forms, *weschei* Mall., *xenochaeta* Mall., and the one described below. I have seen specimens agreeing with the description of *modesta* Stein from Africa, from which continent *assimilis* was described under that name, and a series of specimens from Ceylon which agree with Wiedemann's description of *assimilis*. These differ from the two first mentioned species in having the fore femora with the series of bristles on the posteroventral surface distinct only on the apical half, a character which is present in the new species also. The fore tibia in *assimilis* has no anterodorsal bristle as in *weschei* and the mid tibia lacks the ventral bristle which is present in *xenochaeta*. In the other characters the females of *assimilis* and the new species are similar, but I have a male from Formosa before me which is distinctly different from the males of the Australian species now described, and as this appears to agree with the form recorded as that species from that island by Stein I have had no hesitation in using a new specific name for it. It would be advantageous to have an examination of the types of *assimilis* Wiedemann and *modesta* Stein made by some competent worker to learn whether they are, as Stein reports, synonyms, or distinct species.

In my recently published key I included *assimilis* amongst the Australian species; this name may be dropped for *incerta* included in the present paper.

Lispa incerta sp.n.

Male and female.—Head black, interfrontalia opaque, orbits, face, cheeks and occiput white pruinescent, triangle yellowish pruinescent, upper half of orbits blackish; antennae black, greyish pruinescent, apex of second segment yellowish; palpi yellow. Thorax grey pruinescent, darker on disc of mesonotum, slightly shining, and with three or five faint darker vittae. Abdomen grey pruinescent, each tergite with a pair of large subtriangular shining black spots, those on fourth visible tergite fused except at apex. Legs black, femora grey pruinescent, tibiae tawny yellow, fore pair darkened apically. Wings hyaline. Calyptrae slightly yellowish. Halteres yellow.

Eye facets enlarged at middle on inner margin in both sexes; arista plumose; antennae about four-fifths of the face length in male, shorter in female; palpi spoon-shaped. Thorax with 2 + 4 dorsocentrals, the presutural and anterior two pairs of postsuturals very short. Abdomen elongate ovate. Fore tibia with one posterior median bristle; mid and hind femora attenuated apically, hind pair each with two strong bristles on anteroventral surface, one just beyond middle and the other near apex, and one at apex on posteroventral surface; mid tibia with one posterior and five or six apical bristles; hind tibia with one posterodorsal, one anterodorsal, and one anteroventral bristle. First posterior cell distinctly narrowed apically.

Length, 7-8 mm.

Type, male, allotype, Eidsvold, Queensland. Paratypes, Babinda and Darwin, Queensland.

The male from Formosa which I assign to *assimilis* has the mid femur with long hair-like bristles on entire length of ventral surfaces and a few much shorter hairs scattered on same surfaces of hind femur.

A MONOGRAPH OF THE AUSTRALIAN LORICATES.

(Phylum Mollusca—Order Loricata.)

By Tom Iredale and A. F. Basset Hull.

IV.

Family Lepidopleuridae.

This family, based on the absence of slitting in the insertion plates, appears to consist of heterogeneous elements; the species referred to it are mostly rare, the majority dwelling in deeper water and only secured when stones or other objects upon which they have settled are dredged. Some species have been procured from great depths, 2,000 fathoms or more. We have regarded the series as degenerates, mainly from an Ischnochitonoid source, the most characteristic feature being the posterior situation of the few gills. This cannot be regarded as an archaic feature, but as a phase of degeneracy. It must be obvious that a mollusk of this order must have developed the girdle by means of slit insertion plates, accompanied by gills the whole length of the body; and that by retrogression into deep water the slitting became unnecessary and the lengthy gills were not required. It is interesting to note that Thiele found that the radula varied so much that he concluded no description should be framed without the inclusion of the radular characters. This may be theoretically accepted, but practically it would mean the nondescription and consequent neglect of the whole of this family, save by radula specialists, whose number to-day can be counted on one hand.

The loss of slit insertion plates seems to be a present day feature in every group, beginning with the posterior valve. Thus *Lucilina* has the tail valve completely furnished with teeth in a notable insertion plate; *Onithochiton* is superficially inseparable, but when the posterior valve is examined interiorly it is seen to have a callus only, without teeth or slits. Other cases of unslit posterior valves can be seen in *Plaxiphora* (*sensu lato*), *Liolophura, Clavarizona, Lorica, Loricella, Kopionella, Cryptoplax*, and *Subterenochiton*, the lastnamed being an Ischnochitonid very similar to the Australian Lepidopleurids. A most interesting case is that of the Subantarctic *Hemiarthrum*, which proves to be a *Plaxiphora* with the anterior and median valves showing unslit insertion plates and degenerate external sculpture.

In Australian waters two groups of this family occur, which can be separated by means of the girdle covering and the external appearance, though interiorly the radular characters also differ:—

Terenochiton. Shell small, with girdle scaly; posterior valve normal.

Parachiton. Shell a little larger; girdle clothed with glassy spicules; the posterior valve generally disproportionately large.

Genus Terenochiton.

Terenochiton Iredale, Proc. Mal. Soc., xi., 1914, 28. Type by original designation *Lepidopleurus subtropicalis* Iredale.

Lepidopleurus of Australian writers, but not *Lepidopleurus* Risso, Hist. Nat. l'Eur. Merid., iv., 1826, 267. Type by subsequent designation (Bucquoy, Dautzenberg and Dollfus, 1884) *Chiton cajetanus* Poli.

This group, proposed for a Kermadec shell, may include the Austral forms conchologically similar until the animals be examined; the type of *Lepidopleurus* is a very different shell, the conchological northern equivalent being *Leptochiton.* The sculpture in all the species is essentially alike, and the following descriptions are therefore comparatively formed, as when one member is identified the rest are immediately recognised by superficial likeness alone.

Shells of small size for the family, generally unicolored, of medium elevation, elliptical to oval, rarely elongate ovals; sculpture characteristic of the Austral members of the family (except *Hemiarthrum,* a Subantarctic shell doubtfully referable to the family in any phylogenetic sense) consisting of minute erect pustules, strung together on the central areas, obscurely forming rays on the anterior and posterior valves and lateral areas; girdle scales very small, oval, striate; insertion plates absent throughout, the sutural laminae small, triangular, very far apart.

Nearly all Loricates have a minute spiculose edge to the girdle, and through the lack of insertion plates Terenochitons curl their girdles upward at death, showing such spicules more clearly than usual. Some observers have mistaken such spiculose edge for the beautiful spiculose girdle of *Parachiton,* which, however, is quite distinct.

The Australian species of the genus *Terenochiton* are separable into two small groups (which may later prove to have distinct radular features) a smaller and a larger series, although all the shells are relatively small. The following is a key to the species:—

Shell small, broad:
- Sculpture weak, irregular .. .. *badius.*
- Sculpture more pronounced, regular .. .. *matthewsianus.*

Shell small, broader: areas not differentiated .. .. *niger.*
- Sculpture finer and more regular:
  - Mucro posterior .. .. *erratus.*
- Sculpture coarse .. .. *sperandus.*
- Sculpture on central areas much bolder .. .. *liratellus.*

Shell larger; elongate:
- Concentric growth lines prominent .. .. *liratus.*

Terenochiton badius.

(Plate xxxix., figs. 1 and 2.)

Lepidopleurus badius Hedley and Hull, Rec. Aust. Mus., vii., 1909, 260, Pl. lxxiii., f. 1, 2. Port Jackson, N.S.W. Type in Australian Museum.

Shell small, oval, elevated, subcarinated, side slopes curved, median valves narrow, sutures straight. Colour pale to dark orange buff.

Anterior valve covered with minute scattered elevated pustules, not forming distinct rays.

Median valves: Lateral areas scarcely raised or differentiated, sculptured as anterior valve; pustules more massed but never rayed; central areas with similar pustulose sculpture, but pustules arranged in linear rows, not coalescing and

fairly regularly spaced, about fifty across the valve, not differentiated on the jugum, twelve pustules to a row.

Posterior valve; mucro anterior, elevated, at about anterior fourth; post-mucronal area a little concave, sculptured as anterior valve; ante-mucronal area very small, sculptured like central areas.

Girdle covered with very minute compressed elongate oval, striated scales.

Interior white. Slits none. Sutural laminae small, semi-triangular, distant.

Dimensions: 6 x 3.5 mm. (Type).

Station: Under sandstone embedded in sand, below low water mark.

Habitat: New South Wales, Victoria, South Australia.

Remarks: The foot of the animal is deep red in the New South Wales examples; while Ashby states that the South Australian examples have a buff foot. The shells from the latter locality are sculptured with larger pustules, having fewer and more perpendicular rows in the central areas, eight pustules to a row.

Terenochiton matthewsianus.

(Plate xxxix., fig. 3.)

Lepidopleurus matthewsi Tate and May, Proc. Linn. Soc. N.S.W., 1901, 412. *Nom. nud.*

Lepidopleurus matthewsianus Bednall, Proc. Mal. Soc., vii., 1906, 92, pl. ix., f. 1-1f. Gulf, St. Vincent, South Australia. Type in coll. Matthews. Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 218, pl. xvi., f. 5, 5a. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 3.

This species is a little larger than the preceding; more elongated, round-backed, moderately depressed; lateral areas a little larger and better defined; sculpture throughout more regular, pustules regularly closely rayed on the anterior and posterior valves and lateral areas; 50 to 60 rays on anterior valve, 40 rays on posterior valve, 8 to 10 rays on lateral areas.

Posterior valve elevated, with mucro central; posterior slope straight.

Dimensions: 9 x 3.5. (Type).

Station: Below low water, under stones.

Habitat: South Australia, Victoria, Northern Tasmania.

Remarks: Shells from Port Lincoln, South Australia, show a still coarser sculpture.

Terenochiton niger.

Lepidopleurus niger Torr, Trans. Roy. Soc. S. Aust., xxxv., 1911, 105, pl. xxv., f. 5 a-f. Hopetoun, Western Australia. Type in coll. Torr. Ashby, *ib.*, xlvii., 1923, 220, pl. xvi., f. 4.

This shell is described as shorter, broader, and more depressed than *T. matthewsianus*, with no distinction between lateral, dorsal, and central areas of the median valves.

Dimensions: 4 x 2½ mm.

Station: Under a stone in a shallow pool.

Terenochiton erratus.

(Plate xxxix., figs. 7-10.)

Terenochiton erratus Hull, Aust. Zool., iv., 1923, 159, pl. xxiv., f. 6-9. Rabbit or Mistaken Island, King George Sound, Western Australia. Type in Australian Museum.

This shell is differentiated from *T. matthewsianus* by the more regular grain

striation of the sculpture, and the still more posterior mucro. The sculpture is a little finer in the central areas. Post-mucronal slope concave.

Dimensions: 5 x 3 mm. (Type), maximum length 10 mm.

Station: Under stones below low water mark.

Habitat: South Western Australia.

Remarks: When alive the shell is a pale rose colour which fades at death.

Terenochiton liratellus, n.sp.

(Plate xxxix., fig. 5.)

Like a miniature *T. liratus;* shell small, elongate oval, moderately elevated, subcarinated. Colour pink.

Anterior valve finely closely rayed with about fifty pustulose ribs.

Median valves: Lateral areas well differentiated and rayed similarly to the anterior valve; central areas strongly sculptured with fifteen longitudinal rows of pustules at each side, more distant and widely separated towards the margin, massed on jugum, but still distinct.

Posterior valve with mucro ante-median; post-mucronal area concave, sculptured as anterior valve, rays distinct; ante-mucronal area like central areas.

Interior: Pinkish-white.

Girdle: Covered with minute scales.

Dimensions: 5½ x 3 mm.

Station: Under stones on seaward side of rocky escarpment, below low water mark.

Habitat: Port Cartwright, South Queensland (Hull).

Remarks: Type in Queensland Museum.

Terenochiton sperandus, n.sp.

(Plate xxxix., fig. 6.)

Shell small, depressed, semi-carinated, elongate oval, side slopes straight. Colour brownish-pink.

Anterior valve very large, regularly rayed with about sixty pustulose rays.

Median valves: Lateral areas similarly rayed with eight rays; central areas longitudinally regularly ribbed with about twenty-five pustulose rays across the valve, closer together on the jugum, separating a little laterally.

Posterior valve with mucro ante-median, elevated; ante-mucronal area very small; post-mucronal area concave; sculpture as on anterior and median valves.

Girdle covered with minute scales.

Dimensions: 4 x 2½ mm.

Station: Dredged in 70 fathoms, off Ulladulla (C. W. Mulvey).

Habitat: New South Wales.

Remarks: Type in the Australian Museum.

Terenochiton liratus.

(Plate xxxix., fig. 4.)

Lepidopleurus liratus H. Adams and Angas, P.Z.S., 1864, 192. Yorke's Peninsula, South Australia. Type lost.

Lepidopleurus inquinatus of Australian workers since 1896, but not *Chiton inquinatus* Reeve, Conch. Icon., iv., 1847, pl. xxiii., sp. and f. 154. Van Diemen's Land in error = New Zealand. Type Mus. Cuming in Brit. Mus.

Lepidopleurus liratus Iredale and May, Proc. Mal. Soc., xii., 1916, 99. Ashby,

Proc. Roy. Soc. Vict., xxxiii., 1921, 155. Trans. Roy. Soc. S. Aust., xlvii., 1923, 218, pl. xvi., f. 1.

This species is larger, more elongate, semi-carinated, side slopes a little curved, a notable feature being the strong concentric ridge formation, suggesting long growth periods. The anterior valve is closely radially rayed with very small pustules packed together, about eighty rays being counted; six deep concentric grooves form a characteristic item; these growth grooves occur all round the shell, on the lateral areas of the median valves and the post-mucronal area of the posterior valve; the central areas are more openly sculptured than in any of the preceding species, the pustules being strung together and widely separated laterally, six to eight crowded and straight on the jugum, ten to twelve irregular and obliquely slanting rows on each side.

Posterior valve normal, mucro elevated, central; post-mucronal slope concave.

Girdle covered with minute rounded striated scales.

Interior pinkish-white; sutural laminae small, triangular, distant.

Dimensions: 9 x 4 mm.

Station: Under stones below low water mark.

Habitat: South Australia. (? Victoria).

Remarks: The neotype described is from Hardwicke Bay, the type locality.

Genus Parachiton.

Parachiton Thiele, Revision Chitonen (Chun's Zoologica, heft 56), Part 1, 1909, 14. Type by monotypy *Lepidopleurus* (*Parachiton*) *acuminatus* Thiele.

Shells more elongately ovate than the preceding forms; median valves deep; the posterior valve large, generally being abnormally long, with the mucro posterior to sometimes terminal; moderately depressed; of pure white or delicately pinkish colouration; sculpture as in *Terenochiton,* but always finer and more elegant; the girdle covering consisting of fine elongated glassy spicules. Interior and other shell features as in *Terenochiton.*

This group was proposed by Thiele for a Lepidopleurid of peculiar superficial appearance which showed a distinct style of radula. The notable shell feature is the elongated posterior valve, and the species appear to be widespread throughout the Austral-Neozelanic area in deeper water. One species occurs on the littoral in Port Jackson.

Although the description reads somewhat like that of *Deshayesiella,* autoptic examination shows that no relationship exists. The species can be easily separated by means of the position of the mucro and the sculpture. Two series may be recognised, the northern forms with the true exaggerated posterior valve, and the southern forms with the posterior valve large but not extraordinarily so. These latter appear to be more closely related to *Terenochiton* through *T. liratus.*

The following is a key to the species of *Parachiton*:—

Posterior valve abnormally large:

Shell round-backed:

Sculpture coarse, bolder, laterals rayed .. .. *puppis.*

Sculpture fine, laterals indistinctly rayed .. .. *litoreus.*

Sculpture weak; no raying on laterals .. .. *capricornicus.*

Posterior valve not abnormally large:

Shell highly elevated:

Sculpture regular, carinated .. .. *columnarius.*

Sculpture confused granules only .. .. *opiparus.*

Shell moderately elevated, slightly carinated:
Mucro post-median .. .. *collusor.*
Shell moderately elevated, not carinated:
Mucro ante-median .. .. *profundus.*

Parachiton puppis.

(Plate xxxix., figs. 15-19.)

Parachiton puppis Hull, Aust. Zool., iii., 1923, 158, pl. xxiv., f. 1-5. Vaucluse, Port Jackson, N.S.W. Type in Aust. Mus.

Shell elongate, thin, narrow, round-backed, moderately elevated, with a suggestion of carination. Colour chalky white when alive, becoming pale buff when dried. The sculpture is uniformly grain-striate.

Anterior valve finely closely rayed, over 100 of the minutely grained striae may be counted at the anterior margin.

Median valves: Lateral areas distinctly raised, radially striate, the rays very numerous and crossed by three or four deep growth lines; central areas closely finely ridged with regular straight rows of coalescing granules, larger than those on the lateral areas.

Posterior valve very large, mucro elevated, at about the posterior fifth, post-mucronal slope steep, concave; post-mucronal area very small, sculptured as anterior valve; ante-mucronal area disproportionately long, sculptured as central areas.

Girdle densely clothed with fine elongate glassy spicules.

Interior pearly white; sutural laminae small, triangular, distant.

Dimensions: 12 x 5½ mm., (Type): maximum 16 x 8 mm.

Station: Under stones embedded in mud or soft sand, below low water mark.

Habitat: Port Jackson, New South Wales.

Remarks: This is a somewhat rare species, and so far it has been taken in a restricted area at Vaucluse (Watson's Bay). The animal is large, soft, and generally distended with water; the foot transparent and extending laterally beyond the shell on both sides. When dried, the body contracts forward, leaving the gill rows distinctly visible in the posterior cavity. The resemblance of the posterior valve in shape to the stern of a cruiser suggested the specific name.

Parachiton litoreus, n.sp.

(Plate xxxix., fig. 13.)

Shell elongate, depressed, round-backed. Colour cream.

Anterior valve finely rayed with about 100 pustulose rays.

Median valves: Lateral areas indistinctly rayed, about 20, visible only at an angle in a strong light; central areas having about 60 longitudinal rows of fine pustules, fairly evenly spaced throughout.

Posterior valve large; mucro nearly terminal, elevated; post-mucronal slope deeply concave, small, no ray formation discernible.

Girdle finely spiculose.

Dimensions: 10 x 4 mm. (curled).

Station: On the beach.

Habitat: Murray Island, Torres Strait.

Remarks: This shell was collected by Mr. C. Hedley. The type is in the Australian Museum.

PARACHITON CAPRICORNICUS, n.sp.

(Plate xxxix., fig. 14.)

Shell elongate, round-backed, moderately elevated, glossy. Colour pale pink.

Sculpture as in *P. litoreus*, but the pustules are very small and strung together into fine lines.

Median valves: Lateral areas a little raised, more glossy than the central; pustules larger and more separated; raying obsolete; faint growth lines; central areas regularly finely longitudinally lined with pustulose lines.

Posterior valve abnormally large; mucro nearly terminal.

Dimensions: 12 x 4 mm. (curled).

Station: Dredged in 17-20 fathoms.

Habitat: Masthead Reef, Capricorn Islands, Queensland.

Remarks: This shell was collected by Mr. C. Hedley. The type is in the Australian Museum.

PARACHITON COLUMNARIUS.

(Plate xxxix., figs. 11-12.)

Lepidopleurus columnarius Hedley and May, Rec. Aust. Mus., vii., 1908, 213, pl. xxiv., f. 27, 28. Off Cape Pillar, south coast of Tasmania. Type in Aust. Mus. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 1. Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 219, pl. xvi., f. 3, 3a.

Lepidopleurus pelagicus Torr, Trans. Roy. Soc. S. Aust., xxxvi., 1913, 165, pl. v., f. 2 a-f. Off Cape Jaffa, South Australia. Type in coll. Torr. Ashby, *id, ib.*, xlvii., 1923, 220, pl. xvi., f. 3b.

Shell elongate, thin, much elevated, arched, sub-carinated. Colour pinkish.

Anterior valve closely rayed with 100 very fine pustulose rays.

Median valves deep; lateral areas rayed with about 20 rows; slightly differentiated; central areas longitudinally ribbed, about fifty distinct fine pustulose ribs, more closely packed on the jugum.

Posterior valve with mucro behind the middle; post-mucronal slope rather steep.

Dimensions: 8 x 3 mm. Type (curled).

Station: Dredged in 100 fathoms.

Habitat: Tasmania, South Australia, Victoria.

Remarks: Torr's *P. pelagicus* is described as decidedly arched and strongly carinated; the mucro is median and elevated. This description does not agree with the type of Hedley and May's shell, and therefore Torr's shell may be regarded as sub-specific until further material is available for examination.

PARACHITON OPIPARUS, n.sp.

(Plate xxxix., fig. 20.)

Shell somewhat resembling *P. columnarius*, but though highly arched it is not carinated. Colour pink.

Sculpture very fine throughout, no distinct rays or lines can be seen with a lens, only a compact finely pustulose surface giving a matt appearance. The lateral areas of the median valves are only indicated by a slight fold.

Posterior valve not abnormally large; mucro post-median; post-mucronal slope concave.

Girdle very finely spiculose.

Dimensions: About 10 x 5 mm. (curled).

Station: Dredged in 100 fathoms.

Habitat: Off Cape Wiles, South Australia.

Remarks: This shell was collected by Mr. C. Hedley. The type is in the Australian Museum.

The whole appearance of this shell differs so much from that of the typical *Parachiton* that it is suggested it is no near relation, but in the meanwhile until further material is secured we place it in this genus.

Parachiton collusor, n.sp.

(Plate xxxix., fig. 22.)

Lepidopleurus profundus Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 221, pl. xvi., f. 2, 2a. Gulf St. Vincent, S.A. Type in coll. Ashby.

Shell somewhat resembling *P. profundus* May, but larger, round-backed, semi-carinated. Colour pinkish.

Anterior valve closely rayed with fine pustules, about 100 rays; three deep concentric growth lines close together near the margin.

Median valves: Lateral areas finely rayed, rays divaricating, but only about fifteen counted, six growth lines (or periods) close together near the margin; central areas finely ridged with lines of pustules massed on the jugum, separating somewhat irregularly and slanting laterally, twenty-five on each side, spaces between latticed with fine lines.

Posterior valve large but not abnormal; mucro a little behind the middle.

Girdle clothed with fine glassy spicules.

Dimensions: 18.5 x 6 mm. (curled). Ashby's type 20 x 6.5 mm.

Station: Dredged.

Habitat: South Australia. Victoria.

Remarks: This shell looks like a deep water form of *Terenochiton liratus* in which the girdle scales have been replaced by spicules. Compared with May's *P. profundus* the sculpture of the central areas is finer; the mucro is more posterior.

Parachiton profundus.

(Plate xxxix., fig. 21.)

Lepidopleurus inquinatus Sykes, Proc. Mal. Soc., ii., 1896, 86, pl. vi., f. 4, and of Australian workers since, but not *Chiton inquinatus* Reeve, Conch. Icon., iv., 1847, sp. and f., 154. Van Diemen's Land in error = New Zealand. Type in Mus. Cuming in Brit. Mus. Ashby, Proc. Roy. Soc. Vict., xxxiii., 1921, 155 (error only), corrected in Trans. Roy. Soc. S. Aust., xlvii., 1923, 217.

Lepidopleurus profundus May, Illust. Index Tas. Shells, 1923, Appendix ex Ashby M.S. for *L. inquinatus* pl., xiv. Ten fathoms off Pilot Station, River Derwent; 15 fathoms Geographe Strait, Tasmania. Type in coll. May.

Shell small, elongate oval, moderately elevated, not carinated; posterior valve not much elongated. Colour pinkish-cream.

Anterior valve closely finely rayed with rows of small pustules, coalescing and intercalating rays intervening with growth, the rays numbering up to 100.

Median valves rather deep; the lateral areas finely rayed as the anterior valve, rays similarly intercalating, about fifteen ribs at edge of valve; central areas strongly ridged longitudinally with rows of nearly separated pustules, the interstices wide towards the side and finely latticed, these ribs appearing as if thrown off the lateral areas and thence traversing the central areas, about twenty on each side of the jugum; the jugal area being indicated by about ten of these rows massed together.

Posterior valve not as large as usual in this genus; mucro ante-median and elevated; post-mucronal area a little concave, sculpture like that of anterior valve; ante-mucronal area sculptured like central areas; growth lines notable as weak terraces on the lateral areas, as concentric grooves toward the margin of the anterior valve, but scarcely marked on the posterior valve.

Girdle covered with slender glassy spicules.

Interior pinkish-white; sutural laminae small, triangular, distant.

Dimensions: 10 x 5 mm.

Station: Dredged in 10 fathoms off Pilot Station, River Derwent (Estuary), Tasmania. (? Victoria).

Remarks: The foregoing description is the first published of May's species, and is based upon one of the original series from which the author figured the species.

Family Lepidochitonidae.

This family, of world-wide distribution, comprises species characterised by the nature of the girdle covering and the peculiar insertion plates; the radular features allying them to the Ischnochitonidae, of which they may be a very early offshoot, much specialised. The majority of species live in the Southern Hemisphere, but some occur in the North, where *Ischnochiton* is absent.

Shells varying in size from small to large (the largest species live in Tasmania and New Zealand, and have developed a secondary girdle covering of scattered corneous processes), depressed or elevated; colouration generally dark, (reds, browns, and purples predominating); sculpture of coarse granulation, but a few species with longitudinal ditches on the central areas; girdle leathery, generally densely clothed with elongated spicular scales, packed latitudinally so as to form a carpet-like edging commonly of greater width than usual in the scaly girdled Loricates, and with scattered corneous processes in a few instances; insertion plates long, thick, brittle, and coarsely denticulate; usually more than one slit in the insertion plates of the median valves; the sutural laminae commonly continuous. Eyes have been recorded in this family by Torr in connection with *Icoplax mayi*, from South Australia, and by Odhner for a New Zealand species. We find them present in all the species here dealt with; very rarely seen in *Eudoxoplax*, a few discovered in *Levicoplax*, more notable in *Icoplax*, being abundant in *I. luminosa*, in which species the ocelli are rayed more regularly than in *Lucilina*, etc., but not so clearly visible to the naked eye.

The differential characters of the genera may be epitomised as follows:—

Girdle without corneous processes; less than 20 slits in terminal valves:—

Shell highly elevated:

Central areas deeply grooved . . . . . *Icoplax.*

Shell varying from depressed to moderately elevated:

Central areas smooth, with occasional pits in valves vi. and vii. *Levicoplax.*

Girdle with scattered corneous processes; more than 20 slits in terminal valves . . . . . *Eudoxoplax.*

Genus Icoplax.

Icoplax Thiele, Das Gebiss der Schnecken (Troschel), II., 1892, 392. Type by monotypy *Chiton puniceus* Couthouy.

Shell of medium size, highly elevated, somewhat broadly ovate; colour little variable, dull; central areas deeply longitudinally grooved; lateral areas notably raised; girdle composed of long slender curved spicules placed latitudinally so that about one-third is seen, the whole presenting a textile appearance. (In

dried specimens the girdle sometimes cracks, and the spicules become displaced, when they resemble the bunches of siliceous spicules seen in other groups).

Icoplax mayi.

(Plate xxxix., figs. 23-27.)

Callochiton mayi Torr, Proc. Roy. Soc. Tas., 1912, 1, pl. 1, f. 5-7. Stanley, North-west Tasmania. Type in coll. Torr. Trans. Roy. Soc. S. Aust., xxxvi., 1912, 164, pl. v., f. 1 a-f. Spencer Gulf, South Australia. May, Illustr. Index Tas. Shells, 1923, pl. xiv., f. 6.

Shell medium, ovate, elevated, carinated, side slopes straight. Colour greenish with a few brown markings, end valves brown. The whole shell is minutely granulate, the surface dull (matt).

Anterior valve: Apex elevated.

Median valves with lateral areas very elevated, granulate; central areas with deep longitudinal channels, about eleven in each side, the lateral five extending across the valve, the next three median ones extending only half way across, and three small, almost pits, approaching the jugum.

Posterior valve with mucro ante-median; post-mucronal slope nearly straight; ante-mucronal area grooved as central areas.

Girdle broad; scales generic. Interior rose; slits 16-3-12.

Dimensions: 15 x 8 mm. (Type). 20 x 12 mm. (Maximum).

Station: Under stones below low water mark.

Habitat: Tasmania (North and East), Victoria, South Australia.

Remarks: This is a rare species. It resembles the type of the genus.

Icoplax rufa.

Callochiton platessa Sykes, Proc. Mal. Soc., ii., 1896, 86. Victoria, *fide* Ashby, Proc. Roy. Soc. Vic., xxxiii., 1921, 150.

Callochiton rufus Ashby, Trans. Roy. Soc. S. Aust., xxiv., 1900, 87, pl. i., f. 2 a-g. Gulf St. Vincent, South Australia. Type in coll. Ashby.

? *Callistochiton rufus* Ashby, Thiele, Die Fauna Sudwest Aust., iii., 1911, 402. Sharks Bay, W.A.

Shell medium, broadly ovate, carinated, side slopes curved. Colour bright terra-cotta red, with white spots on dorsal area of some valves, and white lateral area of valve vii.

The sculpture of the whole shell consists of rather widely separated small pustules arranged in quincunx. The lateral areas of the median valves are distinctly raised, having two or three faint vertical sulci; central areas longitudinally ribbed with scimetar-shaped riblets; dorsal area raised, wedge-shaped, divided from the central areas by a deep spindle-shaped pit, tapering off into a curved groove at the anterior margin. Posterior valve with mucro median, and although shallow, decidedly more prominent than in *L. platessa;* ante-mucronal area traversed by eight longitudinal strongly raised ribs, similar to those of the central areas of the median valves; post-mucronal area smooth.

Girdle broad, leathery, densely clothed with evenly packed elongate scales arranged in rows, the apices curving across to the next row.

Interior: Slits 11-2- .

Dimensions: 16 x 10 mm.

Station: Dredged.

Habitat: South Australia, Victoria. ? Western Australia (Thiele).

Remarks: Only one specimen was dredged in Gulf St. Vincent by Sir Joseph Verco. Although we have not seen the type, Ashby's figures furnish indications

of a sculpture intermediate between *I. mayi* and *L. platessa*. The identification by Sykes of the shell collected by Bracebridge Wilson, as *L. platessa* is shown by Ashby to be erroneous.

Icoplax luminosa, n.sp.

(Plate xxxix., figs. 28, 29.)

Shell very small, elongate oval, elevated, sub-carinated. Colour reddish-brown.

The whole shell is minutely sculptured as in the genus; under the microscope eyes are seen very numerously ranged on the anterior and posterior valves and lateral areas; the central areas of the median valves and the ante-mucronal area of the posterior valve having three or four deep longitudinal grooves on each side, the lateral two of which cross the valve, the next extends more than half way, and the one nearest the jugum less than half way across; lateral areas much raised.

Posterior valve with mucro elevated, central, post-mucronal slope straight or a little convex.

Girdle wide, characteristic of the family.

Interior rose; slits 12-2-12; teeth thick, scarcely denticulate; solid; sutural laminae continuous.

Dimensions: 6 x 3 mm.

Station: Dredged in 17-20 fathoms.

Habitat: Masthead Reef, Capricorn Group, Queensland.

Remarks: This species seems to come close to *Callochiton sulcatus* Nierstrasz, Siboga Exped. Monog., xlviii., 1905, 35, pl. 1, f. 8, pl. iii., f. 66-69, from shore Sula Bear and 8-10 M, Moluccas. The type was collected by Mr. C. Hedley, and is in the Australian Museum.

Genus Levicoplax, n. gen.

Type, *Chiton platessa* Gould.

Callochiton of recent Australian writers, but not *Callochiton* Gray, P.Z.S., 1847, 126. Type, *Chiton laevis* Pennant.

Shell medium to large, elevated or depressed, elongate to rounded oval, carinated or round-backed. Colour variable, apparently of a protective nature, reds, pinks, browns and greens agreeing with environment, but almost entirely evanescent, becoming uniformly dull red or brown when dry. Sculpture minutely granulose; matt; lateral areas scarcely raised; girdle scales as in preceding genus.

Levicoplax platessa.

(Plate xxxix., fig. 30.)

Chiton platessa Gould, Proc. Bost. Soc. Nat. Hist., ii., 1846, 143. New South Wales = Port Jackson. Type lost (?). U.S. Expl. Exped., 320, atlas, f. 434, 434a.

Lepidopleura platessa Gould, Otia Conch., 1862, 242.

Chiton crocinus Reeve, Conch. Icon., iv., 1847, sp. 146, pl. xxii., f. 146. Hab. ? = New South Wales. Type in Mus. Cuming in Brit. Mus.

Chiton versicolor A. Adams, P.Z.S., 1852, 92, pl. xvi., f. 5. Sydney, N.S.W. Type in Mus. Cuming in Brit. Mus. Not *Chiton versicolor* Sowerby, Mag. Nat. Hist., 1840.

Callochiton platessa Pilsbry, Man. Conch., xiv., 1892, 49, pl. 10, f. 1-5. May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 7.

Callochiton platessa var. *fossa* Ashby, Trans. Roy. Soc. Aust., xlvi., 1922, 19,

pl. iii., f. 4. Gulf St. Vincent, South Australia, and Sydney, N.S.W. Type in coll. Ashby.

Shell medium to large, round-backed to carinated, moderately broad to elongate oval, girdle wide. Colour varying according to environment, but fugitive, dried shells becoming brown, brownish-red, or dull greenish. The sculpture of the whole shell consists of a minute pustulation forming a coarse, matt surface.

Anterior valve rather small; lateral areas of median valves scarcely raised, elevation marked by a shallow depression; posterior valve with mucro central, elevated or planate.

Girdle broad, thin, densely clothed with very fine elongated scales.

Interior generally bluish-white with a rose centre; slits 14-4-16; the sutural laminae continuous but becoming interrupted in valves vi.-viii.

Dimensions: 47 x 29 mm. (Maximum of series from Vaucluse, New South Wales).

Station: Under, or on the upper side of stones below low water mark.

Habitat: South Queensland, New South Wales, Victoria, Tasmania, South Australia, South Western Australia.

Remarks: When alive this shell is covered with a glutinous epidermis which appears to contain the fugitive protective colours. The variation in elevation and breadth of individual specimens is perhaps greater than in any other species of Loricate. In a small percentage of specimens collected in New South Wales a few short sulci may be found, particularly on valves vi., vii., and viii., in the central areas. This variety has been distinguished by Ashby as variety *fossa,* and he records it also from South Australia. As his figured example was a Port Jackson shell, we designate that as the type locality of the variety. South Australian specimens differ, being coarser in sculpture, and probably not attaining such large proportions as the extreme eastern and western examples. We have valves from Foul Bay, S.W. Australia, collected by Mr. S. W. Jackson, which indicate the existence of a much larger and flatter shell, with shorter insertion plates, and still coarser sculpture.

LEVICOPLAX ELONGATA.

Callochiton elongatus May, Proc. Roy. Soc. Tas., 1919, 55, pl. 14, f. 1 a, b. Type in coll. May. Illus. Index Tas. Shells, 1923, pl. xiv., f. 5.

Shell small, elongate, moderately elevated, not carinated. Colour pinkish-brown, mottled with green.

Sculpture as in *L. platessa,* but a little finer; posterior valve large, mucro elevated, ante-median, ante-mucronal area very small, post-mucronal area large, posterior slope nearly straight.

Girdle wide, scales much coarser than those of *platessa,* appearing almost as oval, not linear scales.

Interior: Pinkish. Slits 16-1-12; continuity of sutural laminae variable.

Dimensions: 7.4 x 3.6 mm. (Type), 9 x 5 maximum.

Station: Under stones below low water mark.

Habitat: Norfolk Bay and Port Arthur, Tasmania.

Genus EUDOXOPLAX.

Eudoxoplax Iredale and May, Proc. Mal. Soc., xii., 1916, 94. Type by monotypy *Chiton inornatus* Tenison-Woods.

Shell large, moderately elevated, broadly ovate; girdle very wide, thin, leathery, with a few scattered horny processes. Sculpture similar to that of

Levicoplax, but no trace of sulcation in the central areas. Interior, slits numerous, anterior 24 to 27, median 4 to 7, posterior valve 20 to 27, teeth solid, grooved, scarcely denticulate, sinus narrow, deep, but sutural laminae continuous.

Eudoxoplax inornata.

(Plate xl., fig. 1.)

Chiton inornatus Tenison-Woods, Trans. Roy. Soc. Vict., xvii., 1881, 82, pl. f. 8, 9. North Tasmania. Type in Tasmanian Museum.

Callochiton lobatus Pilsbry, Man. Conch., xiv., 1892, 53, pl. 8, f. 83-85, *ex* Cpr. M.S. Tasmania. Type in Mus. Cuming in Brit. Mus.

Eudoxoplax inornatus May, Illus. Index Tas. Shells, 1923, pl. xiv., f. 4.

Shell large, elongate oval, moderately elevated, sub-carinated, side slopes curved. Colour bright red when alive, drying to dark chocolate-brown, sometimes with patches of green or yellow on one or two valves.

Sculpture of the whole shell minutely granulose in quincunx; not glossy. Anterior valve broad, not very deep; median valves with lateral areas little elevated; posterior valve with mucro elevated, ante-median, posterior slope a little concave.

Interior bluish-white, brownish in centre; slits as in genus, slit rays very deep and extending almost to the centre of each valve.

Girdle very broad, leathery, densely clothed with minute elongated suberect siliceous spinules and with a few scattered corneous processes; sinuate posteriorly.

Dimensions: 75 x 44 mm.

Station: Under stones below low water mark.

Habitat: Tasmania.

Remarks: Examples from southern Tasmania (Port Arthur) are larger, more elevated, and comparatively broader than those from the north and east. The foot of the animal is a bright salmon-red.

Family Callistochitonidae.

The superficial appearance of members of this family has brought together a group of world-wide range, especially developed on the American coast, also common in Australia, but absent from New Zealand. By means of the radular features Thiele has associated these with the Ischnochitonids, but has placed in the genus *Callistochiton* species conchologically quite unlike.

Shells small to medium, elongate ovals, of moderate elevation; generally uniform colouration; sculpture remarkably bold, 8 to 12 elevated ribs on the anterior and posterior valves and 2 ribs on the lateral areas, these ribs composed of massed nodules, in one genus of coalescing granules; central areas with longitudinals of similar formation but much weaker; girdle scales oval, sometimes very compressed, striate; insertion plates generally showing scallopping in agreement with the external ribs; sutural laminae large, sometimes continuous.

The following is a key to the genera:—

Girdle scales not polished, striate: scallopping present:
- Sutural laminae separated .. .. *Callistelasma.*
- Sutural laminae continuous .. .. *Callistassecla.*

Girdle scales not polished, striate; scallopping obsolete:
- Sutural laminae separated:
  - Superficial sculpture diagnostic .. .. *Lophochiton.*

Girdle scales polished, striate; scallopping absent .. .. *Solivaga.*

Genus CALLISTELASMA, n. gen.

Type, *Chiton antiquus* Reeve.

Callistochiton of Australian workers, but not *Callistochiton* Dall, Proc. U.S. Nat. Mus., 1881, 283, 289, 290 (Feb. 1882), of which the type is *Chiton pulchellus* Gray.

Shells small to medium, elongate oval, round-backed, rarely carinated, girdle wide; colouration modest. Sculpture bold, of elevated nodose ribs on end valves and lateral areas, central areas ridged; girdle scales minute, oval, chaffy, not polished, striate, elongate, compressed, rarely roundish; insertion plates generally notably festooned; slits agree in number and position with the external ribs; sutural laminae distant.

(The type of *Callistochiton* is a South American species, superficially like the Australian shells, but having a posterior valve more like *Lophochiton*, the teeth thrown more forward, and the sutural laminae widely separated; the girdle scales smooth).

CALLISTELASMA ANTIQUA.

(Plate xl., fig. 6.)

Chiton antiquus Reeve, Conch. Icon., iv., 1847, pl. 25, sp. and f. 169. Australia—Port Jackson, New South Wales. Type in Mus. Cuming in Brit. Mus.

Chiton apparata Angas, P.Z.S., 1867, 223, ex Carpenter M.S., in synonymy of *C. antiquus* Reeve. Port Jackson.

Callistochiton sarcophagus E. A. Smith, Rep. Zool. Coll. Alert, 1884, 79, ex Carpenter M.S. in synonymy of *C. antiquus*. Type in Mus. Cuming in Brit. Mus.

Callistochiton antiquus Haddon, Zool. Challenger Polypl., 1886, 20. Pilsbry, Man. Conch., xiv., 1893, 274, pl. 59, f. 29-35. Iredale and May, Proc. Mal. Soc., xii., 1916, 114, pl. iv., f. 5a.

Shell of medium size, regular oval, moderately elevated, not carinated, side slopes curved, girdle wide. Colour from pale buff to reddish-brown, sometimes black, rarely bluish-green.

Anterior valve with ten to twelve elevated nodose ribs, twelve nodules marked on a medium specimen, nodules transversely elongate, interstices minutely granose.

Median valves: Lateral areas with two similar elevated nodose ribs, the posterior one tending to duplicate with age, and markedly elongate nodulose, interstices minutely granose; central areas ridged with a dozen rows of small coalescing pustules at each side; latticed between with fine lines; jugal area with crisscross sculpture.

Posterior valve with mucro median, planate; post-mucronal area a little convex, sculptured as anterior valve; ante-mucronal area as central areas.

Girdle wide; scales very small, oval, striate.

Interior bluish-green; slits 8 to 10-1-10 to 12.

Dimensions: 50 x 17 mm.

Station: Under dirty stones between tide marks.

Habitat: Southern Queensland, New South Wales. Victoria (East only).

Remarks: This shell frequents stones embedded in muddy sand, or where numbers of stones are massed together with debris of dead shells and rubbish. Its colour is protective, and varies from light to dark in accordance with its surroundings. It is sluggish, becoming sedentary with age, when it is frequently encrusted with serpularia and other growths.

CALLISTELASMA MERIDIONALIS.

(Plate xl., fig. 2.)

Callistochiton antiquus meridionalis Ashby, Trans. Roy. Soc. S. Aust., xliii., 1919, 400, pl. xlii., f. 7. Marino, South Australia. Type in coll. Ashby.

Callistochiton antiquus mayi Ashby, ib., id., p. 401, pl. xlii., f. 8, 9. Penguin, North Coast, Tasmania. Type in coll. Ashby. May, Illus. Index Tas. Shells, 1923, pl. xv., f. 8.

Easily separable from the preceding species by the lack of development of the linear ridges on the central areas, these only appearing as slanting lines near the sides of the valves, all the remainder of the area being sculptured in crisscross, forming pits. This is beautifully shown in young shells, such as the type of *C. mayi*, and observable in the oldest shells, which are commonly larger than the average New South Wales shell.

The insertion plates are similar to those of the preceding species, but the sutural laminae are rounder and more distant, a wide deep sinus being present. The scales are similar in the juvenile, but in the senile shells they are more rounded and separated.

Habitat: Victoria, South and South-west Australia, Northern Tasmania.

Remarks: Examples from King George Sound, Western Australia, are more finely sculptured in the central areas. It is possible that examination of a series from the west may justify separation of a subspecies, for which we suggest the name *hesperia*.

CALLISTELASMA PERIOUSIA, n.sp.

(Plate xl., fig. 8.)

Callistochiton antiquus Smith, Rep. Zool. Coll. Alert, 1884, 79 (Port Molle).

Distinguishable from *C. antiqua* by the distinctly annulate character of the nodules on the ridges of the lateral areas; the consistently broader posterior ridge; the more numerous (13 on each side) longitudinal lines in the central areas; the fine latticing so characteristic of the southern shell is present.

Habitat: Northern Queensland (Mackay to Cooktown).

Remarks: E. A. Smith identified the shell collected by Coppinger of the *Alert* as Reeve's *C. antiquus*. Coppinger's example was taken at Port Molle, Whitsunday Passage, Queensland. We have examined shells from Mackay, Grassy Island (Whitsunday Group), Port Denison, and Howick Islands, north of Cooktown, all of which consistently show the variations from *C. antiqua* detailed above.

CALLISTELASMA GENEROS, n.sp.

(Plate xl., figs. 3 and 4.)

Shell medium, elongate oval, depressed, round-backed. Colour greenish-white, with fine black lines and greenish blotches. Umbones pink.

Anterior valve ten-ribbed, ribs obsoletely nodulose, interstices roughly pustulose.

Median valves: Lateral areas two-ribbed, the anterior one duplicating, subnodulose; posterior one with a succeeding line of obscure pustules; central areas with jugal tract minutely pustulose, almost smooth, merging laterally into a rude crisscross sculpture, succeeded by five slanting ridges extending to the margin, with smooth intervals.

Posterior valve with mucro smooth, ante-median, depressed; post-mucronal slope straight; post-mucronal area ten-ribbed, ribs a little more nodulose than those of valves i. to vii. and tending to duplicate.

Girdle broad, scales very small, elongate, regular, 8-grooved.

Interior white; slits 10-1-10; teeth scallopped.

Dimensions: 11 x 7 mm. (curled).

Habitat: Masthead Reef, Queensland.

Remarks: This shell, several examples of which were collected by Mr. C. Hedley, superficially resembles *Lophochiton,* the colour and the more granular sculpture distinguishing it externally from the plain brownish shells of the rest of the genus. Its interior characters, however, are those of *Callistelasma.* Type in Aust. Mus.

Genus CALLISTASSECLA, n. gen.

Type, *Callistochiton mawlei* Iredale and May.

This form is characterised by the continuous sutural laminae, a feature otherwise of family value.

CALLISTASSECLA MAWLEI.

(Plate xl., figs. 5 and 7.)

Callistochiton mawlei Iredale and May, Proc. Mal. Soc., xii., 1916, 113, pl. iv., f. 5. Port Arthur, Tasmania. Type in Tasmanian Museum. May, Illus. Index Tas. Shells, 1923, pl. xv., f. 7.

Shell medium, elongate oval, elevated, semi-carinated, side slopes a little curved. Colour buff to reddish-brown, the girdle generally banded.

Anterior valve with twelve to fourteen bold elevated ribs, scarcely nodulose, intervals minutely latticed towards the apex.

Median valves: Lateral areas elevated with two ribs, annulate nodulations appearing towards the sides, resembling growth periods; interstices deep and smooth, faint latticing near jugal area; central areas longitudinally regularly lined with elevated ridges, interstices finely latticed, 25 ridges on each side, those on the jugum being closer together.

Posterior valve with mucro depressed, median, post-mucronal slope a little convex owing to the elevated ribs, eleven in number, like those of the anterior valve; ante-mucronal area sculptured as central areas.

Girdle scales minute rounded ovals, deeply grooved.

Interior white; slits 10-1-10, teeth very slightly scalloped; sutural laminae continuous.

Dimensions: 17 x 9.5 mm. (type), 24 x 12.5 mm. (maximum).

Habitat: Southern Tasmania.

Genus SOLIVAGA, n. gen.

This distinct genus is based upon a species dredged in shallow water by Surgeon Archer at Singapore, and which we regard as *Callistochiton finschi* Thiele (Revision Chitonen, 1910, 36, pl. viii., f. 57-60). This species was described from two small shells collected by O. Finsch on the East coast of Sumatra (Java Sea) which is practically the same locality. Thiele gave figures of the fifth and eighth valves and one of the girdle scales, and placed it under Callistochiton, apparently from its resemblance to some other species he there located by means of the radular characters. We are describing and figuring the Singapore species, so that the Australian shell, regarded as conchologically similar, will be recognised when again found.

[SOLIVAGA FINSCHI.

(Plate xl., figs. 14-16.)

Shell roundly oval, elevated, carinated, side slopes straight, girdle broad. Colour buff, sparsely spotted with bluish-green, girdle sometimes banded with bluish-green.

Anterior valve large, a little concave, apex slightly recurved, minutely coarsely pustulose, ray formation developing with age, so that the largest specimen seen (12 x 7 mm., slightly curled) shows fifty regular pustulose rays, not separable near the apex; posterior edge showing faint teeth laterally.

Median valves: Lateral areas sculptured similarly to the anterior valve, the rays forming more slowly, eight to ten rays, toothed on the posterior edge; central areas similarly minutely pustulose, longitudinal rows of larger pustules regularly crossing the valves, more closely packed towards the jugum, twenty being counted on each half.

Posterior valve; mucro ante-median, about anterior third; post-mucronal slope a little concave, sculptured as anterior valve; ante-mucronal area with the sculpture of the central areas.

Girdle broad, clothed with longitudinal oval scales, irregularly packed, with about ten grooves, apices smooth.

Interior white; slits 12-1-10; no scallopping; teeth short, sharp, and Ischnochitonid in appearance; sutural laminae thin, large, the jugal tract intervening in the foremost, a spade-like process arising in the hinder valves, very like that found in *Loricella*.

Dimensions: Maximum 12 x 7 mm. (curled); medium shell, 9 x 6 mm. (Type of *C. finschi* 8.5 x 5.5).

Station: Dredged in shallow water.

Habitat: Singapore.

Remarks: The figured shell is in the Australian Museum].

SOLIVAGA RECENS.

Callistochiton recens Thiele, Die Fauna Sudwest Aust., iii., 1911, 402. Sharks Bay, Western Australia. Type in Berlin Museum.

Thiele described a minute shell, 5 x 3 mm., giving no figures but stating that his figure of *Callistochiton finschi* (Rev. Chitonen, 56 (Chun Zoologica) 86, pl. 5, f. 57-60) is like the one under review. This species (*finschi*) is conchologically quite unlike any of the shells previously referred to *"Callistochiton,"* and such like shells are so classed by Thiele on account of the radular characters. It is quite unlike *Lophochiton,* which is mentioned in connection with it by Ashby.

The following is a translation of Thiele's description:—The colouration is whitish with some washed-out grey and brown flecks, the girdle being banded. The shell is carinated, the side slopes straight; the lateral areas are closely, and towards the outer edge more boldly nodulose, while in the central areas the granules are arranged distinctly in longitudinal rows, not very close together; the slits in the anterior valve correspond with the ribs of the tegmentum. The edges of the terminal valves are somewhat wavy. The anterior valve has ten slits, the posterior valve is irregularly slit; the sutural laminae are broad. The apex of the posterior valve is scarcely elevated; the post-mucronal area is obsoletely rayed. The girdle scales are grooved. Further the shell is similar to that I have figured as *Callistochiton finschi.*

Genus Lophochiton.

Lophochiton Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 233. Type by original designation *Lophochiton johnstoni* Ashby = *Chiton coccus* Menke.

This generic name was proposed for a supposed Callistochitonid without the characteristic festooning of the insertion plates. Simultaneously a closely allied species had been described as a *Callistochiton.* The genus is undoubtedly related to the Australian Callistochitonids, but is well characterised by its extraordinary granose sculpture, its peculiar posterior valve, and the obsolescence of the characteristic festooning of the insertion plates.

Shell small, rounded oval, elevated, carinated, posterior valve with humpy mucro. Sculpture like that of *Callistochiton,* overridden by granular pustules. Insertion plates without much festooning, otherwise as in *Callistochiton.* Girdle scales small, typically Callistochitonid.

An allied species, referable to this genus, occurs in the Moluccas, being described as *Callistochiton carpenteri* by Nierstrasz (Siboga Exped. Monog., xlviii., 1905, 39, pl. i., f. 11, pl. iii., f. 88-92, Banda), while we have seen an undescribed species from New Caledonia.

Lophochiton granifer.

(Plate xl., figs. 9-13.)

Callistochiton granifer Hull, Aust. Zool., iii., Aug. 15, 1923, 161, pl. xxv., f. 5-8.

Palm Islands, Queensland. Type in Australian Museum.

Shell small, broadly ovate, semi-carinated. Colour buff to greyish-green, occasionally having a few scattered brown spots.

The sculpture generally consists of coarse granules, mostly uniform in size, but very irregularly arranged, and becoming slightly larger towards the periphery.

Anterior valve with twelve to fifteen radiating folds, with very narrow interstices, becoming obsolete posteriorly; apex emarginate.

Median valves: Lateral areas distinctly differentiated, with two bold granose ribs, having a deep sulcus between, and on the posterior edge a line of projecting separated tooth-like processes, all roughly granose; central areas covered with erect granulose pustules, massing into irregular longitudinal lines.

Posterior valve with mucro rather behind the middle; post-mucronal slope convex, the post-mucronal area small, sculptured with ten elevated granose ribs; ante-mucronal area long and sloping, granules radially disposed, sharper and more regularly arranged than those in the central areas of the median valves.

Girdle densely clothed with uniform grooved scales.

Interior; white, with bluish spot in valve viii.; slits 9-1-9; sutural laminae small, rounded, distant.

Dimensions: 9 x 5½ mm. (Type, curled), maximum of series collected 14 x 9 mm.

Station: Under stones embedded in mud or coral sand and debris, below low water mark; also dredged in 15 fathoms.

Habitat: Queensland from Capricorn Group to Thursday Island.

Remarks: The type of this species was collected by Mr. C. Hedley off the Palm Islands, north of Townsville, Queensland. Specimens were later collected by one of us at Stone Island, Port Denison, Armit and Grassy Islands in the Whitsunday Group, Howick Islands, north of Cairns, Flinders Islands near Cape Melville, and Thursday Island, Torres Strait. The long series thus obtained has enabled us to modify some details of the original description. The animal, like

other Callistochitonids, shows a preference for muddy or dirty situations, and is frequently associated with *Ischnochiton luticolens.*

LOPHOCHITON COCCUS.

Chiton coccus Menke, Zeitschr. fur Malak. (Menke), 1844, 62. North West Coast, New Holland. Type ?.

Lophochiton johnstoni Ashby, Trans. Roy. Soc. S. Aust., xlvii., 1923, 234, pl. xvi., f. 7a, b, c, pl. xvii., f. 1 a-d. Carnarvon, Western Australia. Type in coll. Ashby.

We have seen a median and the posterior valve of Ashby's type shell, which differs from the preceding species in the colour, which is buff suffused with pinkish, and having a few orange spots on some of the valves. Ashby informs us that the anterior valve is flatter than that of *L. granifer,* the fluting practically absent from the apical half, and the ribs broader and less raised. The sulcus dividing the ribs of the lateral areas is much shallower. The granose sculpture is generally finer. Slits 11-1-10.

Remarks: This species is undoubtedly the previously undetermined *Chiton coccus* of Menke, taken on the "North-west coast of New Holland, on *Tridacna elongata.*" Pilsbry's translation of the original description of this shell is here quoted for comparison:—"Shell elliptical, subdepressed, thin, pellucid, ashey. Terminal valves with granose-nodulose rays, the anterior 11, posterior 10; other valves with the median areas granulose, marked with a brown spot in the middle, roseate posteriorly; lateral areas on each side furnished with a pair of strong radiating granose ribs. Girdle very subtly granulose, hoary variegated with dark spots. Length 4, breadth 2 lines."

The examination of a series of this shell may result in further accentuation of the differences between the western and the eastern species, or possibly, on the other hand, in the reduction of the eastern shell (*granifer*) to subspecific rank.

Family LORICIDAE.

This peculiar family is at present known only from southern Australia and New Zealand, and consists of a few species of medium to large size, depressed or elevated, characterised by the loss of the insertion plate of the posterior valve; in addition the girdle is posteriorly slit or sinuate, this feature being indicated in the posterior valve itself. According to Thiele the radula is so similar to that of *Callistochiton* that he subordinated the shells as a subgenus of that genus. In this he was quite wrong, as the group was already well specialised in the Eocene beds of Victoria and Tasmania, many fossil species having been described, differing very slightly from the existing forms.

Shells medium to large, elevated or depressed, elongated oval to broadly ovate, colouration generally dull, ochraceous, but showing bright tinting. The sculpture may be termed delicate, consisting of scattered pustules, sometimes in ray formation on anterior and posterior valves and lateral areas; central areas more or less ridged with fine lines of coalesced pustules. Girdle covering of scales of varying sizes, with spiculose tufts or corneous processes of complicated growth scattered throughout. Insertion plates striated, obsolete in posterior valve, sutural laminae large, sinus toothed.

Key to the species:—

Girdle covering large irregular striated scales and numerous spiculose tufts:

Posteriorly slit its whole width:

Anterior valve normal .. .. *Lorica.*

Girdle covering small suberect scales and complicated corneous processes:
Posteriorly slit only half way:
Anterior valve abnormally large .. .. *Loricella.*
Posteriorly sinuate only, anterior valve normal .. .. *Kopionella.*

Genus Lorica.

Lorica H. and A. Adams, Ann. Mag. Nat. Hist., ser. ii., vol. ix., 1852, 355. Type by monotypy *Chiton cimolius* Reeve.

Aulacochiton Shuttleworth, Mittheil. Naturf. Gesell. Berne, 1853, 68. Type by monotypy *Chiton volvox* Reeve.

Shell large, elongate oval, elevated, carinated, posterior valve small with recurved terminal mucro, tegmentum weakly slit, girdle slit. Sculpture of small separated erect pustules, sometimes linked into rays or lines. Girdle covered with rounded oval striated scales of varying sizes, with numerous spiculose tufts scattered over the girdle. Anterior valve regularly eight-slit, teeth finely pectinated; median valves one-slit; sutural laminae extending nearly across the valve, sinus consisting of a small deep gap at the jugum only; insertion plates in posterior valve reduced to a striated callus interrupted by a deep sinus below the sinuated mucro.

Lorica volvox.

(Plate xl., figs. 18 and 20.)

Chiton volvox Reeve, Conch. Icon., iv., 1847, pl. vi., sp. and f. 31. Sydney, New South Wales. (Jukes). Type in Mus. Cuming in Brit. Mus.

Chiton rudis Hutton, Trans. N.Z. Inst., iv., 1872, 179. Specimen in Dominion Museum, Wellington, Loc. unknown = New South Wales (Mestayer).

Lorica volvox Haddon, Zool. Challenger, xv., 1886, 31. Pilsbry, Man. Conch., xiv., 1893, 237, pl. 52, f. 14-21.

Shell large, elongate oval, carinated, side slopes straight, sutures straight. Colour generally brown to blackish, occasionally having one or more valves dull red or green.

Anterior valve with small erect pustules ranged into radials and coalescing with age, twenty-five to fifty may be counted, some being short or intercalated; apex erect, recurved, callused; posterior edge of valve with projecting pustules, callus adorned with pustules.

Median valves with lateral areas sculptured as anterior, six to ten radials, posterior edge of valve with projecting pustules; central areas ridged with lines of coalesced pustules, imperfectly joined on jugum, twelve to eighteen ridges on each side, ridges a little sinuous, latticed between.

Posterior valve with mucro terminal, recurved; post-mucronal area restricted to a small swollen area on the fold of a ridge forming the posterior edge of the valve; ante-mucronal area sculptured as central areas.

Girdle broad, clothed with rounded oval, striate scales, smaller on the outside, and with many spiculose tufts, one at each suture, eight around the anterior valve, four behind the posterior valve, and three rows alternate with the sutural tufts; fringed with spicules.

Interior white; slits 8-1-0; sutural laminae very broad; teeth finely pectinated.

Dimensions: 78 x 37 mm.

Station: Under stones in muddy positions, below low water mark.

Habitat: New South Wales.

Remarks: This is a sedentary species attaining large proportions, and generally affected by parasitic growths. In old shells and dried specimens which

have not been very carefully preserved the spiculose tufts are frequently reduced in number or even entirely disappear.

LORICA CIMOLIA.
(Plate xl., figs. 19 and 21.)

Chiton cimolius Reeve, Conch. Icon., iv., 1847, pl. xxi., sp. and f. 141. Australia (we select South Australia). Type in Mus. Cuming in Brit. Mus.

Lorica cimolia Iredale and May, Proc. Mal. Soc., xii., 1916, 112. May, Illus Index Tas. Shells, 1923, pl. xvi., f. 14.

This distinct species is easily separated from *L. volvox* by the sculpture of the central areas, the linear ridges being distant and the wide interspaces not latticed; the granose sculpture of the terminal valves and the lateral areas is characterised by fewer and more widely spaced grains.

It reaches somewhat larger dimensions, and the spiculose tufts are sparser, and more frequently altogether absent.

Habitat: South Australia, Victoria, Tasmania.

LORICA PAUCIPUSTULOSA.
(Plate xl., fig. 17.)

Lorica paucipustulosa Hull, Aust. Zool., iii., 1923, 197, pl. xxvii., f. 3. Rabbit Island, King George Sound, Western Australia. Type in Western Australian Museum.

This western species is easily separated by the still further diminution of the ridging of the central areas, and the still fewer granules on the terminal valves and the lateral areas of the median valves.

Habitat: South Western Australia.

Genus LORICELLA.

Loricella Pilsbry, Man. Conch., xiv., 1893, 238. Type by monotypy, *Lorica angasi* H. Adams and Angas. Pilsbry, Proc. Acad. Nat. Sci. Philad., 1894, 86 (full description).

Shell large, rounded oval, depressed when young, elevated and carinated when senile, anterior valve abnormally large and broad, posterior valve small, with low recurved terminal mucro, not slit but sinuate; girdle broad, very much produced in front and partly slit posteriorly. Colouration generally dull. Sculpture rayed on anterior and posterior valves and lateral areas, ridges on central areas; the development of sculpture is somewhat irregular, sometimes very faint, in other cases very pronounced. Girdle covered with very small round scales, among which are bunches of corneous processes of complex design, more noticeable along the anterior edge which is scallopped. Interior with insertion plates in valves i. to vii., strongly pectinate, eight regular slits in anterior, one in median valves; sutural laminae very wide, only separated by a narrow gap under the jugum, into which is inserted a pectinated sinuate block; posterior valve with a sinuate callus showing two obscure lateral slits. [*Squamophora oviformis* Nierstrasz, Siboga Exped. Monog., xlviii., 1905, 50, pl. i., f. 15, 16, pl. iv., f. 97-101, appears closely allied. This species was dredged in 73 m. 6° N., 121° 30 E.].

LORICELLA ANGASI.
(Plate xl., figs. 22-24.)

Lorica angasi H. Adams and Angas, P.Z.S., 1864, 193. Rapid Bay, South Australia. Type in Brit. Mus.

Chaetopleura rugosa Angas, P.Z.S., 1867, 223. Port Jackson. Not of Gray or Sowerby.

Lorica angasi Pilsbry, Man. Conch., xiv., 1893, 238, pl. 51, f. 9-13.
Loricella angasi Pilsbry, Proc. Acad. Nat. Sci. Philad., 1894, 87.
Loricella torri Ashby, Trans. Roy. Soc. S. Aust., xliii., 1919, 62, pl. x. Quarantine Station, Port Jackson, N.S.W. Type in coll. Ashby.

Shell as for the genus. Colour generally dull brown or grey, sometimes banded with darker longitudinally; occasionally dull green, rarely blue.

Anterior valve very broad, nearly twice as broad as long, flattened, apex depressed, a few pustules on edge; rayed with eight primary ribs, sometimes many subsidiary ones as strong, so that sixty or more rays may be counted.

Median valves: Lateral areas ribbed as anterior valve, sometimes strongly, in other cases scarcely any ribbing; central areas similarly, sometimes closely ridged throughout, in other examples few of the ridges continue right across the valve, beginning late and extending only half way.

Posterior valve small, depressed, mucro terminal and recurved; post-mucronal area restricted to a linear ridge; ante-mucronal area as central areas.

Girdle generic. Interior white; slits 8-1-0.

Dimensions: 68 x 40 mm.

Station: Under stones in muddy situations below low water mark.

Habitat: New South Wales, Victoria, South Australia, Tasmania.

Remarks: The type locality of *Loricella angasi* being South Australia, the Sydney shell has been separated as a distinct species, but the differential features claimed are merely individual variations, common to the whole range of the species. When series are compared the southern shells appear to grow larger and become more elevated, and to have more "spear heads." The sculpture is as variable, and consequently subspecific value is the most that should be suggested, but even this is a matter of opinion. The south Tasmanian forms differ so little from either the Peronian or Adelaidean shells that they have been classed with the former, which geographically they might be, but in the related genus *Lorica* the south Tasmanian shells belong to the Adelaidean.

[LORICELLA BAKERI.

Ischnochiton bakeri Torr., Trans. Roy. Soc. S. Aust., xxxvi., 1912, 169, pl. vii., f. 8a, b, c, f.

"General appearance: Shell almost round, valves narrow, flattened; colour greyish-white mottled with brown.

Anterior valve: Covered with microscopic imbricating pustules, closely packed, resembling girdle scales.

Median valve: Dorsal area triangular, smooth, spotted. Lateral areas distinctly raised with four or five irregular pustules. Median valves covered with microscopic granules.

Posterior valve is missing.

Girdle: Covered with imbricating striated scales. The outer edge of the girdle is fringed with delicate spicules.

Measurement: 4 x 3 mm.

Hab.: Henley Beach (Mr. Baker).

Remarks: Strongly resembles a juvenile *Loricella angasi,* but its striated girdle scales distinguish it."

Note: We have inserted this species, with the author's description, in this place with considerable doubt].

Genus Kopionella.

Kopionella Ashby, Trans. Roy. Soc. S. Aust., xliii., 1919, 71. Type by original designation *Plaxiphora matthewsi* Iredale.

This peculiar form is here placed with some doubt, but a number of its characters agree with those of members of this family, though the sculpture is in disagreement. The character used for distinguishing the genus was the presence of "peculiar oar-headed bristles or spicules" on the girdle, the other features cited at the time being "minor differences."

Shell medium, moderately elevated, subcarinated, rounded oval. Colouration greenish marked with blue-black. Sculpture not unlike that of *Poneroplax*, wavy lines not very nodulose serving as ribs on anterior and posterior valves, lateral areas raised, ribs indistinct, central areas obscurely wavy. Posterior valve with mucro terminal and recurved, insertion plates reduced to a callus. Insertion plates in anterior and median valves short, ten-slit in former one-slit in latter; sutural laminae broad, sinus small, with spade-like process present in valves vi. and vii.; slits slightly scallopped. Girdle having small erect scales and complex corneous processes.

Kopionella matthewsi.

(Plate xl., figs. 25-28.)

Plaxiphora matthewsi Iredale, Proc. Mal. Soc., ix., 1910, 99. (Sultana Bay), South Australia. Type in Brit. Mus. Iredale and May, Proc. Mal. Soc., 1916, 101, pl. v., f. 4a, a'. (Tasmania).

Plaxiphora conspersa Bednall, Proc. Mal. Soc., ii., 1897, 154, and of other Australian workers since. Not *C. conspersa* Angas.

Plaxiphora hedleyi Torr, Trans. Roy. Soc. S. Aust., xxxv., 1911, 103, f. 2 a-f. (*fide* Ashby). Rabbit Island, Albany, South West Australia. Type in coll. Torr.

Plaxiphora zebra Torr, *id., ib.*, 106, pl. xxv., f. 6. (*fide* Ashby). Port Esperance, South West Australia; founded on one valve only. Type in coll. Torr.

Kopionella matthewsi Ashby, Trans. Roy. Soc. S. Aust., xliii., 1919, 71, pl. xi., f. 1, 1a.

Kopionella tasmanica Ashby, *id., ib.*, xliv., 1920, 268, pl. xi., f. 1 a-c. (D'Entrecasteaux Channel), South Tasmania. Type in coll. Ashby. May, Illus. Index Tas. Shells, 1923, pl. xv., f. 9.

Shell, specific characters as given for the genus.

Dimensions: 22 x 13 mm. (Type), 26 x 16 mm. (maximum).

Remarks: The south Tasmanian form has been differentiated specifically, but no such value is apparent in the series examined by us. The South Australian shells vary in elevation and sculpture so that Tasmanian ones agree easily in these details, and the only feature for separation appears to be in the formation of the corneous processes, a doubtful feature as far as yet known.

EXPLANATION OF PLATES.

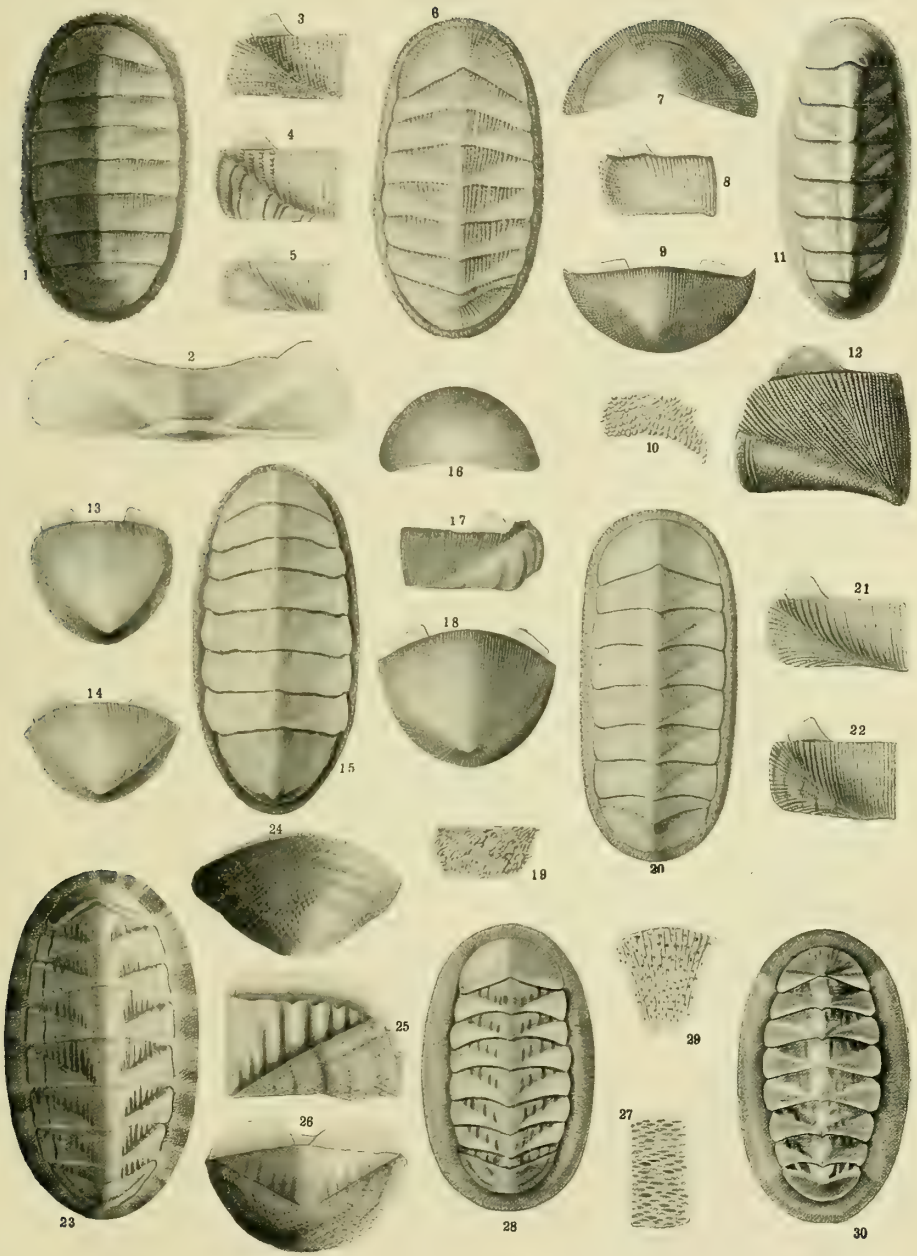
Plate xxxix.

Fig. 1. *Terenochiton badius* Hedley & Hull, whole shell.
2. *Terenochiton badius* Hedley & Hull, interior of median valve.
3. *Terenochiton matthewsianus* Bednall, one-half median valve.
4. *Terenochiton liratus* H. Adams & Angas, one-half median valve.
5. *Terenochiton liratellus* Iredale & Hull, one-half median valve.
6. *Terenochiton sperandus* Iredale & Hull, whole shell.
7. *Terenochiton erratus* Hull, anterior valve.

8. *Terenochiton erratus* Hull, one-half median valve.
9. *Terenochiton erratus* Hull, posterior valve.
10. *Terenochiton erratus* Hull, girdle scales.
11. *Parachiton columnarius* Hedley & May, whole shell.
12. *Parachiton columnarius* Hedley & May, one-half median valve.
13. *Parachiton litoreus* Iredale & Hull, posterior valve.
14. *Parachiton capricornicus* Iredale & Hull, posterior valve.
15. *Parachiton puppis* Hull, whole shell.
16. *Parachiton puppis* Hull, anterior valve.
17. *Parachiton puppis* Hull, one-half median valve.
18. *Parachiton puppis* Hull, posterior valve.
19. *Parachiton puppis* Hull, girdle scales.
20. *Parachiton opiparus* Iredale & Hull, whole shell.
21. *Parachiton profundus* May, one-half median valve.
22. *Parachiton collusor* Iredale & Hull, one-half median valve.
23. *Icoplax mayi* Torr, whole shell.
24. *Icoplax mayi* Torr, anterior valve.
25. *Icoplax mayi* Torr, one-half median valve.
26. *Icoplax mayi* Torr, posterior valve.
27. *Icoplax mayi* Torr, girdle scales.
28. *Icoplax luminosa* Iredale & Hull, whole shell.
29. *Icoplax luminosa* Iredale & Hull, eyes in anterior valve.
30. *Levicoplax platessa* Gould, whole shell.

Plate xl.

Fig. 1. *Eudoxoplax inornata* Tenison-Woods, whole shell.
2. *Callistelasma meridionalis* Ashby, one-half median valve.
3. *Callistelasma generos* Iredale & Hull, one-half median valve.
4. *Callistelasma generos* Iredale & Hull, whole shell.
5. *Callistassecla mawlei* Iredale & May, one-half median valve.
6. *Callistelasma antiqua* Reeve, one-half median valve.
7. *Callistassecla mawlei* Iredale & May, whole shell.
8. *Callistelasma periousia* Iredale & Hull, one-half median valve.
9. *Lophochiton granifer* Hull, whole shell.
10. *Lophochiton granifer* Hull, anterior valve.
11. *Lophochiton granifer* Hull, one-half median valve.
12. *Lophochiton granifer* Hull, posterior valve.
13. *Lophochiton granifer* Hull, girdle scales.
14. *Solivaga finschi* Thiele, whole shell.
15. *Solivaga finschi* Thiele, one-half median valve.
16. *Solivaga finschi* Thiele, girdle scales.
17. *Lorica paucipustulosa* Hull, whole shell.
18. *Lorica volvox* Reeve, one-half median valve.
19. *Lorica cimolia* Reeve (= *L. duniana* Hull), one-half median valve.
20. *Lorica volvox* Reeve, posterior valve and girdle.
21. *Lorica cimolia* Reeve, posterior valve (side view).
22. *Loricella angasi* Adams & Angas, whole shell.
23. *Loricella angasi* Adams & Angas, posterior valve and girdle.
24. *Loricella angasi* Adams & Angas, girdle processes.
25. *Kopionella matthewsi* Iredale, whole shell.
26. *Kopionella matthewsi* Iredale, posterior valve.
27. *Kopionella matthewsi* Iredale, posterior valve, side view.
28. *Kopionella matthewsi* Iredale, girdle processes.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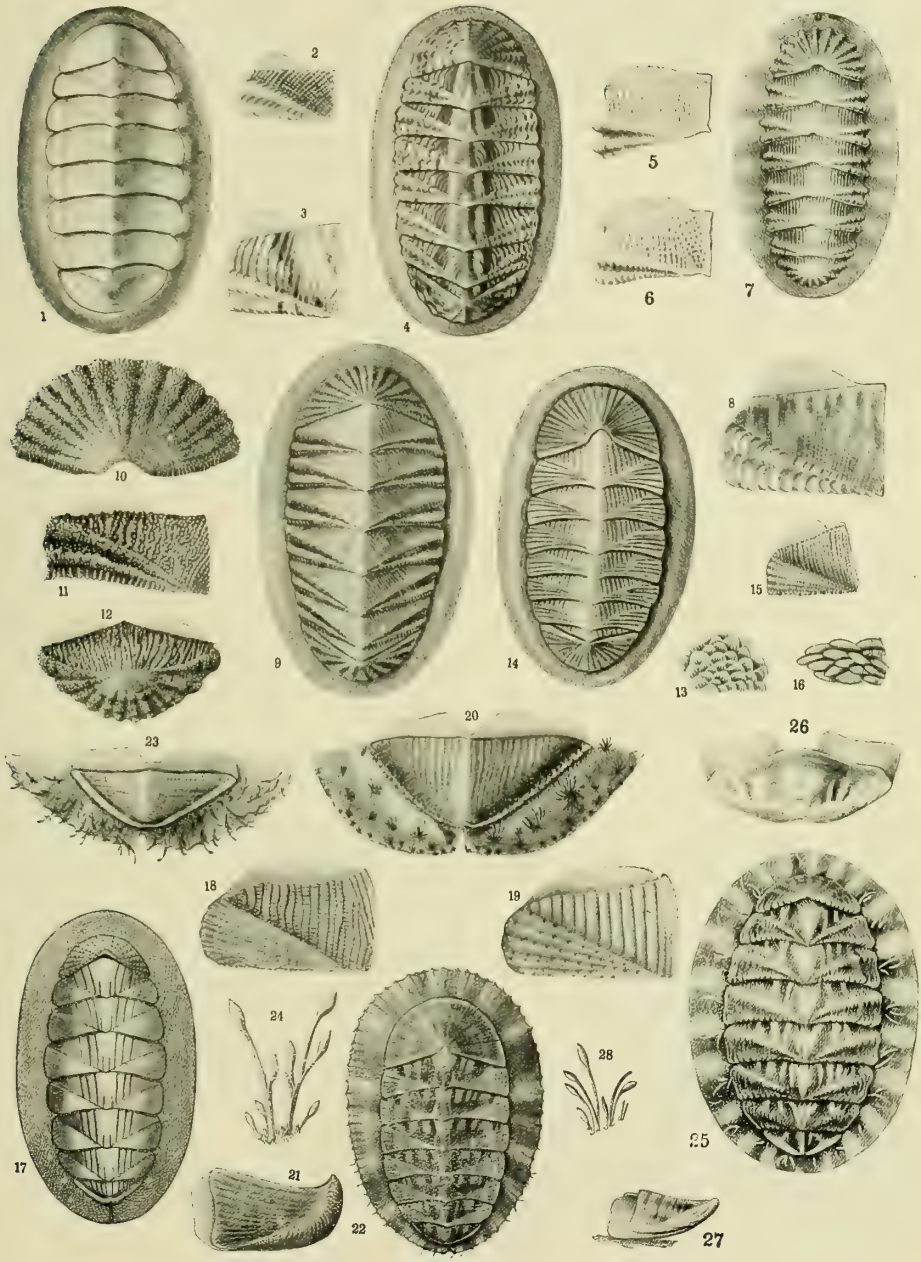
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CAPTAIN COOK'S "KANGURU."
From the original plate.

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