The AUSTRALIAN MUSEUM MAGAZINE

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The Taipan.

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THE AUSTRALIAN MUSEUM

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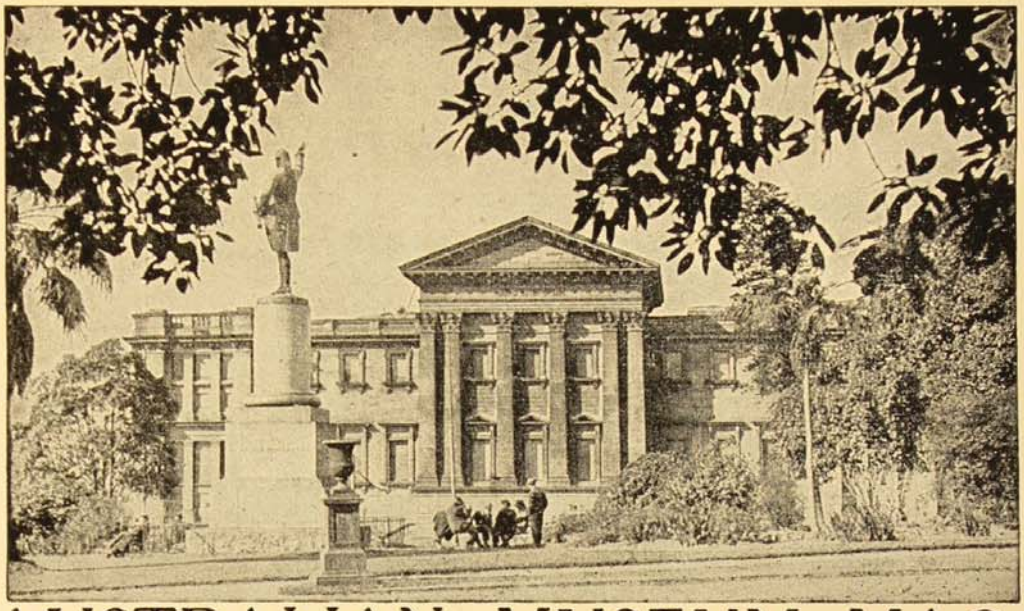

THE AUSTRALIAN MUSEUM MAGAZINE

(Photography, unless otherwise stated, is by Howard Hughes.)

● OUR FRONT COVER. This snake is the Taipan which was recently collected at Cairns, North Queensland.

The Taipan is Australia's deadliest snake. Its colour varies from light olive-brown to dark-chestnut or russet-brown, becoming grey-brown on the sides. Underneath it is creamy-yellow to white, occasionally spotted with reddish-pink, suffused with a mother-of-pearl iridescence. See article on page 73. Photograph from life by P. C. R. Boswell, of the National Museum, Melbourne.

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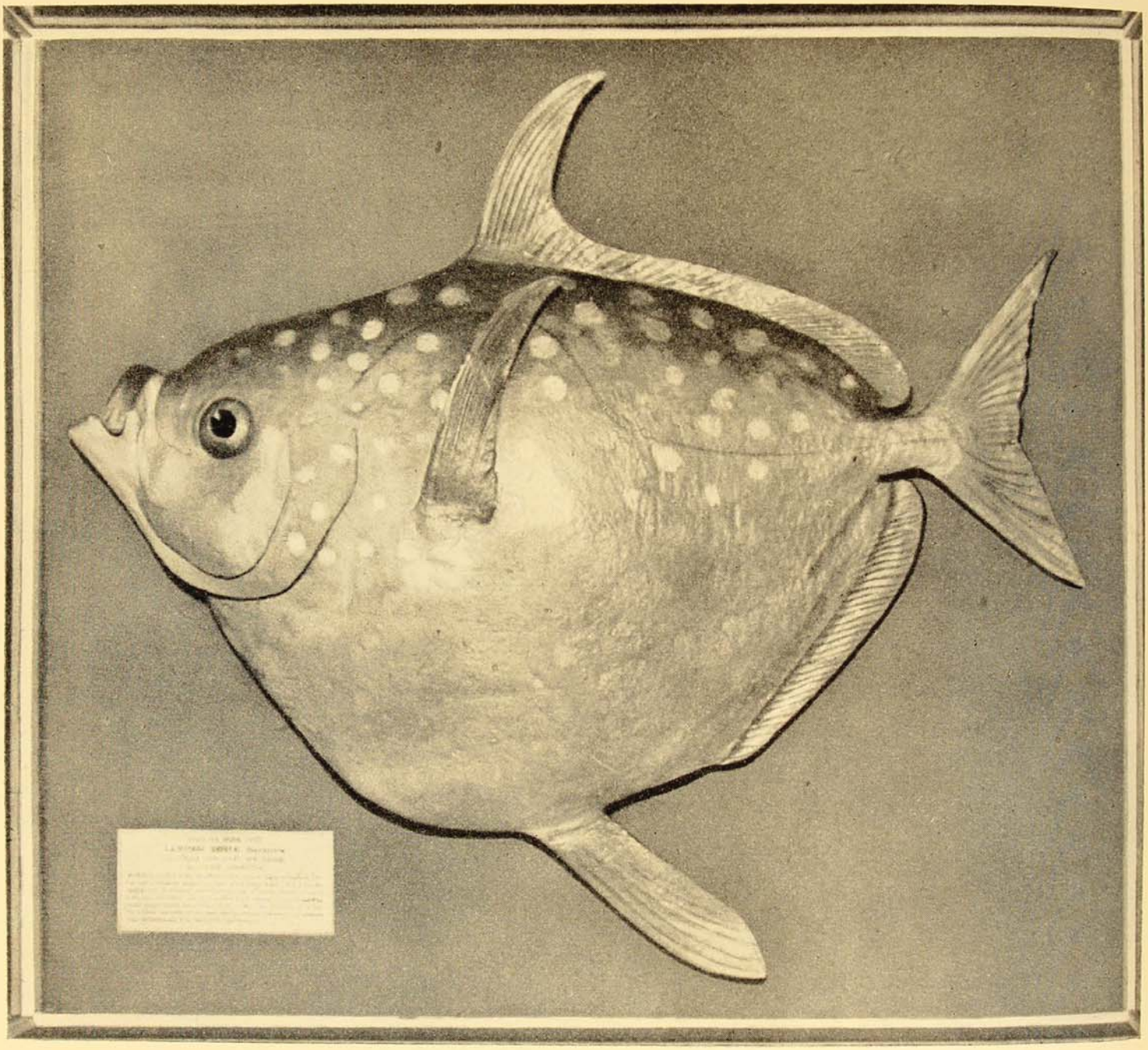

A striking exhibit on the landing outside the Fish Gallery of The Australian Museum is this Opah or Moonfish *(Lampris regius)*. The red fins, silvery and pink body with large pearly spots, and the unusually deep shape are distinctive of this rarity. The fish is almost four feet overall and came from Timaru, New Zealand. The flesh is red and has been described as " tender, oily and of a rich, exquisite flavour, scarcely surpassed by any other fish whatsoever."

THE AUSTRALIAN MUSEUM MAGAZINE

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Vol. X, No. 3. September 15, 1950.

Unesco and Museums

The following message was addressed by M. Jaime Torres Bodet, Director-General of Unesco, to the Second Biennial Conference of the International Council of Museums London, 17 to 22 July, 1950.

I have been most reluctant to forego my visit to London to follow your work at first hand. Yours is a Conference to which I had been particularly looking forward, as my day-to-day experience has deepened my conviction that museums, by their very nature, bring us a long way towards the attainment of Unesco's goal; and that the aims and ideal of your Council are closely akin to those of our Organization.

Of the duties devolving upon us under our Constitution, three, as you know, were placed above all others by the founders of Unesco: to collaborate in the work of advancing the mutual knowledge and understanding of peoples; to maintain, increase and diffuse knowledge, and to give fresh impulse to popular education and to the spread of culture. Were it necessary, it would be easy for me to demonstrate that these are the three functions which museums all over the world are constantly performing and which the International Council of Museums is helping them to fulfil by informing them with a spirit of active international collaboration.

Anthropological and ethnographical museums, art galleries and exhibitions of applied art, natural history museums, technological or health museums all make their contribution to the mutual knowledge and understanding of peoples. We look to them first of all to shed light on the complex relationship between all peoples and to illustrate the history of travel, of intellectual cross-currents and inter-acting influences. As Professor Henri Focillon, a pioneer of international co-operation, remarked, "Museums were the first beginnings, the first vehicle of a European and a world consciousness." There is no denying that modern exhibition methods and the constantly improved techniques of arranging and displaying objects and documents are among the most effective means of drawing the general public towards an even clearer awareness of human fellowship.

You of all people realize the need for regular contacts between museums in different countries. How are rare specimens or objects of art to be identified without the assistance of the museums of the country from which they come? How compile the catalogue of a collection without comparing the works of the same master or the same school, scattered among many different galleries? These continual exchanges of information and ideas make each museum a symbol and an instrument of international collaboration.

In order to maintain, increase and diffuse knowledge, Unesco has been especially entrusted with the "conservation and protection of the world's inheritance of books,

works of art and monuments of history and science." The duty to which you have been called is none other than to carry out this high mission of preserving the collective heritage of mankind. In helping you to discharge this responsibility in the best interests of all peoples, Unesco, then, is doing no more than its duty. But our Constitution enjoins on us the additional task of recommending international conventions to the peoples concerned. This calls for close collaboration between your organization and ours. The General Conference of Unesco, at its recent session in Florence, instructed me to prepare and submit to Member States a draft international convention for the protection of cultural property in the event of armed conflict and further to consider the possibility of another international convention instituting in all countries a special tourist tax to raise funds for the upkeep of museums and historic monuments. It is obvious that in its study of these two important projects, Unesco will need your counsel and co-operation.

I should now like to dwell on another of Unesco's tasks, that of giving "fresh impulse to popular education and to the spread of culture." I attach the utmost importance to this work, in which, in my opinion, museums can and must take the lead. People are still too ill-informed about the work of many of your colleagues in making their museums living institutions, driving forces in the cultural life of their countries. I am not thinking only of the large museums in capital cities: the importance of provincial museums is not to be overlooked. Nor do I think only in terms of the traditional art galleries and history or natural history museums, but also of the scientific and technological museums, and hygiene and health exhibitions. M. André Léveillé, the President of the Board of Editors of our review *Museum*, has drawn attention to the educational responsibilities of museums in his admirable article "Museums in the Service of All, Crusade for Museums." He points out that the role of museums has always been under-estimated and often completely disregarded. "When we discuss education, science and culture", he writes, "we always take into account teaching methods in all their various forms—courses, lectures and so forth. Our attention is drawn to libraries and to reading matter of every description and, finally, to the film, the press and the radio. Only rarely, however, is any attention paid to museums and to the wealth of resources they now possess. A new and positive factor is, in short, being completely ignored." M. Léveillé further emphasizes the power peculiar to museums of, through their use of colour and form, bringing the visual memory into play. How true is his remark that the visitor to a museum is free, free to see what he wants to see, to stop and take notes, make comparisons or retrace his own steps. He is not called upon to experience any uniform reaction; he is free to be himself, yet at the same time he will be led to reflect and to exercise his critical faculties. It is for you to illustrate and utilize this vital function of museums, so rarely appreciated even by its beneficiaries, and to make it serve the cause of juvenile and adult education which must ever be our prime concern.

If I have stressed the educational aspect of museums, it is not through any failure to recognize the importance of their other functions. I merely wish to lay emphasis on the grave responsibilities as educators that face all directors and curators of museums. I might here remind you of the familiar legal maxim that the conferment of certain powers on an authority automatically imposes the duty of properly exercising those powers.

I trust I have brought home to you the importance I attach to collaboration with museums and with the International Council of Museums for the progress of Unesco's own work. The working papers of your Conference which I have read, are an indication to me of the large amount of work you will carry out in the days ahead. Much of your agenda has a direct bearing on various aspects of Unesco's programme. Without wishing to discriminate between the subjects you are to consider, I should like you to know how keen an interest I take in some of your discussions. You are

to study the co-ordination of international exhibitions. The General Conference of Unesco has instructed me to submit for consideration and later adoption by Member States draft international regulations regarding travelling exhibitions. Before despatching to the various governments the draft framed by my assistants, I wished to have you study it; your advice, opinions and suggestions will be of the greatest value to me.

The General Conference of Unesco also recommended that your Council should study, on the basis of the best work so far accomplished, the drawing up of a universal system for the listing of museum collections and the presentation of catalogues of art and history.

Lastly, I should be grateful if all attending this Conference would support Unesco in its constant endeavours to serve the interests of your profession. I have already mentioned Unesco's periodical *Museum*, which aims at bringing before museum curators in every country the outstanding achievements of their colleagues. If you will, you can help to develop and improve *Museum* and to set it on a firmer footing by making it better known and ensuring its wider circulation and by sending us your suggestions in this connexion. Similarly, I cannot urge you too strongly to furnish us regularly with information about your museums, as well as with reports, catalogues and photographs which may add to the documentation centre established jointly by your Council and Unesco; they will enable us to supply information on matters about which we receive daily inquiries from many of your colleagues.

As you see, there are immense possibilities for the collaboration which can and must be fostered between the International Council of Museums and Unesco. It is a source of gratification to me that Unesco has been able to take so active a part in the final preparation of the Second Biennial Conference of ICOM and I offer my sincerest good wishes for its success.

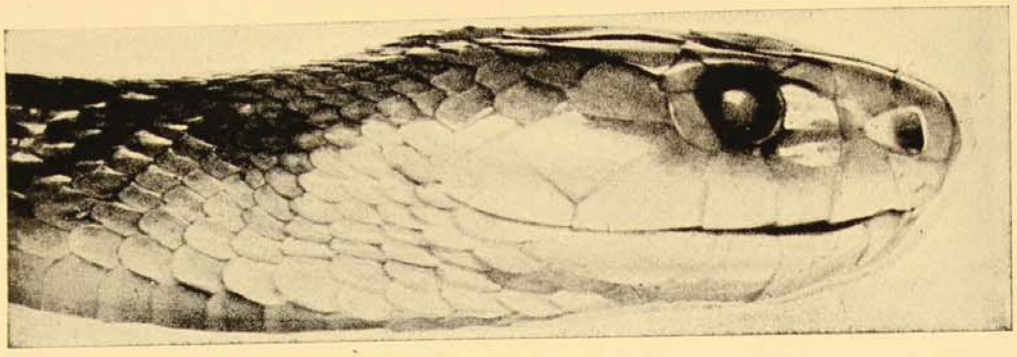
The Taipan

By J. R. KINGHORN, C.M.Z.S.

THE daily press recently gave considerable publicity to Australia's largest venomous snake, the Taipan, following the death of a Sydney collector from its bite.

Much of the information was of a somewhat sensational nature and several statements to the effect that a Taipan was worth as much as £2,000 were greatly exaggerated, and may have resulted in a "taipan rush" by collectors seeking quick fortunes.

The Taipan is the largest venomous snake in Australia and is second in size only to the King Cobra of India. When fully adult it may attain a length of eleven feet. Originally found at Coen, Cake York, Queensland, by collector W. McLennan in June, 1922, two perfectly prepared skulls and a complete skin were sent to the Australian Museum where the snake was recognized as new to science. It was described as *Oxyuranus maclennani*, and given the vernacular name of the Giant Brown Snake. Further examination showed this snake to be identical with one described years earlier by a German herpetologist who called it *Pseudechis scutellatus*, but it was not a *Pseudechis*, which genus includes the common black snake, so this name was discarded and the snake is now known scientifically as *Oxyuranus scutellatus*. Some years ago, Dr. Donald Thomson, who was collecting throughout northern Australia, found that the natives knew this snake by the name Taipan, and regarded it as the most deadly known to them so Taipan has been adopted as the vernacular name, Giant Brown Snake being rather misleading.



The head of the Taipan is long and narrow and the eye, which is large, varies in colour from orange-yellow to orange-red.

After Thomson.

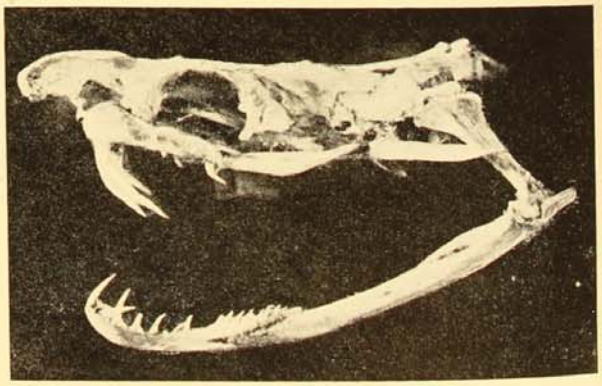
For many years it was thought that the Taipan was restricted in range to the Cape York area and westward to the eastern boundary of Arnhem Land, but during the war it was discovered in southern Papua. We now know that it may be met with between the Fly River and the Port Moresby district, several heads and a complete specimen having been received from that area.

Dr. Thomson, who knows more about the Taipan than does any other scientist, records that it is common along the shores of the Gulf of Carpentaria where there are colonies of rats upon which it feeds. It lives in holes in the ground, probably the deserted burrows of rats or other small mammals. The Taipan is mainly diurnal in habits, generally coming out in the morning and evening to avoid the extreme midday heat. One specimen was taken by Thomson as late as 7.30 p.m., after it had fatally bitten a dog.

From all accounts this giant venomous snake is extremely aggressive and continues to fight savagely after capture, often severely injuring itself in its attempt to bite its captor or to escape. Thomson collected six specimens but found them very difficult to keep in captivity. However, from these he was able to make extensive and valuable notes on its method of biting, and its venom yields. He noted also that the Taipan, when annoyed, did not flatten its neck in the manner of other snakes, but depressed the sides of its neck in such a manner as to cause the vertebral column to protrude conspicuously as a sharp keel. When about to attack it raises several coils of its body from the ground, and flattens its head so that the angles of the jaw are forced outwards. When it strikes it does so with unbelievable rapidity and bites several times in quick succession, then, taking a firm hold, it bites again several times so as to eject almost all its stored venom.

The aborigines know its lethal nature for they say that a bite from a large one, which would exceed five feet in length, would result in death. At least five white persons have been bitten and only one recovery has been reported, that of a man bitten at Mossman, Queensland, in 1939. However, there is no absolute certainty that the victim in this instance was bitten by a Taipan, even though a supposed duplicate sent in for identification proved to be a Taipan. Two fatal cases were reported by Dr. H. Flecker at Cairns in 1939, both victims dying within seven hours. This will give some idea of the rapidity of the action of the venom.

Small quantities of the venom of the Taipan have been critically examined and valuable experiments have been carried out, but the supply has been insufficient for the production of antivenine. The venom



The skull of the Taipan. The large fangs are three to four times greater than those of the Black or Tiger Snakes.

Photo.—G. C. Clutton.

contains a thrombase which has the effect of coagulating the blood with great rapidity if it is injected direct into the blood stream, but there also is a breaking down of the smaller cells. The most dangerous constituent is a neurotoxin that produces paralysis, death being due to respiratory paralysis within a comparatively few hours.

The action of the venom is similar to that of the tiger snake. The reason why the Taipan may be considered the most deadly snake in Australia is that the fangs are very long and the venom is injected deeply into the flesh of the victim. An interesting comparison of the average length of the fangs of our dangerous snakes may be cited as follows:—Brown Snake 2.8mm., Copperhead 3.3mm., Tiger Snake 3.5mm., Black Snake 4.0mm., Death Adder 6.2mm., Taipan 12.5mm.

The only bites for which a specific antivenine is available are those of the Tiger Snake but this antivenine may be used for bites from Death Adders and Taipans in greatly-increased quantities, though with no certainty of its efficacy. The preparation of antivenine is a long and tedious task involving carefully controlled experiments with smaller animals, such as rabbits, so as to arrive at an estimate of a certainly lethal dose per body weight of the victim. At least thirty Taipans would need to be available to ensure a plentiful and regular supply of venom before production of antivenine could be commenced. It would seem that, lacking an antivenine for the treatment of Taipan bites, the most effective method for a bite on a limb would be local venesection under the direction of a medical man. In effect, venesection involves the special ligating, the opening of a vein and the washing out of the poisoned blood, with the blood of the victim. This has been effectively carried out following bites from death adders, and there appears to be no reason why it should not be done for bites from the Taipan, or any other snake that produces a neurotoxic venom. It must be understood that in the case of a bite from a snake producing a powerfully neurotoxic venom, a ligature does little more than delay death. Complete details of experiments by Dr. C. H. Kellaway on venesection practised first on sheep and, later, methods recommended for the treatment of bites on the limbs of man have appeared in the *Medical Journal of Australia* prior to the year 1939.

SOME time ago, in an article on "'Photographic' Fishes" published in this MAGAZINE[1], I reproduced a quaint seventeenth century illustration of a tunny with figures on its skin resembling a fleet of ships. This curiosity was from Ulysses Aldrovandi's *De Piscibus*,[2] Book V.

I have been at a loss to explain the curious markings on the old Italian naturalist's tuna and, although I have seen many tunny caught, or in a fresh state, in Australian waters, none had anything like a fleet of ships on its side! The explanation flashed across my mind recently when seeing the film *Stromboli*, in which there are dramatic scenes of the penning and killing of the Mediterranean tuna. When these are gaffed from the pen or net, each huge fish is hauled inboard by several men using up to about six knife-hooked gaffs to drag the fish out of the water. If a fish escaped it might well carry the marks of the gaffs for the rest of its life. The Italian fishery has been in existence for many centuries, so allowing for some exaggeration and imagination by the old-time engraver, I think this explains the cuts of "ships" upon the skin of Aldrovandi's tuna, which seems to have fled the scene of its unwelcome "sculpture" until recaptured near Gibraltar.

Much can be learnt nowadays of the growth, migration and behaviour of fishes from the release of tagged or marked specimens, and this case, more than 300 years old, is not without historic interest.

—G. P. WHITLEY.

[1] THE AUSTRALIAN MUSEUM MAGAZINE, Vol. vii, No. 10, 1941, p. 339.

[2] The 1638 edition, in my possession, page 316; or the 1646 edition in The Australian Museum Library, Plate xvi, fig. 6. In the latter it is labelled "Thunnus ex freto herculo, in cuius corio triremes exculptae sunt."

The Opah or Moonfish in Australasia

By G. P. WHITLEY.

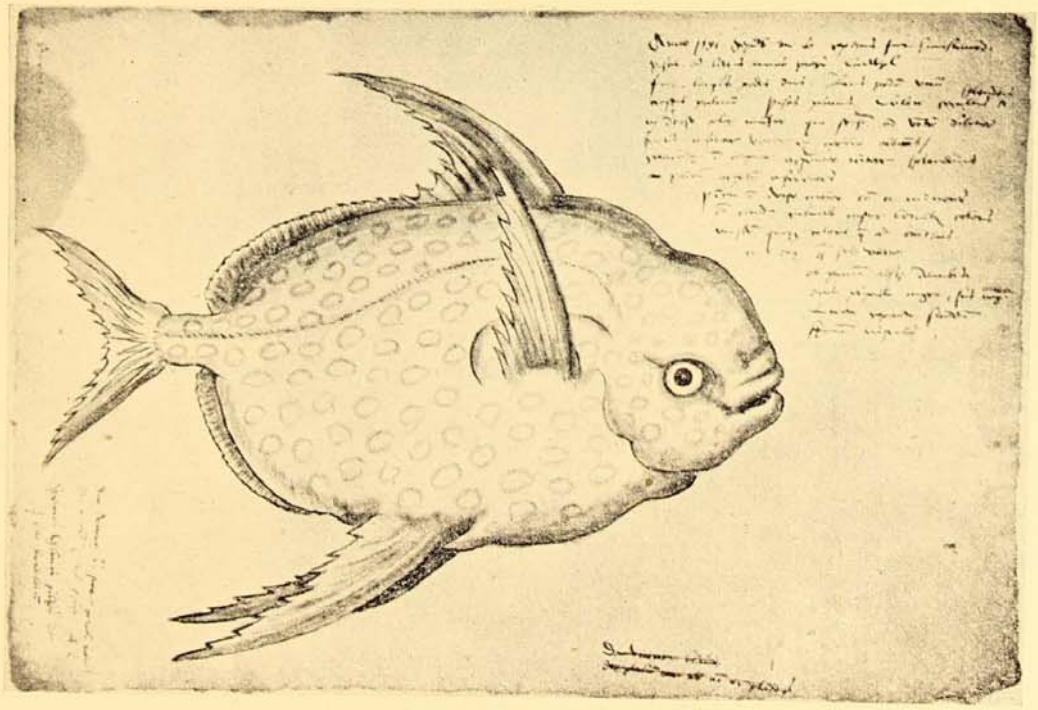
ON the landing outside the Fish Gallery in the Australian Museum is a large case containing a most interesting exhibit—a cast of the Opah or Moonfish.* Not only is this a most rare and beautiful specimen, but it seems never to have been treated in any magazine article. There is a tradition that this Moonfish once had its brief hour of glory when it is said to have been carted through the streets of Sydney, encased in ice, as part of a procession, thought to have been the Eight-Hour Day procession of 2nd October, 1899. The Sydney newspapers of that month did not record or illustrate its presence in that pageant, but in the *Sydney Mail* for November 11, 1899, p. 1177, we find mention of it, as follows:—

A RARE FISH.

The New South Wales Fresh Food and Ice Company exhibited recently at its King-street Fish Depot a splendid specimen of a very rare fish, known as *Lampris luna*, and also sometimes called the Opal [*sic*] fish. It was caught by some men employed on the Timaru dredge, New Zealand, and after being exhibited in Timaru was forwarded to Dunedin. Professor Benham, of the Otago University, on seeing the fish, pronounced it of the *Lampris luna* species, of which only one specimen is recorded as having been caught in New Zealand, namely, on the coast of Wellington in 1883. The fish is 3 ft. 6 in. long, 2 ft. 4 in. deep, and about 9 in. in thickness. It is of a general reddish colour. The tail is rather small, measuring only 7 in. across. From its metallic hue the fish is a pretty object. Its shape is similar to that of the sun fish, by which name it is sometimes called. Other names have also been given to it, such as the moon fish and the opal fish. Gunther names the species *Lampris luna*, and says it is a very beautiful fish, growing to a length of 4 ft., bluish on the back, with round silvery spots, and the fins of a deep scarlet. The spots are not very distinct in the specimen referred to. Sir John Richardson calls the same fish the opal or king fish, and describes it as rare, a few specimens only having been caught at the Orkney Islands.

* See Frontispiece.

Though called Opal fish in the *Sydney Mail*, the correct name is Opah, Moonfish, or Mariposa, and the scientific name is nowadays *Lampris regius*. It is believed to live at considerable depths in the open ocean. It has no teeth and feeds on squid, molluses, jellyfish, crustacea and small fishes. W. P. Pycraft (*Illustr. London*



A sixteenth century painting of an Opah by a Dutch artist.
After Engel.

News, April 6, 1935), in calling attention to the reduction of the hinder end of the body of the Opah, thought it probable that it could dive for at least a part of its food. The red flesh is said to be "tender, oily, and of a rich exquisite flavour scarcely surpassed by any other fish whatsoever", and the Maori called it *Arokura*, meaning "red flesh." The eggs and young, and indeed the whole life history, are unknown.

The colours are a "rich brocade of silver and lilac, rosy on the belly, everywhere with round silvery spots." The maximum length is about 4 feet and the weight exceeds 300 pounds; but a 6-foot specimen was once reported from the Orkney Islands, and this probably weighed about 600 lb.

Apart from Australia and New Zealand, the Opah has been found in the following localities: Falkland Islands, Eastern U.S.A., North Atlantic, Shetland Islands, Ireland, Holland, Adriatic, Marman Coast, Mediterranean, California and Mexico to Alaska, Hawaii, Japan and South Africa.

It is rarely caught on long lines; in 50 to 280 fathoms; generally specimens are found cast ashore after storms.

I saw a fresh one in a Californian fish-shop in 1938. If only a series of specimens could be compared from different localities it could be determined whether more than one species is represented. At present, a single cosmopolitan type is all that is allowed, but the Australasian fish may well deserve specific separation.

In view of its rare appearance I list below for the Opah all the known Australasian records.

Date of Capture.	Locality.	Authority.
Dec., 1882	.... Manawatu River, New Zealand; 3 ft. 6 in.	Hector, Tr. N.Z. Inst., xvi, 1883, p. 322.
1883	.... Timaru, New Zealand.	Hector, 1883.
1883	.... Coast of Wellington, New Zealand.	*Sydney Mail*, 11/11/'99.
Dec., 1895	.... Port Arthur, Tas.; 3 ft. 7 in. 130 lb.	Morton, Proc. Roy. Soc., Tas., 1896 (1897), p. 99; Whitley, Proc. Roy. Soc., Tas., 1928 (1929), p. 49.
1895 or '6	.... Lake Takapuna, New Zealand.	Anon., Rept. Auck. Inst., 1895/6.
Oct., 1899	.... Timaru, New Zealand.—Our cast and skeleton.	Waite, Rec. Austr. Mus., iii, 1899, p. 166; *Sydney Mail*, 11/11/'99.
——	New Zealand and Chatham Is.	Waite, Rec. Cant. Mus., i, 3, 1911, p. 186.
Dec., 1911	.... Fremantle, W. Australia.	Whitley, Austr. Zool., 1945.
July, ——	.... Corner Basin, Victoria; 3 ft. 4½ in. 56 lb.	Kershaw, Vict. Nat. xxx, 1913, p. 95, p. vi.
——	Oberon Bay, Victoria; 20 faths.	Kershaw, 1913, p. 96.
——	Port Molyneux, New Zealand.	Ann. Rept. Otago Univ. Mus. 1921, p. 11, and Benham, N.Z. J. Sci. Tech. iv, 1922, p. 316.
——	Chatham Is.	Drummond, N.Z. *Herald*, 9/2/'24.
——	Chatham Is.	Young, Tr. N.Z. Inst., lx, 1929, p. 146, pl. xvi.
1936	.... Storm Bay, Tas. About 4 ft. long.	*Advocate*, 2/12/'36.
Feb., 1950	.... Off Orowaiti River, Westland, New Zealand; 33 in. 36 lb. Male.	W. J. Phillipps, MS.

Lacépède almost struck a dithyrambic chord when praising the Opah's beauty. His account should really be enjoyed in the original French (Hist. Nat. Poiss. iv, 1802, p. 587), but the following is an attempt at a translation:—

"When it flashes close to the surface of the sea it does not reflect a silvery light like that of the moon; it dazzles with the brilliance of gold; and it is with the sun's disk rather than that of the orb of night that it were necessary to compare the richly decorated facade either side of it presents. Many reflections of azure, of a light green and of silver make play on this golden ground, in the midst of a great many spots the colour of pearl or sapphire; the fins are of the liveliest red and it is this which has made one observer say that this Opah must be regarded as like a noble lord of Neptune's court, in full festive attire."

Long before Lacépède, who wrote during the French Revolution, Europeans had seen the Opah, for as early as 1581 a painting of one was made in Holland—the first picture of this fish—and this has recently been reproduced (in Zool. Meded., xxv, 1945, p. 10, pl. iii) by Engel, a learned Netherlands zoologist who has specialized in the natural history of olden times and whom I met in Amsterdam in 1937.

So from time to time, at unpredictable intervals, appears the Opah, filling us with wonderment and a desire to know more about this strange and aristocratic descendant of Eocene ancestors which still roams the least known depths of ocean.

Such then is the Opah, and this the hitherto untold tale of the magnificent cast* amongst our exhibits. Unlike some forgotten film star whose faded photograph we still see languishing in some cinema foyer, this luminary of the fishy firmament still graces our gallery with distinction, "comme un seigneur de la cour de Neptune, en habite de gala."

*The mould was destroyed in 1903.

Gustavus Athol Waterhouse

B.E., D.Sc., F.R.E.S.

DR. G. A. WATERHOUSE was associated with the scientific and administrative work of the Australian Museum for a period of nearly thirty years. He was elected Honorary Entomologist in 1919 and during the succeeding years he took an active interest in the entomological work and also spent much time studying the Lepidoptera. From an early age his chief interest was the Butterfly fauna of Australia and his collection, commenced in 1893 while he was still at school, became the finest and most complete existing collection of the Butterflies of Australia. He presented it to the Museum in 1930[1]. It includes all the results of his extensive experiments in hybridizing species of the Satyrine genus *Tisiphone*, accompanied by his observations contained in notes on the pairings of *T. abeona* and *T. rawnsleyi* in 1920, and on two series of pairings of *T. abeona* and *T. morrisi* in 1920-22 and 1922-24.

He was an Elective Trustee of the Museum from 1926 until he resigned in 1947 on account of ill health. He was President of the Board of Trustees in 1930, and for a number of years was Chairman of the Scientific and Publication Committee of the Trustees. During this period he followed the work of the Museum closely and made a valuable contribution to the administration of the institution.

Gustavus Athol Waterhouse was born at Waverley, on 21st May, 1877. He was educated at the Sydney Grammar School (thus having an early opportunity of becoming acquainted with the Museum which is adjacent to the School) and at the University of Sydney, where he

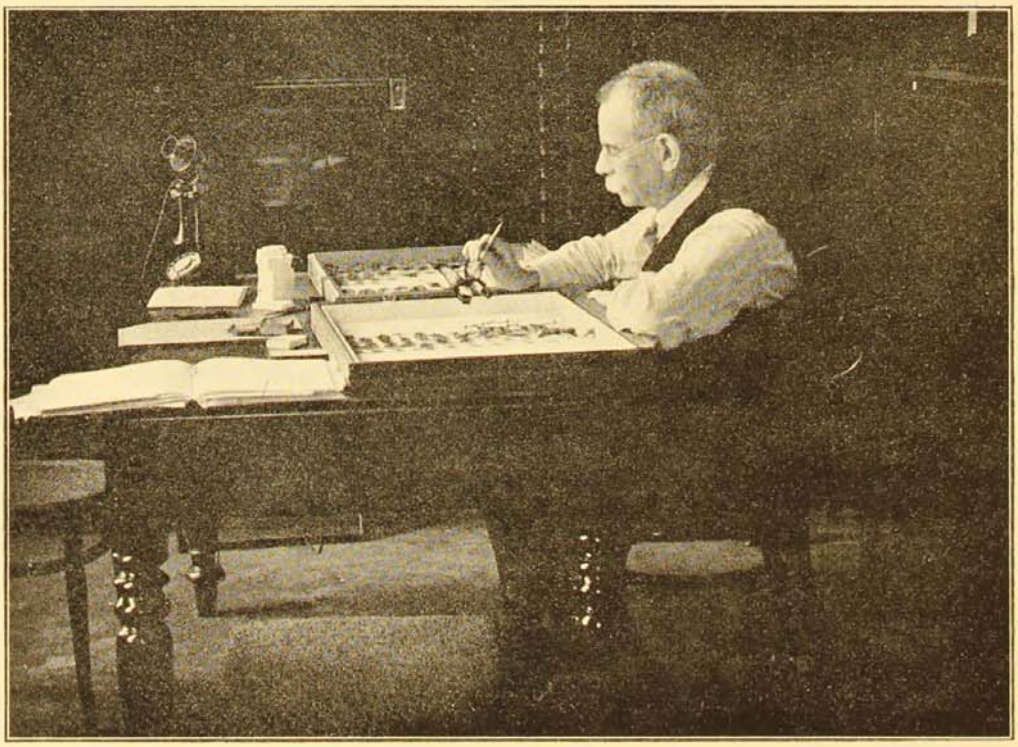
[1] See THE AUSTRALIAN MUSEUM MAGAZINE, Vol IV, No. 4, October-December, 1930, p. 112.

obtained the degrees of B.Sc. (1899), B.E. (1900) and D.Sc. (1924). From 1900 to 1926 he was on the assay staff of the Sydney branch of the Royal Mint. When the mint was closed in 1926 he retired, and devoted most of his time to his scientific pursuits and his interest in the affairs of a number of the scientific societies in Sydney. He died, on 29th July, 1950, after a period of about seven years of almost continuous ill-health.

He was a well known and active figure in all the natural history societies in Sydney and had occupied the presidential chair of the New South Wales Naturalists' Club, the Naturalists' Society of New South Wales, the Linnean Society of New South Wales, the Royal Zoological Society of New South Wales, and the Zoology Section of the Australian and New Zealand Association for the Advancement of Science. He had also been Honorary Treasurer of the Linnean Society for fifteen years, and of the Australian and New Zealand Association for the Advancement of Science for twelve years. He was Honorary Secretary of the Royal Society of New South Wales for two years, and a member of the Executive Committee of the Australian National Research Council for a number of years. The Royal Entomological Society of London conferred on him the unusual distinction of Honorary Life Fellowship.

His most important scientific work consisted of his contributions to the knowledge of Australian butterflies. These were included in a number of papers in the publications of scientific societies, as well as several separate publications—*The Catalogue of Rhopalocera of Australia* (1903), *The Butterflies of Australia* (1914, with G. Lyell), and *What Butterfly is That?* (1932). His two Presidential Addresses to the Linnean Society of New South Wales (1922, 1923) contained the results of his experiments in the hybridization of species of *Tisiphone*. In 1936 he visited England and spent some months studying type specimens of Australian Butterflies and early literature on Australian Entomology mostly at the British Museum (Natural History). He included much of the result of this study in his Presidential Address to Section D of the Australian and New Zealand Association for the Advancement of Science at Auckland in January, 1937.

By his death the Museum, as well as the scientific societies, lost one who had made a notable contribution to the advancement of natural history in Australia.—A.B.W.



The late Dr. Waterhouse working at his collection in the Australian Museum. This photograph was taken in 1930.

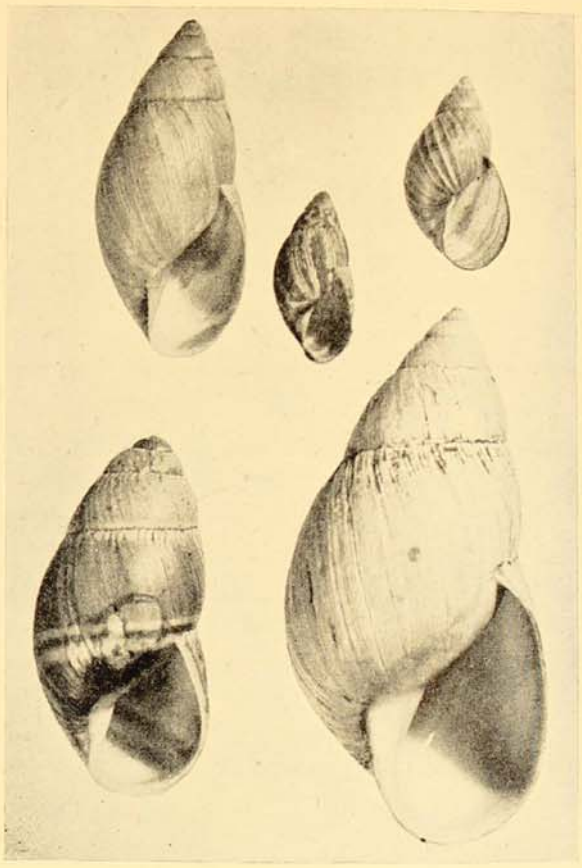
Photo.—G. C. Clutton.

Land Shells of Australia

BY JOYCE ALLAN.

PART II.

THE uniqueness of the Western Australian land shell fauna is a source of considerable interest, its most extraordinary group being the Bulimoid snails, the Bothriembryons. These are not found anywhere except in the south-west Australian region with the exception of a few stragglers in other parts of the continent, namely, three species in Eyre Peninsula in South Australia and one in central Australia, with a somewhat related form in Tasmania. Shells are elongate-oval in shape, variable in colour, either uniform, speckled or banded, and range from one-half inch to two inches in length. They occur abundantly in forest or scrub country, sometimes as high as forty feet on trees. There are now considered to be about forty different species living here of which the following are amongst the better known ones: the Rhodostoma Bothriembryon (*Bothriembryon rhodostoma*), a rose-yellow shell banded with brown which occurs abundantly in the Recherche Group, King's Bothriembryon (*Bothriembryon kingii*) has a purplish-chestnut colouring sometimes in streaks, and lives in the King George's Sound area, and the Dux Bothriembryon (*Bothriembryon dux*), the largest of all the species, chalky white with a contrasting rose-pink aperture to the shell. It also occurs in the King George's Sound region. Angas's Bothriembryon (*Bothriembryon angasi*), reddish-brown with two yellow bands, is one of the species which has crept into South Australia. A central Australian one is *spenceri*, and the Tasmanian Bulimoid snail is *Tasmanembryon tasmanicus*. Apart from a few species of small Endodonts any other land shells in Western Australia appear to be stragglers from central Australia, which has a typically desert type of land snail fauna; shells are not much more than one inch high, typical snail shape, and, as a general rule, of a drab colour.



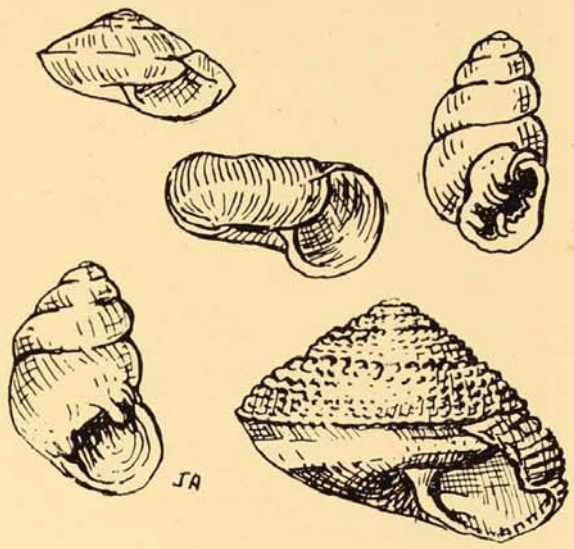
Bothriembryons, a group of Bulimoid snails, most of which are peculiar to south-western Australia. In the upper row from left to right are the Rhodostoma Bothriembryon, rose-yellow in colour, the chestnut-streaked King's Bothriembryon, and a related form, the Tasmanian Bulimoid snail. In the bottom row is another Tasmanian land snail, the Tasmanian Caryodes, and the Dux Bothriembryon, largest of the group, chalky-white with rose-pink aperture.

A number of small, rather swollen, circular or depressed shells with a wide umbilicus at the base and hairs covering the reddish-brown surface are the Hairy Chloritis snails (family Chloritidae) which occur in New South Wales and Queensland. An example of these, which can be easily recognized, is Porter's Hairy Chloritis, *Austrochloritis porteri*, which lives in brush country of coastal rivers of northern

New South Wales. A few species of the family, which lack hairs but have a granulated surface, live in north-west Australia and Northern Territory.

Southern Australian regions contain the richest fauna of the small species of land shells, minute Endodonts (family Charopidae) and small Zonitids (family Nitoridae), ranging from the size of a pin's head to about an inch; some species of these also occur in New South Wales and Queensland. The former are characterized by a flattish shape with closely packed radial ribs, and the latter ones, the Zonitids, are small glassy miniatures of the more solid snails. Other small shells are the Pupoid or Chrysalis shells, shaped as their name implies but having several whorls. These live on or at the base of trees and shrubs. The shell aperture may open on the right or left side of the central axis and is sometimes armed with teeth, occasionally so strongly, that the aperture becomes almost slit-like as in Hedley's Pupoid (*Australbinula hedleyi*). Pupoid shells only measure from 4 to 7 millimetres in length, are brownish coloured, and therefore difficult to distinguish from soil debris. Some minute shells like these have the aperture with a horny lid or operculum, not sealed by a mucus epiphragm, and mostly favour the coastal regions of northern Australia as a habitat. One example, the Slit-mouthed Operculate Snail (*Dolopupina pineticola*) which generally clusters in numbers in the earth at the foot of tree roots and scrub of northern New South Wales, has a circular aperture with a thick slit at each side. These operculate snails belong to the sub-class Prosobranchia, whereas the majority of land snails, which are inoperculate, form the large sub-class Pulmonata.

Two very extraordinary land snails occur in Tasmania, the Granulated Tasmanian Snail (*Anoglypta launcestonensis*) which inhabits north Tasmania is unique in shape and sculpture, its shell is closely granulated above, is yellowish-green and black in colour with a broad yellow band round the middle of the body whorl. The other is the Tasmanian Caryodes (*Caryodes dufresni*), a chestnut-brown shell encircled with

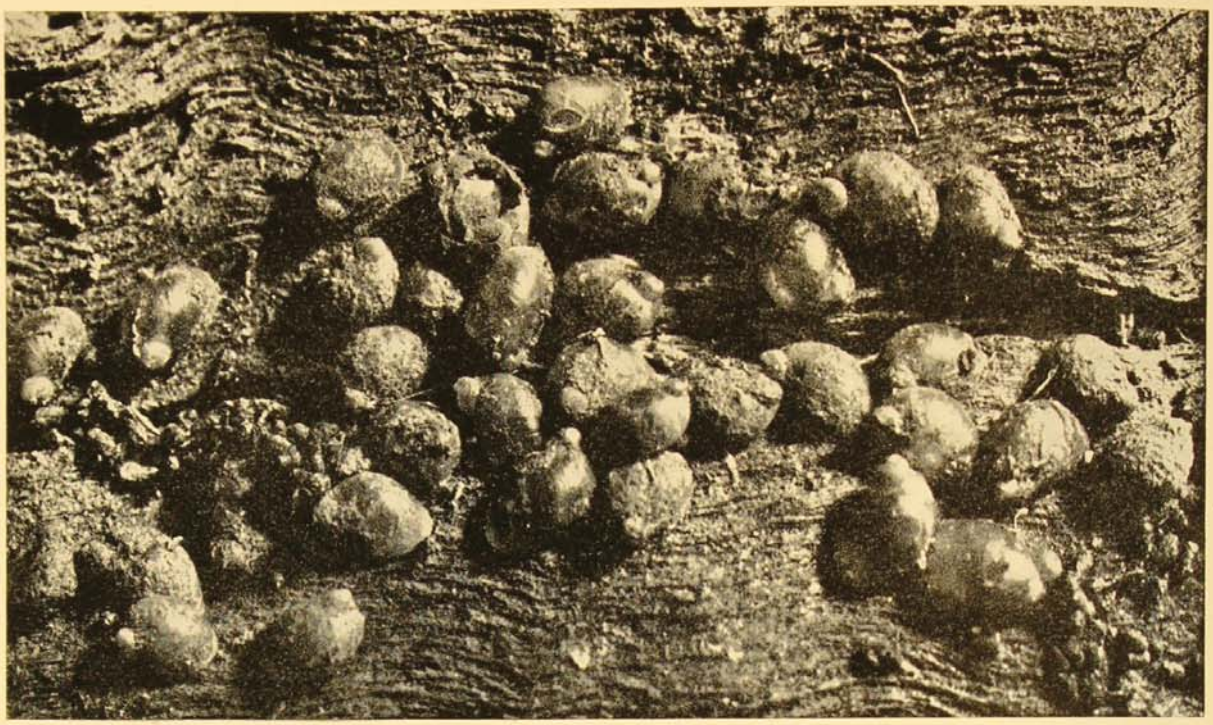


Unusual types of land snails. On the top left is a half-inch high, glassy, Zonitid snail, *Nitor subrugatus*, from coastal regions of New South Wales; on the right is Hedley's Pupoid or Chrysalis snail, and in the middle is a minute Endodont, *Gyrocochlea vinitincta*, from wet scrubs of northern New South Wales coastal regions. In the bottom row from left to right are the Slit-mouth Operculate snail, *Dolopupina pineticola*, which has a slit at each side of the circular aperture and clusters in numbers at roots of trees and shrubs, and the inch-high Granulated Tasmanian snail, *Anoglypta launcestonensis*, a remarkable yellow, green and black shell endemic to Tasmania.

J. Allan, del.

yellow and blackish bands. This species is distributed widely throughout Tasmania and lays large, white, elongate-oval eggs.

A few other groups of smaller shells sometimes encountered in the Australian bush include the Amber shells (family Succineidae), of an amber colouring, and in appearance very like some of the pond snails, such as the Fluke Snails. They are very delicate, almost glassy shells, some living on trees and others on the ground. Only a few species occur, a tree-living form being *Arborcinea eucalypti*, which clusters in numbers under bark of gum trees, or on branches and leaves of other trees in New South Wales and Queensland. A smaller relative, *Arborcinea arborea*, lives beneath loose bark of Eucalypti in South Australia. A common ground-living example is *Austrosuccinea australis* which congregates in damp spots in Victoria and South Australia, and has been found to

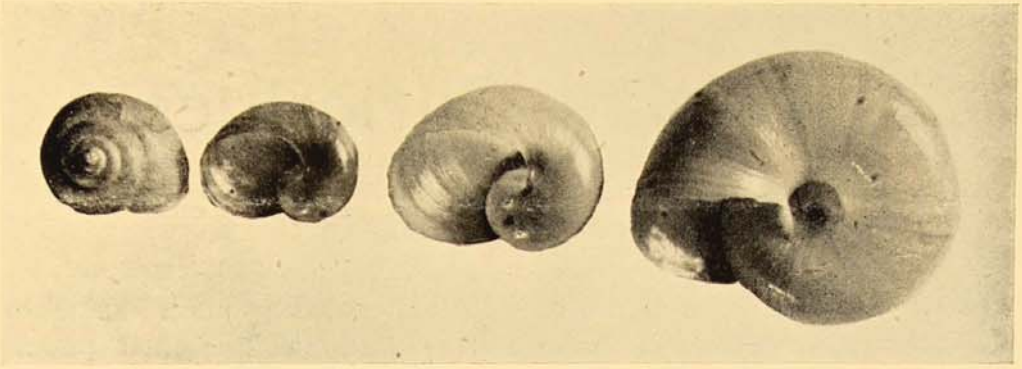


Tree-living species of Amber snail *(Arborcinea eucalypti)* clustering under bark of gum trees. They are very delicate, glassy, amber coloured snails about half an inch long, closely resembling some types of pond snails in appearance. A ground-living species has been found to harbour in its interior a larval stage of a trematode worm.

harbour in its interior a larval stage of a trematode worm. Amber shells do not reach beyond about one-half inch in length.

Glass or slug-like snails (family Helicarionidae) are a group between typical snails and true slugs. They resemble the latter in general appearance but have a delicate, glassy, ear-shaped and slightly coiled shell, flesh to green colour, on their backs, the animal being much too large to retract within it. They mostly live amongst bushes and leaves (a few climb trees) from Tasmania to Queensland. The shells are less than one inch long, but the animal extended may reach more than two inches. A well-known Queensland one is Strange's Glass Snail (*Vercularion strangei*) with a smooth, transparent, golden-yellow to greenish shell. The Black Glass Snail (*Helicarion niger*) from Victoria has a flattened reddish shell and black animal. The common Sydney Glass Snail (*Vercularion freycineti*) has a bright greenish shell, an orange-grey animal with brilliant orange-red sides to the foot. It has a quaint habit of whisking its tail rapidly from side to side as it moves along. In addition, a Tasmanian species is *Helicarion cuvieri*, and Macgillivray's Glass Snail (*Parmavitrina planilabris*), originally under the specific name *macgillivrayi*, inhabits northern New South Wales and south Queensland; also in New South Wales is *Helicarion hyalinus*.

There are no land-living bivalve shells, that is, shells made of two parts like the sea-living oyster; all terrestrial shells are univalves, coiled like the garden snails. This must seem strange, as the sea and the fresh waters, like rivers and creeks, contain both types. But a bivalve would need to be very specialized in structure to live out of water permanently, since two of its principal functions, feeding and reproduction, are dependent upon moving waters for their operations—waters passing over the living bivalve carry food and oxygen into the shell and also distribute the reproductive cells. The change from a sea-living univalve mollusc to a land form has progressed by stages and has meant chiefly the replacing of breathing gills by a modified lung structure, as in the garden snail, to suit air-breathing conditions. The opening to this lung structure can be clearly seen on the right-hand side near



Some interesting smaller types of land snails. From left to right are Porter's Hairy Chloritis which lives in brush country of coastal rivers of northern New South Wales and has hairs covering the reddish-brown shell, two Glass snails, the common Sydney Glass snail and the golden-yellow Strange's Glass snail of Queensland. On the extreme right is the golden coloured glossy, carnivorous snail *Strangesta capillacea* which is a notorious enemy of the garden snail.

the shell opening, if a snail is examined as it moves along. In their method of reproduction and of obtaining food by tearing weed or animal matter by means of jaw and radula, there has been little variation in general principle in the change-over from a sea-living to a land-living snail, the chief adaptation structurally that has accompanied a land-living existence being the substitution of the lung cavity for a gill. But a much more complicated change would surely have to be made before land-living bivalves could evolve as a part of a land molluscan fauna.

All land snails are hermaphrodites, that is they have both sexes present in an individual, and they lay comparatively few eggs, small, rounded or oval in shape, whitish in colour. The garden snail lays between forty and one hundred at a time and, in common with most snails, buries them lightly under the surface of the soil. Although chiefly vegetable feeders some land snails are omnivorous, eating both vegetable and animal matter, usually favoured in a decayed state. A few groups are carnivorous, attacking other live snails, even young of their own kind, and one introduced species in particular, *Helicella cellaria*, will furiously attack garden slaters. An excellent snail to mention as a carnivorous Australian type and to keep in a garden is one or another of the genus *Strangesta*, shiny, thin, flat shells with a rolled appearance to the whorls and mostly of a chestnut or golden horny colour. These are great enemies of the garden snail and will soon reduce its numbers if placed amongst them. The genus *Strangesta* is found throughout Australia, the common New South Wales species being *Strangesta capillacea*, but all others rather closely resemble it. The carnivorous snail sits over the opening of the snail about to be attacked, forces the victim further and further up into the rapidly-narrowing spire of its shell until the shell bursts with the pressure, and then the attacker devours its prey. One disadvantage of these carnivorous snails, however, is the fact that as soon as the young hatch out they are inclined to attack one another, so survival at that early stage goes to the fittest, and only a percentage live beyond it, whereas with the garden snail and other vegetable feeders, all the young have an equal chance of survival.

Geological Curiosities

PART I.

By R. O. CHALMERS.

AN important and time-consuming part of a Museum Curator's duties is the identification of specimens and the answering of inquiries submitted by the general public. The department of mineralogy and petrology deals with all geological matters outside the field of fossils and most of the specimens submitted are minerals and rocks. The inquirer usually has some idea, no matter how vague, of what minerals and rocks are.

From time to time, however, certain objects are submitted which, though reasonably common to the geologist, are a complete mystery to the finder, and can therefore best be described as curiosities from the lay point of view. It is hoped to deal with quite a number of these in a series of articles, starting with concretions and dendrites.

CONCRETIONS.

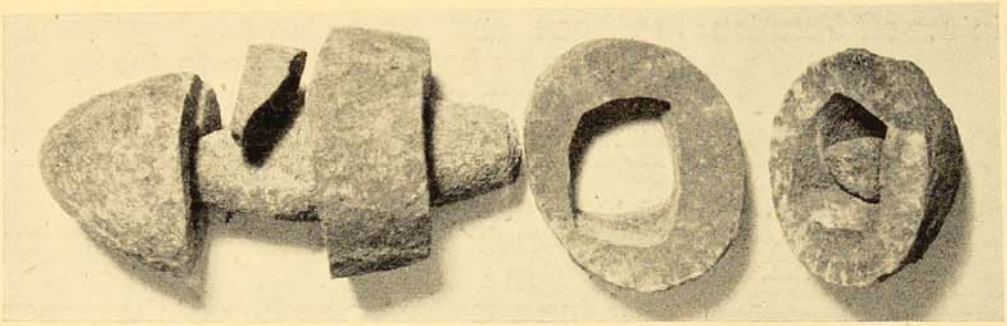
Concretions seem to arouse more bewilderment in the lay mind than any other geological curiosities. Indeed, sometimes the geologist himself is at a loss to explain, in every instance, the mechanism of formation. Concretions are defined in various ways. They are said to be "segregations of mineral matter which grow in size by addition externally, internally or interstitially," or "nodular growths of various minerals sparsely distributed throughout the country rock." Simplest of all, concretions can be regarded as "stones that grow." The term "growth" is not, of course, used in the biological sense but in the same sense as one speaks of the growth of a crystal. If a small hard foreign body is dropped into a saturated sugar solution, for instance, it acts as a nucleus round which crystals of sugar will immediately grow. In the same way, foreign bodies have acted as nuclei round which concretions accumulate and grow. Numerous examples of nuclei are quoted in literature, such as fossils, mineral fragments, small hard pebbles of quartz and chert, and even snail shells. The nucleus is by no means apparent in every instance.

Concretions occur in various ways. Sometimes they are firmly embedded in the strata in which they have formed. Again, they may occur as hard objects loosely embedded in the soil. Since they contain a concentration of mineral matter they are harder than the rocks in which they have formed and, when weathering reduces the parent rock to soil, remain as relatively hard objects. Sometimes in wind-blown, arid regions, such as in the Longreach district, Queensland, and in the Tibooburra district in the far north-western sector of New South Wales[1], as described by Mr. E. J. Kenny, a Trustee of this institution, to take only two examples, they may be found lying on the surface, the loose soil having long been blown away.

Concretions assume various shapes. At times they are perfectly spherical, a rather unusual shape in nature. Again they may be ellipsoidal or have the shape of a flattened sphere or ellipsoid. At times they may be so flat as to be discoidal. Spiral and ring-like concretions have even been recorded. Very often, of course, they have no regular form and occur in all sorts of fantastic shapes many of which strikingly imitate various organic bodies and even articles of human manufacture. What geologist has not encountered such objects submitted with the desire to impress on him that here indeed is a rarity such as a petrified "rib", "foot", "hoof", "sea-shell" or some other familiar object which the concretion chances to resemble. Some of these objects of course could occur as

[1] Kenny, E. J. The West Darling District. *Min. Res.* No. 36, Mines Dept., N.S.W., 1934, p. 72.

fossils, e.g., ribs and other bones and seashells. Concretions of this type as well as objects and markings on rocks that resemble fossils are called by the geologist "pseudo-fossils." Many of them, such as "feet" and "hooves" could not possibly be fossilized as a whole and at times all the geologist's powers of persuasion and tact are required to disillusion their finders. Even when not considered to be petrifactions of familiar objects they are always regarded as being of more than usual interest. In Scotland they have been referred to as "Fairy Stones" and in the valley of the Rhine, as Lösspuppen (loess dolls) or Lössmänchen (little men of the loess). Loess is the name applied to extensive deposits of wind accumulated homogeneous clay or loam first described from the Rhine valley. These deposits frequently contain concretions.

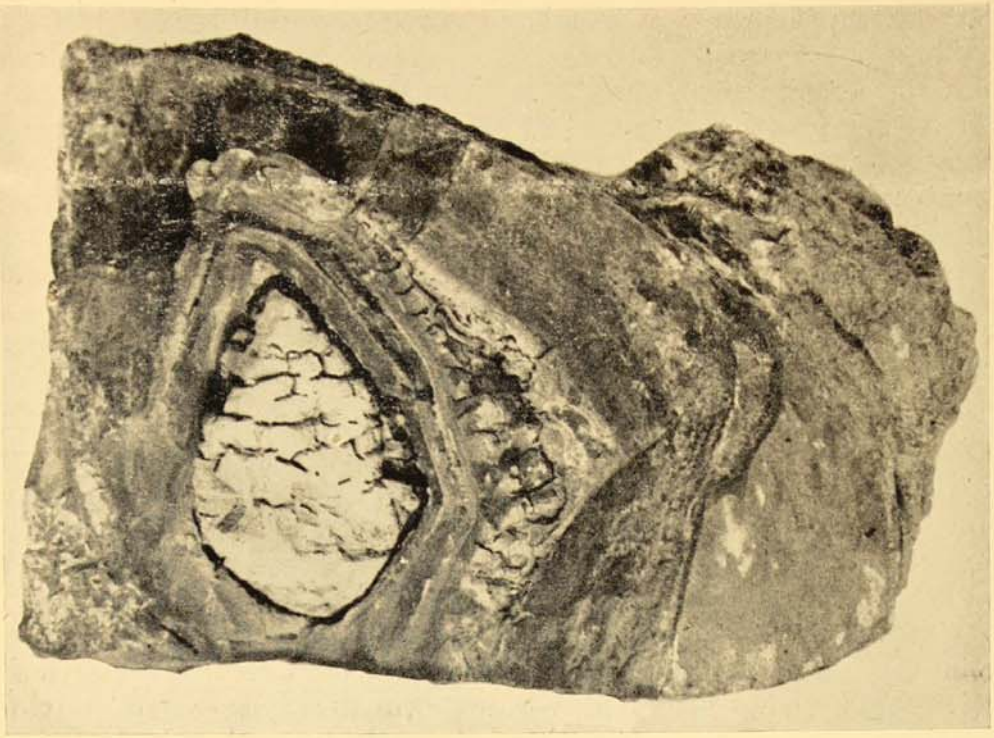


This "exploded" view of a calcareous concretion shows that the outer shell has been deposited round an elongated nucleus which is a glendonite. The five parts into which the outer shell has been broken fit together perfectly. About half natural size.

In a different and less superstitious way the Australian shows that he realizes that they are of unusual interest. If not considered to resemble known objects they are usually regarded as meteorites as if only a celestial origin could explain such unusual shapes. This explanation is offered especially when the concretion is more or less perfectly spherical. Apparently to some a meteorite is a kind of heavenly cannon-ball hurtling through space, although in reality meteorites are quite irregular in shape.

What causes concretions to form? Before a complete answer could be given it would be necessary to examine their occurrence, that is the relationship to the geological formations in which they are found. Though most specimens in the Museum collections are sent by the finder, without any details of field occurrence, it is not always possible to give a complete answer. Since concretions are accumulations of mineral matter that have been deposited from solutions, in most cases the principal agent in their formation is the groundwater circulating in the upper levels of the earth's crust. There are exceptions, such as the concretions that are forming on harbour, lake and ocean bottoms at the present time, but it is not my purpose to deal with these here. The types concerning us are those formed by the deposition of mineral matter from groundwater circulating in sedimentary rocks. Two very common chemical constituents in the earth's crust are calcium carbonate and iron, often as the carbonate but more often as the more stable oxide. These are two of the commonest cementing agents in rocks. The groundwater is always carbonated, because rain dissolves carbon dioxide from the atmosphere, and this increases its solvent powers as it soaks into the surface rocks. As circulation proceeds the water becomes rich in dissolved calcium and iron, and when objects capable of acting as nuclei are encountered, deposition of mineral matter takes place around them and a concretion is built up by the solution impregnating the sedimentary rock in which the nucleus already exists. The concretion grows by replacing or displacing the sedimentary rock which has to be sufficiently pervious to permit of ready circulation of groundwater. A concretion of this type from Mt. Vincent, near Maitland, New South Wales, is in the Museum collection. The outer shell was deposited round an elongated nucleus which is one of those curious pseudomorphs known as a glendonite.[2]

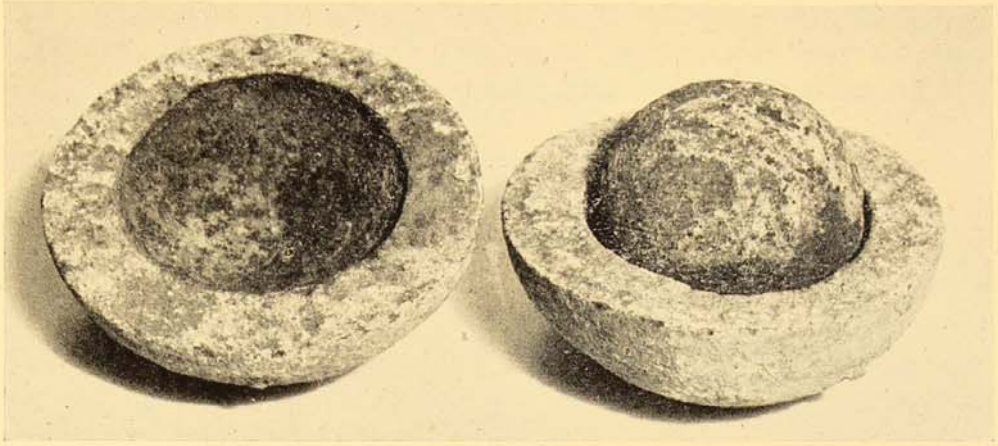
[2] Hodge-Smith, T. Glendonites and Other Fossil Crystals. *Aust. Mus. Mag.*, vi, 10, 1938, 337-339.



This weathered block of ferruginous shale shows a detached central nodule softer and lighter in colour than the surrounding rock. The bands are arranged concentrically and conform to the shape of the nucleus. The darker bands are harder than the lighter bands because they contain more iron oxide. About three-quarters natural size.

Glendonites were formed in shallow land-locked gulfs of the sea in far-off Permian times, under cold, almost glacial, climatic conditions. The glendonite nucleus consists of impure calcite and the concretion built round it contains iron oxide and clayey matter, as well as calcareous material.

Perhaps the best known are the ironstone concretions which originate in a somewhat different way. These do not always grow round a nucleus by accretion, and though usually referred to as concretions, they do not conform with the true definition. The parent rock, generally a sandstone or shale rich in iron, may weather vertically along joint planes and horizontally along bedding planes, thus tending to break up into blocks of various sizes. While this is going on, or even before the separation into blocks has proceeded to any marked degree, circulation of carbonated ground-water is also proceeding. This dissolves iron oxide from the centre of the blocks and as these iron-rich solutions, possibly in a colloidal (i.e., jelly-like) form, radiate out from the centre, deposition of iron carbonate takes place at intervals. This deposition is frequently rhythmic, in other words the process is repeated more than once as the solutions travel outwards. The result is that in time there are a series of iron-rich bands arranged concentrically. As these dry out they become thoroughly oxidized and very hard. Intermediate bands may become soft due to the deposition of iron not being so pronounced. The centre part for the same reason may become softer than the periphery, and if shrinkage takes place on drying it may become a loose detached nodule. As weathering and separation of the block proceeds a gradual wearing away and rounding of the corners take place until the first of the hard iron oxide concentric shells is reached and thus a spherical ironstone concretion has evolved. These are always various shades of reddish or yellowish brown, such colours in Nature always being due to the presence of iron oxide as a pigmenting agent. If the central nodule is completely detached and fits loosely enough in the central cavity it will rattle inside the concretion on shaking, which is all very mystifying. These are sometimes called "rattle stones" or "klipperstein" in German, which being translated means "clicking stone." We illustrate an excellent example of a concretion in the shape of a flattened sphere cracked open to show a completely detached nucleus, which, however, might not have been quite loose enough to rattle. The outer portion and the nucleus are very similar in composition, consisting of clayey material, iron oxide and iron carbonate. It was found near Bowen, Queensland.



A calcareous concretion in the shape of a flattened sphere showing detached nucleus. About half natural size.

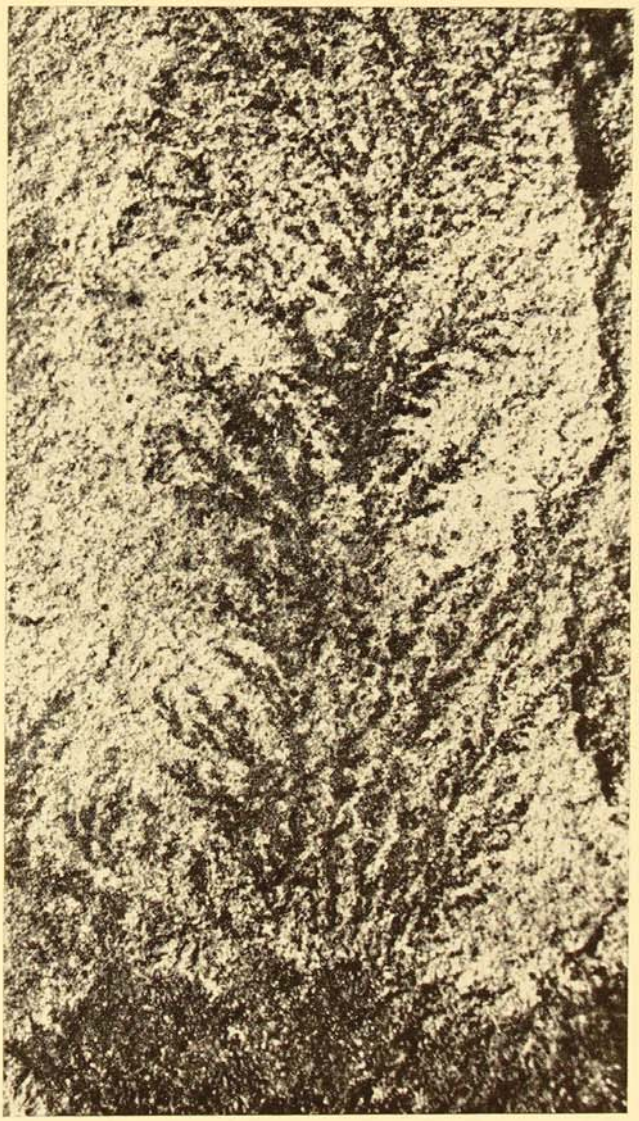
In general, ironstone concretions consist of iron oxide mixed with sandy or clayey material. At times carbonates of iron or calcium are also present.

Sometimes the iron is completely withdrawn from the central portion, leaving the cavity filled with unconsolidated sandy or clayey material which is light in colour because it is deficient in iron oxide. If in such instances the outer shell becomes worn an opening may be formed in it and the loose material may pour out, leaving the concretion hollow.

The foregoing may serve as a brief introduction to the subject of concretions proper. In a later article some of the more curiously shaped objects will be dealt with which, if not always concretions in the strict sense, are all caused by groundwater in its ceaseless work of dissolving mineral matter from rocks and depositing it again under different conditions.

DENDRITES.

A dendrite is a naturally occurring inorganic deposit resembling a plant growth in outline, found on or in a rock or mineral. The word is derived from the Greek *dendrites*. The type most frequently encountered is a fern-like deposit of black manganese oxide or brown iron oxide which is found at times coating the surface of sedimentary rocks, especially fine grained homogeneous types such as shales and fine sandstones. Dendrites, too, are often found coating the metamorphic rock quartzite. These are often submitted to the Museum in the mistaken belief that they are fossil plants. A dendrite, therefore, is an excellent example of a "pseudo-fossil." Dendrites are always deposited along natural planes of separation in sedimentary rocks, such as joints and bedding planes. The



A manganese oxide dendrite on the surface of a slab of Sydney sandstone from Marrickville. Slightly less than natural size.

width of the opening along these planes must be very minute but sufficient to permit the entry of ground water bearing iron or manganese in solution. By the force of capillarity the solutions spread for a considerable distance along such crevices and assume these branching shapes. The narrower the opening, the more complex is branching of the dendrite. Subsequently the iron and manganese salts thus deposited become oxidized by atmospheric action to form the brown and black oxides of these two metals which, of course, retain the branching shapes. Artificial dendrites are readily produced by binding strips of window glass together and dropping solutions of various salts on the upturned edges of the strips. Due to capillarity the solutions spread out between the strips in branching forms. Because these types of dendrites, both natural and artificial, are extremely thin they are referred to as two dimensional forms.

The dendritic effect in both of these moss agates is due to inclusions of fibrous green chlorite. One and a half times natural size.

Three dimensional forms of dendrites also occur. The best known example is moss agate, where mossy aggregates of fibrous minerals are found as inclusions in chalcedony, a cryptocrystalline variety of silica. To show the mossy structure the chalcedony must be very transparent and only slightly milky. The mineral is cut in thin slices and polished to reveal the mossy structure to best advantage; it was once quite a well-known ornamental stone although of recent years its popularity has declined. A fibrous mineral known as chlorite is one of the commonest minerals forming these branching aggregates, and since it is a pronounced green, the resemblance to moss is very marked indeed.

True metals such as gold, silver and copper that occur in native form often assume dendritic shapes, at times fern-like or mossy. Copper and silver occur in these shapes at Broken Hill, and copper also at Mt. Isa, Queensland. Some beautiful specimens of mossy copper forming included masses in perfectly transparent gypsum (hydrated sulphate of calcium) have been found at Mt. Elliott, Cloncurry district, Queensland.

Earthworms and Soil-building in Australia

By ELIZABETH POPE, M.Sc.

IN recent months many requests have been received at The Australian Museum (chiefly from Americans) for help in importing giant earthworms and also for information about their breeding habits. Most of these people wish to use the worms as soil-building agents. "If," they argue to themselves, "an ordinary earthworm can, during its nocturnal activities, cast up as much as twenty ounces of soil in one year, then a giant species which may attain a length of from six to ten feet should be a veritable bulldozer and turn over pounds of earth in the same time." Therefore they all wish to obtain egg capsules or live specimens of the Gippsland earthworm, *Megascolides australis,* presumably so they may claim that their worms are bigger and consequently better than those of their neighbours. Some inquirers have even suggested that they might cross the giant earthworms with the smaller, more ordinary-sized, garden earthworms and thus obtain a large worm with all the beneficial habits of the smaller types.

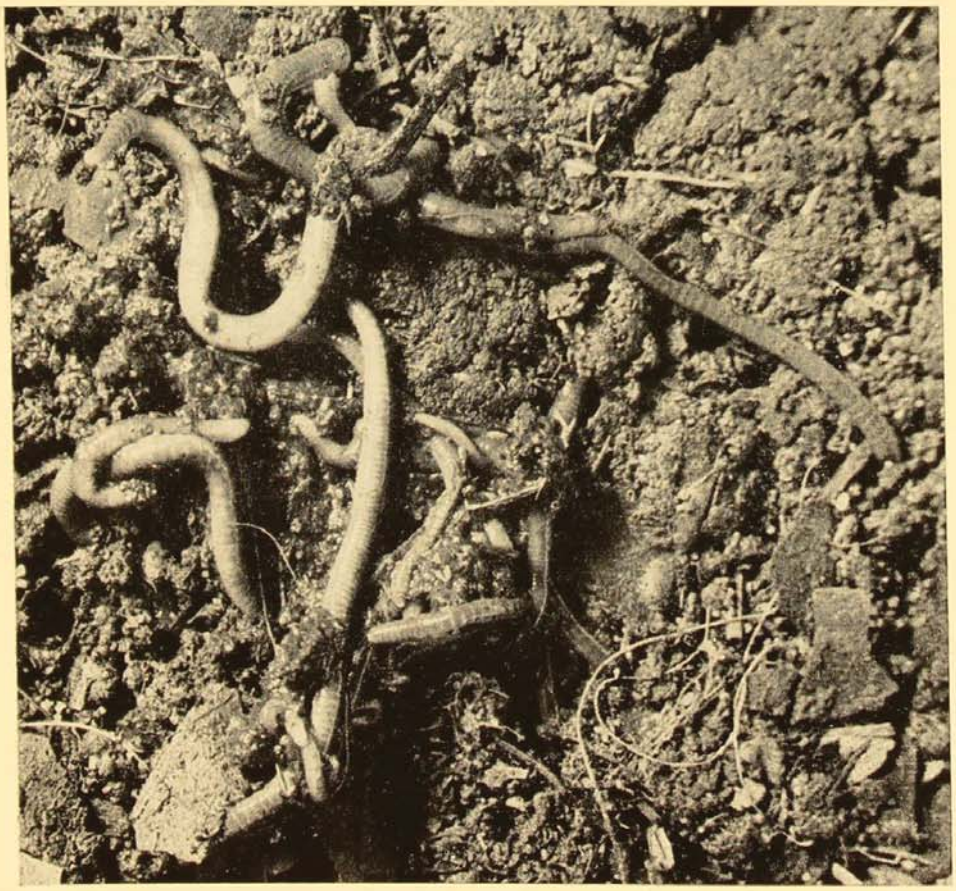
Why has this public interest suddenly become manifest, both here and abroad, and just what is the possibility of using our giant earthworms in some of the ways suggested? Has the Giant Gippsland Worm anything of advantage that the small "domestic" worms have not? In the first place, the thinking portion of the general public has belatedly become aware of the startling menace of soil erosion and increased interest is being taken in any measure which will help to retard it or which will help to restore the diminishing topsoil. Add to these people all those keen backyard-gardeners and nurserymen who would do anything to increase the fertility of their soil and, last but not least, those back-to-nature cranks and the opponents to the use of chemical fertilizers, which they term unnatural. This gives a formidable list of persons interested in the role played by earthworms in increasing soil fertility.

One of the earliest and most readable publications on this subject is Charles Darwin's *The Formation of Vegetable Mould through the Action of Worms, with Observations on their Habits,* published in 1881. Anyone interested in this question should read this classic for it discusses thoroughly and in great detail all aspects of the worms' habit of swallowing soil and vegetable matter and passing it through their bodies and thus producing a profound effect on the soil. Darwin and his followers claim, and with good evidence to support them, that by their manner of eating and living the earthworms plough and harrow the soil they turn over. They take dead leaves and animal droppings into their burrows; these are eaten, passed with sand grains through their bodies and thence to the surface as the castings so familiar to us. Moreover, their burrows drain and aerate the earth. In taking vegetable matter into their burrows, or by burying it with their castings, they also manure the soil. Further, the vegetable matter is brought into the layers of soil where the bacteria and other soil microbes can change it into the chemical foodstuffs required by the plants. Worms add chemical secretions from their bodies to the soil particles and these help to promote the growth of plants. They also grind large-sized sand grains in their intestines into smaller ones and thus help to break down newly eroded rock particles. For these reasons the worms have been styled "God's Plough," "Nature's Plough," "Nature's Silent Servant," or more simply "The Farmer's Friend."

Such claims seem absurd were one not aware of the incredible number of earthworms which may be present and one might feel inclined to think that such humble creatures could have but little effect on soil fertility. Experiments have, however, shown that earthworms can turn over as much as 119 tons of earth per acre per year. This is the record amount so far and was found in the Valley of the White Nile in the Sudan, where fertile lands border this famous river. In Europe estimates vary between two and thirty-six tons per acre per annum. Some recent experiments made in New Zealand proved the ability of certain species of worms to renew the fertility of eroded hilly pastures and check the loss of topsoil. An account of this experiment is given by two observers in the *Journal of Agriculture for New Zealand*, July, 1945, where the regeneration of the pastures in the hilly Raetihi District is described.

Carried away by the somewhat spectacular results in this case, and by the figures given for amounts of casts per acre, certain schools of gardeners and agriculturists and suppliers of gardening requisites have begun earthworm culture on a large scale. Some of the more commercially-minded of them began to breed worms and sell them or their cocoons to those who would try anything once or who were too lazy to encourage the natural populations of worms already present. After reading much of the advertising literature distributed by these vendors one is rather left with the impression that all that is needed to make poor soil fertile is to add some thousands of earthworms or their cocoons to every acre of soil and leave the rest to the worms.

Personal experience has shown us, on the other hand, that earthworms will populate most areas on their own account if supplied with sufficient quantities of vegetable matter or manure and, above all, moisture. Given these conditions and time the native species of worms, which are well adapted to local conditions, will soon populate and spread throughout wide areas, especially if lime is added in the right quantities to the soil. There is little need to raise crops of worms of this or that species in artificial conditions in boxes. Exception must, however, be made in the case of nurserymen and others who wish to use high concentrations of worms in seed boxes or for other similar purposes.



A broken clod of well-rotted compost brings to light a mass of reddish earthworms; probably these are *Eisenia foetida* or *Eisenia rosea*.

For those who wish to do this Dr. T. J. Barrett's book *Harnessing the Earthworm,* should be a great help as it describes the whole procedure.

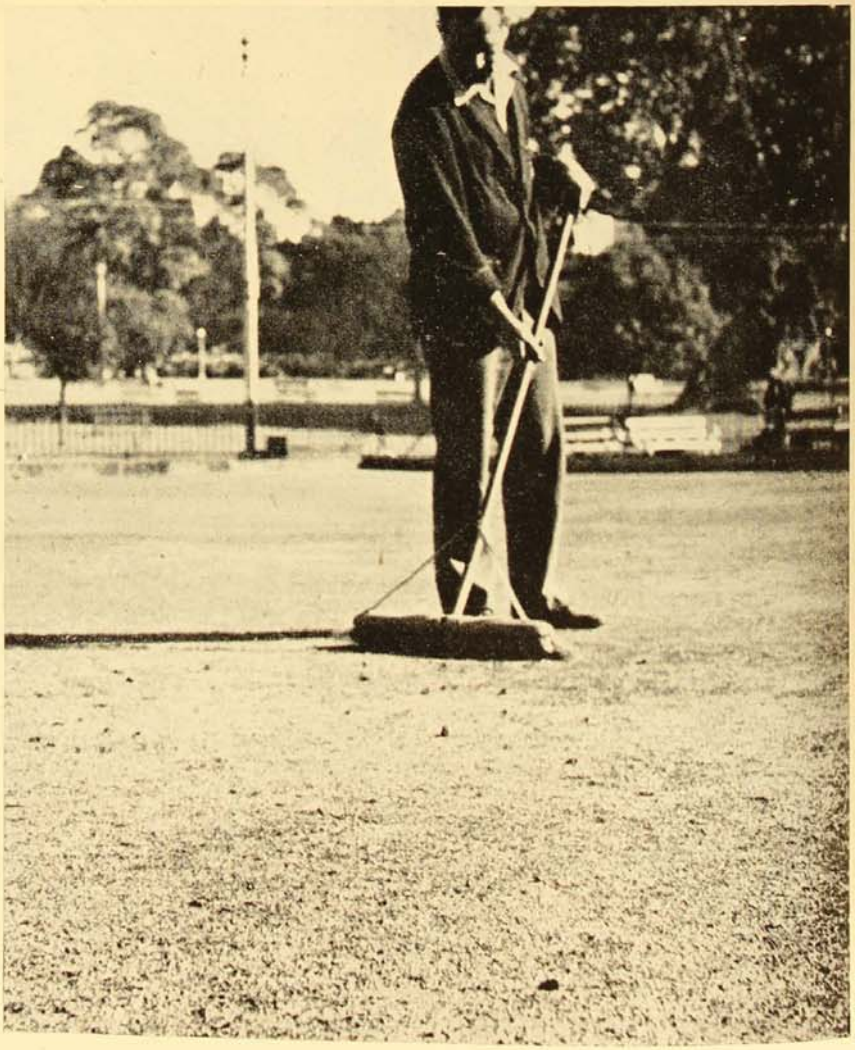
In most gardens the digging in of vegetable debris, parings of vegetables, the addition of grass clippings properly composted and, if possible, animal manure to the soil should produce satisfactory results. In order to promote the formation of compost in our home garden we put all our grass clippings into an old forty-four gallon drum which has had its top removed. No chemicals have been added to it and we have never consciously put in any earthworms or their egg-cocoons. All the attention it has had is to be kept moist most of the time. When the grass has decomposed and sunk to half its original height the lower levels of the compost, from six inches below the surface to the bottom of the drum, become a teeming mass of pinkish-coloured earthworms, probably *Eisenea rosea.* This would seem to be an indication that if suitable vegetable matter is added to the soil the earthworm situation can look after itself. A fact to note is that the leaves of eucalypts and also of many of our native shrubs which contain large quantities of essential oils do not seem to decompose easily and do not form good provender for the worms. In consequence they do not assist much in the quick formation of leaf mould.

While the presence of worm casts on the ground indicates the activities of some earthworms their absence in other areas does not necessarily mean that no earthworms are to be found there. Actually several species, important agriculturally, do not form casts although they carry on all the other beneficial activities that the cast-makers do. This has been shown by investigations made at the Rothamsted Experimental Station in England and ably expounded in a short popular article by Dr. A. C. Evans called "Earthworms and the Soil," which appeared in the periodical, *Discovery,* for March, 1948. This excellent summary should be read by all

The work of earthworms in bringing lower layers of soil to the top is shown on this lawn. The dark casts contrast with the light top-dressing of sand.

gardeners and farmers since it discusses the question of the effects of artificial fertilizers on worms and points out that proper controlled experiments have shown that fertilizers do not kill earthworms if used in correct concentrations.

In this same article the question of soil fertility is discussed without bias towards the "modern humus school" or towards the advocates of chemical fertilizers. In addition most of the experiments at Rothamsted have been running over a period of many years so that the conclusions have added weight. Dr. Evans' remarks are worth quoting in detail. He says: "The highest yields of hay are given by the plots receiving complete fertilizers but with the lowest wormcast production. The maximum production of casts occurs on the organic plots: this might be expected since fourteen tons of farmyard manure every other year represents a considerable addition to the food supply of the earthworms, but this increased earthworm activity does not result in the maximum yield. The plot treated with minerals and sulphate of ammonia *without lime* produced no wormcasts and has developed a considerable surface mat. No trace of this mat is to be found on the corresponding limed plot. The earthworm population of this plot is clearly sufficient to prevent the formation of a mat and the consequent deterioration of the grass. Similarly on Broadbalk [field] (wheat for over 100 years), the highest earthworm population occurs in the dunged plot, but those plots which have received sulphate of ammonia annually for over a century have the same population as comparable plots without sulphate of ammonia. The treatment of acid pastures with fertilizers brings about distinct improvements in the worm population. Untreated pastures contained 52,000 per acre, pasture treated with lime and compound fertiliser or superphosphate and sulphate of ammonia contained 188,000 and 219,000 respectively. The increase chiefly consisted of typical pastureland earthworms."

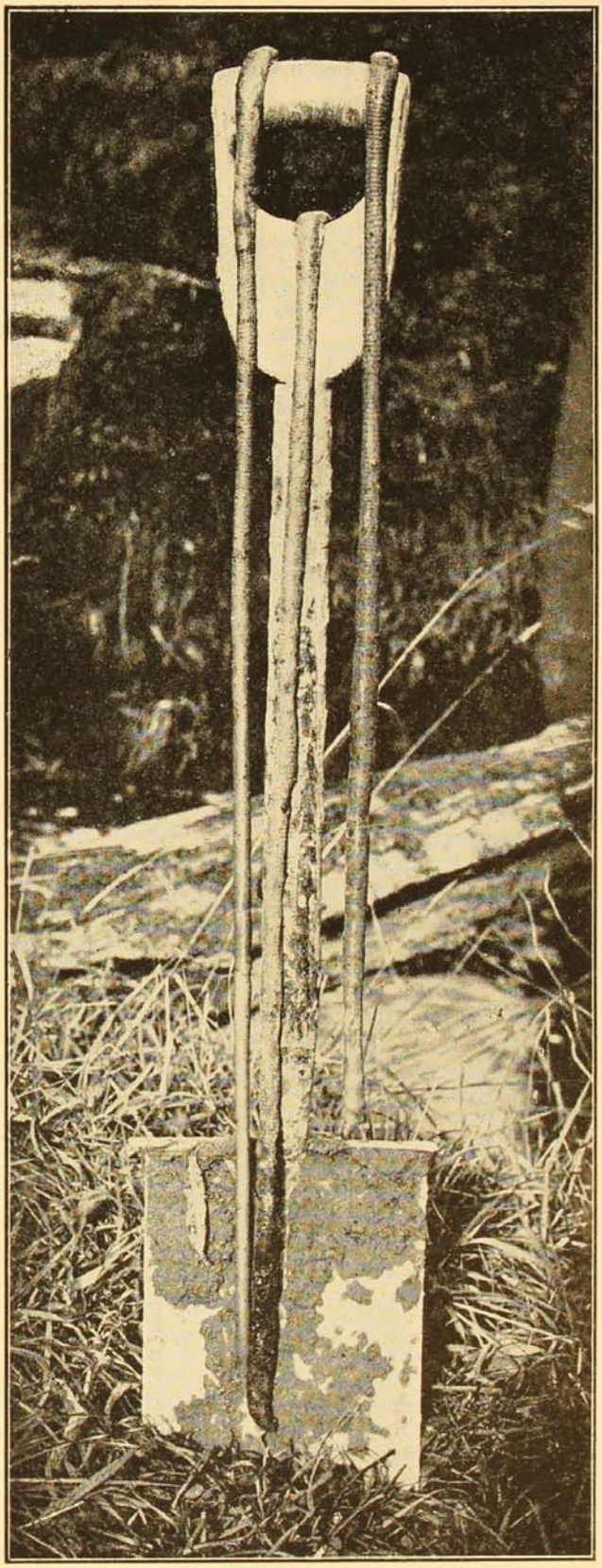


Worm casts are not always wanted. Here a green-keeper sweeps a bowling rink to eliminate the irregularities. Rinks and cricket pitches are treated periodically with chemicals to get rid of the worms.

There is no need to import worms into Australia, for many "Old World" worms are already cosmopolitan in distribution and are well established, having followed in the wake of colonization. If any are imported there should be rigid supervision and possibly a quarantine period to lessen the risk of introducing minute seeds of weeds and viruses in the soil with them. With regard to the export of the Giant Earthworm it is hard to see what practical advantages could result from such an experiment. Even in Australia, the worm's home, *Megascolides australis* is strictly limited in its distribution, being confined to a small area in the Gippsland district of Victoria, near the town of Loch. Its ecological requirements would appear to be somewhat rigid, for it has not established itself outside this area, as an adaptable species would have done. It is also extremely unlikely that the Giant Earthworm could be made to crossbreed with another smaller species.

Few, if any, of the inquirers seem to realize that the giant worm does not make casts as many of the smaller species do. Careful observers, including Baldwin Spencer, the author of the original monograph on the species*, describe how some of the worm holes have small hollow towers of earth associated with them and also mention how many people regard these structures as being due to the work of the worms. Baldwin Spencer states, however, that such piles of dirt are due to the activities of " 'the land crab' as it is popularly called" and subsequent observers have agreed that the worm itself makes no cast. Spencer rightly used the words land crab in inverted commas for he probably realized that, though the small earth-towers were made by crustaceans, they were not truly crabs. A number of subsequent popular writers have used this word crab without qualification, not realizing that land crabs have not yet been recorded from that part of Victoria and the popular name is, as is often the case, inaccurate.

That the earthworks round the Giant Earthworms' tunnels are due to the workings of burrowing crayfish of the genus



Megascolides australis **attains a length of eight or ten feet. Here several of these are draped over a garden spade.**

Photo.—Charles Barrett.

*See the Transactions of the Royal Society of Victoria, 1888, for a detailed description of the anatomy and habits of *Megascolides australis*.

Engaeus seems open to little doubt for similar small towers of earth are made by engaeids and that genus is already known to occur plentifully in the Gippsland district. Experts agree that the only sure sign of the presence of giant worms is the weird gurgling sounds made by them as they retreat through their burrows.

Another reason for not exporting our giant worm freely is that it is, and could be even more, used as a tourist attraction for naturalists and zoologists, many of whom are as interested in the world's largest earthworm as they are in the platypus or members of the marsupial clan. Properly handled and displayed the public would be interested in it too, so the worm should be protected and steps should be taken to preserve an area as a national park where they may continue their harmless ways unmolested by ploughs and other harmful farm machinery. It would be regrettable to see the worm die out.

Our original interest was the prevention of soil erosion and the improvement of soil fertility. If we seek to attain this rather than to make money by attempting to produce larger, certainly not better, worms, it is most likely that the smaller types of worms would prove to be the better agents. In any given area a given weight of small worms should be able to turn over far more earth and vegetable matter than the corresponding weight of large worms as their food requirements would be greater according to the surface mass ratio.

Possibly the present vogue for the intensive breeding of earthworms in boxes, in backyards, will die out in a few years' time. Fortunately, however, for man the essential work of soil-building by the "wild" earthworms will go on as it has in the past. It will be for us to decide whether we help them sensibly and make them our powerful allies by providing them with suitable vegetable matter and sweetening the soil with the right chemicals or whether we neglect them and trust to luck about this aspect of soil conservation, as we do in so many other important matters.

THE public was deeply shocked at the news of the loss of the M.V. *Fairwind* in the last week of June, 1950. In the last two or three years she had been surveying the fisheries of Papua and New Guinea for the Department of External Territories. On her last voyage south, she encountered extremely bad weather and rough seas and must have foundered with the loss of all hands. The skipper was Captain A. Campbell, author of several works on the navigation of New Guinea waters, and the crew consisted of whites and natives. Readers of this MAGAZINE may remember an article concerning one of the *Fairwind* cruises.* The writer recalls many happy memories in Papua with his old shipmates whose loss is now mourned and, from the biological viewpoint alone, particularly deplores the passing of his late technical assistant, David Connelly, whose cheerful and willing help and ambition to succeed in the study of fishes had been so outstanding.

The *Fairwind* disaster brings to mind the complete loss in the line of scientific duty of other research vessels such as the American *Carnegie* and the Australian *Endeavour* in years gone by. Marine zoology is one of the most difficult branches of biology and not the least reason for this is the fact that the sea itself is a very hard master.—G.P.W.

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*See "Fish Doctor in Papua," in THE AUSTRALIAN MUSEUM MAGAZINE, ix, 10, 1949, p. 340.

Bandicoots—Rare and Otherwise

PART I.

By ELLIS TROUGHTON.

WITH the exception of such marsupial orphans as the koala and pouched-mole, our bandicoots constitute one of the smallest yet most interestingly varied families of Australian pouched mammals. In their general appearance, the smaller species are superficially comparable to rats, while the larger ones are about the size of a rabbit. Doubtless, it was this rodent "look" observed by the first settlers about Port Jackson which resulted in the use of "bandicoot" as a popular name for the species first described from "New Holland" in 1797. Actually, the term is a corruption of a Telugu Indian word meaning "pig-rat," originally applied to a large species of rat common in southern India and Ceylon.

It seems likely that the name was first applied to the Australian marsupial by the explorer Bass, who is quoted as writing in 1799 in his diary about the aborigines at the Derwent River, Tasmania: "The bones of small animals, such as opossums, squirrels, kangaroo rats, and bandicoots, were numerous round their deserted fireplaces." However, in 1802, the historian, David Collins[1], first judge-advocate and secretary to Governor Phillip, uses the term bandicoot without explanation evidently as a well-accepted name. As with many other foreign labels now firmly attached to native animals, it would be futile to try to alter a vernacular name accepted so early in the settlement of the country. In any event, the use of similar names for mammals which differ so greatly in their ancestry and world-distribution serves actually to demonstrate the misleading evidences of parallelism in evolutionary development, and stresses the basic fact of their independent origin.

[1] Collins, Account of the English Colony in New South Wales, vol. ii (2nd. Ed.) 1802, p. 188.

At first glance the more typical kinds of bandicoots might be mistaken for miniature kangaroos, but the hind-quarters are not as remarkably elongated so that hopping is less pronounced, an all-fours or galloping action being commonly used. The tail in consequence is usually short and rat-like instead of being developed as a rudder in leaping. The three middle digits of the hands are long and sharp-nailed for digging after insect-grubs. A relationship with the insectivorous and flesh-eating marsupial-mice and native cat family is indicated by the many-incisored or polyprotodont dentition, typical of the mixed feeding habits. But the intermediate position of the bandicoot family is stressed by the special adaptation of the foot-structure, present also in all members of the kangaroo and Australian possum or phalanger families. This common feature is the binding together of the small second and third toes to appear as one, the top joints and nails only being divided. According to some scientific opinion, this joint evenly-clawed digit was evolved as a hair-comb for dislodging the ticks and biting-lice with which bandicoots are infested. But from the independent development of the combined or syndactylous toes in lemur-monkeys, several marsupial families, and various kinds of birds, the twin toes are now scientifically regarded as a climbing or prehensile adaptation, though naturally useful as a combing implement.

There are seven genus-groups of the bandicoot family, of which four inhabit the mainland, two occur in Tasmania, and three are represented in New Guinea and the adjacent islands. The diet in at least two genera is a truly mixed one, consisting of vegetable matter, insects, lizards, mice and young rats. Many suburban gardeners are familiar with the conical pits dug by bandicoots for the extraction of

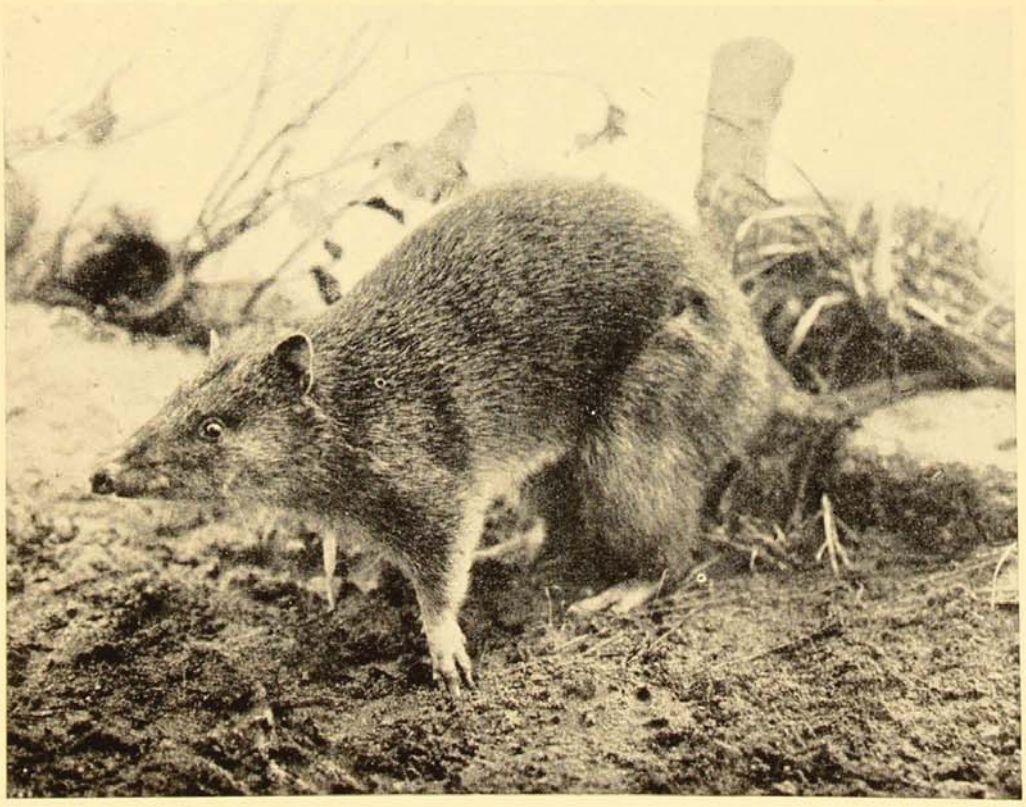
worms and beetle-grubs by the tapered snout and wish to exterminate them because of the occasional damage to seedlings and garden produce. But they are really useful and much maligned little animals, their destruction of insect pests and mice more than compensating for any damage done.

At some time or other, most Australians have quoted or heard such expressions as "miserable" or "lousy" as a bandicoot! It certainly is the misfortune of some species to be heavily infested with biting-lice or Mallophaga, and by ticks in some coastal areas. Far from being miserable they are alert and sprightly little marsupials which have overcome the irritation of parasites, even to the extent of developing an immunity to tick poison in the wild state. As with many other kinds of pouched animals the real tragedy of the bandicoot family is that, as a result of settlement and introduction of the fox, the most remarkable of all, the pig-footed species, is now apparently extinct, while the very odd and beautiful bilby or rabbit-bandicoot, once plentiful in western New South Wales, has been banished to remote central regions and appears fairly plentiful only in south Western Australia.

The Southern Short-nosed Bandicoot.

Although the remarkably elongated snout is characteristic of all pouched bandicoots, this species represents a group which have somewhat broader heads and correspondingly somewhat shorter and stouter jaws. The first to be recorded, this species (*Isoodon obesulus*), was described by Shaw and Nodder in their *Naturalists' Miscellany* in 1797 as from "New Holland." The Tasmanian and Western Australian representatives were subsequently recognized as distinctive geographical races, and a larger species ranging from northern New South Wales to Cape York Peninsula was described in 1877 by Dr. Pierson Ramsay, when Curator of the Australian Museum, as the "brindled bandicoot" in reference to the bright yellowish and blackish-brown ticking on the back, generally characteristic of the genus.

According to the naturalist Gould, the southern species was abundant in the early days in thick grasses along the banks of swamps and rivers and even on dry ridges in thick scrub. Not a burrower, it made a nest of short dried sticks, leaves, and coarse grass, sometimes mixed with earth and artfully contrived to resemble the surroundings. There is no definite chamber



The Southern Brindled or Short-nosed Bandicoot *(Isoodon obesulus)*, a useful destroyer of insects and small rodents, is distinguished from the longer-snouted garden-haunting species by its darker brownish coloration, less tapered head and ears, and stouter limbs. This bandicoot has been exterminated by the introduced fox in many parts of southern Australia.

Photo.—
Harry Burrell, O.B.E.

in the nest into which the animal merely crawls; it repairs the damage at each departure. The bandicoot seems instinctively to detect the approach of bad weather and will feverishly build-up the nest-pile before heavy rains. The aborigines' method of capture was to jump on the nest and hold the animal with their feet.

It is a useful destroyer of small vermin. Professor Wood Jones[2] noted that in captivity it used a peculiar "scrabbling" movement of the hands in dealing with living prey, as in fighting. A toughish worm or dead mouse is rolled and kneaded along the ground while the bandicoot steadily retreats until the victim is a shapeless mass which is then examined and usually eaten. The process is rather prolonged in dealing with mice, ending in the head alone being eaten. In captivity almost anything is eaten, but even those reared in captivity prefer beetles and other insects to any man-made delicacy. Cooked meat is preferred to raw and they are fond of fancy cakes and milk-puddings.

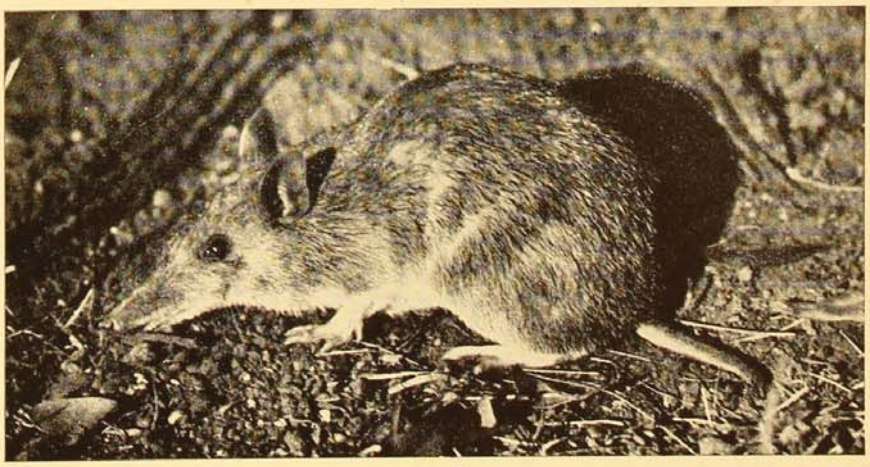
They are naturally pugnacious, a tame captive once killing a much larger long-nosed bandicoot, almost plucking its body in the process overnight. In their peculiar method of fighting the aggressor tirelessly follows and wears down its victim. The attack is made by leaping and attempting to strike with the hind-nails, each successful blow removing some hair and tearing the skin. This style is favoured until the less aggressive animal tires when the other attacks with a rapid scrambling with the hands, inflicting injuries with the sharp nails. They only bite as a last resort although the whole encounter is fought with open mouths, and the only sound made is a cross between a squeak and a snorting grunt.

In the wild state they are said to breed at any time, usually having about four young, although there are eight teats in the well-developed pouch, which opens to the rear. It is most regrettable that the useful and amusing little marsupial, so familiar to the boyhood of past generations, should rapidly be dying out on the mainland. It was once plentiful around Sydney, as shown by a specimen in the Museum from the Moore Park swamps. On Kangaroo Island it is hoped that it will ever survive in the sanctuary of Flinders Chase, where its only enemy is said to be the large goanna common to the island. As Wood Jones stated, "Most lands are fortunate in possessing some inoffensive animal which is ready to accept a truce with man, and assume the part of a friendly dependant. Australia has been blessed by possessing an unusual number of such animals, but it is Australia's distinction that almost all of them have been pressed to the very verge of extinction, and one of the most to be regretted is the little Short-nosed Bandicoot."

Long-nosed Bandicoot—Gentle Villain of the Garden Plot.

One of the largest and commonest species inhabiting the coastal mainland, from Victoria to the Cairns region of north Queensland, is *Perameles nasuta*. As the specific name suggests, this represents the genus of bandicoots having the most tapered snouts and delicate dentition indicative of

[2] Wood Jones. *The Mammals of South Australia*, part ii, 1924, pp. 138-142.



The Long-nosed Bandicoot *(Perameles nasuta)* which is well known in Sydney's outer suburbs, occurs along the eastern coast to northern Queensland. The slender snout is adapted for extracting beetle-grubs or larvae and worms from cone-shaped pits dug by the sharp fore-claws. Although young plants may be uprooted in their nightly forays, the bandicoots' activities are mostly helpful and it should be excluded rather than exterminated because of garden damage.

Photo.—Harry Burrell, O.B.E.

an entirely insectivorous diet. It is also distinguished by the longer, more pointed ears, and the paler greyish-brown coloration which lacks the contrasted yellow and blackish-brown ticking of the back in the short-nosed species.

The Long-nosed Bandicoots are well and rather unfavourably known about the Sydney district for the damage caused in suburban lawns and gardens. It should be realized, however, that their troublesome scratchings are made in search of the harmful larvae or grubs of cockchafer beetles and other insects, and not for the seedlings or plants which are disturbed, though some tubers may be eaten. One definitely useful activity was indicated by a recent complaint that the bandicoots were digging around the roots of citrus trees near Sydney. Consultation with a Museum entomologist showed that the bandicoots were actually feeding upon the "Dicky Rice" or fruit-tree root weevils which damage the citrus roots. Also, regarding lawn damage, there is now positive proof that bandicoots scratch for and consume large quantities of the "Curl-Grub," larvae of a scarabaeid beetle, which feeds on the grass-roots of lawns and pasturage.

Observations of a captive showed earthworms to be a favoured article of diet, with the following method of extraction. Sitting back on its haunches, the bandicoot scratches until the worm's head is uncovered to be grasped by the comb-like incisor-teeth, when the bandicoot's tapered snout is thrust into the cone-shaped pit. Evidently to clean the dainty morsel of all grit, the longest fingers of either hand are run down the full length of the worm. Bread and butter dipped in sugar and milk was much favoured by the captive, but a tendency to use the same feeding method as for worms resulted in much fumbling and rolling of the food in the dirt, which was continually brushed away by the cleanly animal.

Control of Garden Damage by Bandicoots.

In dealing with frequent inquiries of this nature, and having established the useful activity behind the damage to lawn and garden, it is essential to realize that bandicoots are protected marsupials under the Fauna Protection Act. They must not intentionally be destroyed without a permit from the Chief Secretary, and poisoning is forbidden under severe penalty. But even if permits for bandicoot destruction were issued in cases of proven economic damage, the killing of odd individuals would be both futile and wasteful of life while numbers of bandicoots are breeding in the adjacent bush.

Obviously, the only absolute prevention of damage is by fencing garden properties with wire-netting or palings, as adequately as for the control of rabbits. A most important additional reason for such measures for the permanent exclusion of bandicoots in suburban areas would be to restrict tick-infestations, because the Long-nosed Bandicoot is the intermediate host in the breeding cycle of the Dog Tick, also known as the Bush or Bottle Tick[3].

The natural tendency to a mixed-feeding or omnivorous diet in the bandicoot family was shown by some notes from Mr. H. C. Macartney, which accompanied two large specimens sent to the Museum from Montville, in the Blackall Ranges, north of Brisbane. The flesh-eating phase of their diet was shown by the discovery of the beak, feet, and feathers of a two-months-old chicken in the stomach of a large male. It was definitely stated also that sweet potatoes were exposed and gnawed by the bandicoots, the tubers showing unmistakable teeth-marks. Though these details are in keeping with the mixed-feeding habits of the family, they must not be regarded as proving that insect-life is not the main diet of the Long-nosed Bandicoot.

[3] Musgrave, *The Australian Museum Magazine*, vol. ix, No. 5, May-August, 1947, pp. 174-180.

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COLEOPTERA 17—CORYLOPHIDAE AND DERMESTIDAE.

By KEITH C. McKEOWN.

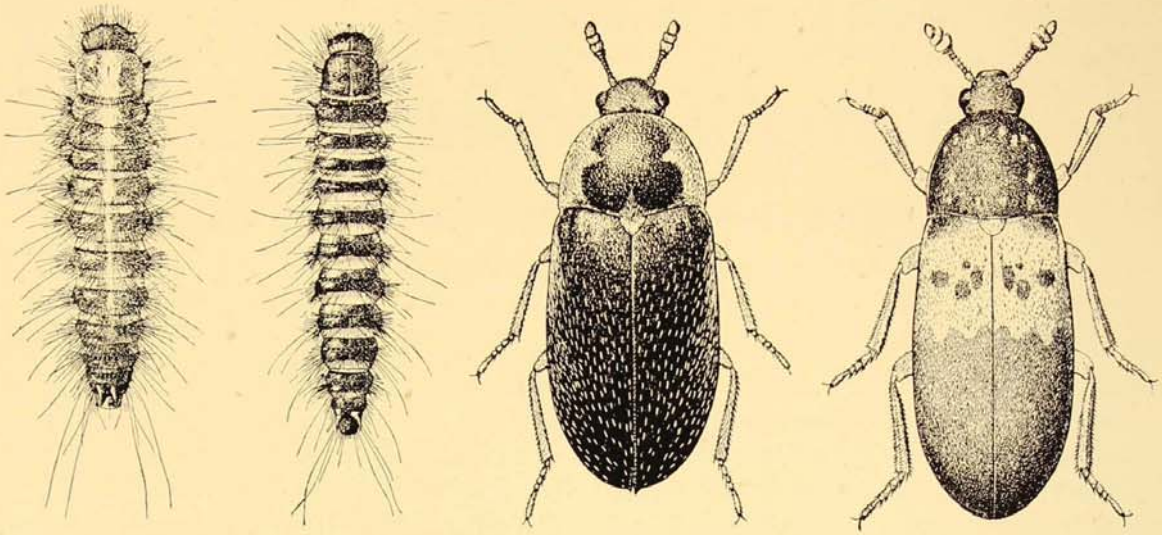
THE Coleoptera, largest of the insect orders, with possibly a quarter of a million described species, presents an overwhelming display of beetles of great diversity of form, coloration, and size. Many small forms escape the notice of all but the collector, or often only that of the specialist; others, perhaps equally inconspicuous, force themselves upon the attention of even the least interested because of their injurious habits—they are so destructive that they cannot be ignored by man. Of the two families discussed here the first, the Corylophidae, spend their lives in the bush, and little is known concerning their lives and habits; the second, the Dermestidae, although often found in the bush, also enter the homes, stores, and factories of man and voraciously destroy many materials of animal origin, food, clothing, and domestic furnishings.

The members of the family Corylophidae, of which only some three dozen are known from Australia, are minute, perfectly oval beetles only 1 to 1½ mm. long, and of somewhat ladybird-like appearance. Unlike the ladybirds, however, which have 3-jointed tarsi or feet throughout their limbs, those of the Corylophids are 4-jointed, although the third is extremely small and likely to be overlooked, and the sides of the prothorax are often produced backwards over the elytra or wing-covers. The hind wings are narrow and delicately fringed with long hairs. It will suffice here to mention that the chief Australian genera are *Sericoderus* and *Corylophodes*. Nothing is known of the lives of these small beetles, but they mostly occur in rotting wood or decaying vegetation. The affinities of this family are somewhat uncertain, but Tillyard places it in its present position, others near the Histeridae.

Some sixty species of Dermestidae have been recorded from Australia, but a number of introduced species also occur and these include most of the destructive forms. The beetles are variable in size, ranging from 7 to 9 mm. in length in *Dermestes* to 2 to 4 mm. in *Anthrenus*. All the species are dull-coloured with scaly or hairy elytra. The antennae are short and sometimes strongly clubbed; when at rest they fit snugly into a recess in the lower surface of the thorax; the tarsi are 4-jointed throughout. A single simple-eye is placed in the centre of the head, like that of the giant, Cyclops, in all genera except *Dermestes*.

The larvae are active creatures with well-formed legs and densely clothed with long hairs, often concentrated into prominent brushes or tufts, the purpose of which is obscure. When pupating, the hairy larval skin splits down the back and remains fixed as a pupal covering. In the bush, the larvae frequent and feed upon the dried bodies of animals, nests of bees, the pupae and discarded larval skins of caterpillars. They also attack furs, hides, wool and woollen materials, silk, cheese, bacon, and similar substances of animal origin, little of that nature coming amiss to them. Many species have become cosmopolitan in their range. More detailed information of life-histories and habits will be given in discussing individual species.

An aspect of the infestation of materials by various species of Dermestids is their role as intermediate hosts of parasites or as vectors of disease. It has received little attention, but H. E. Hinton, of the British Museum (Natural History), in his valuable "Monograph of the Beetles Associated with Stored Products" (1945), lists



1 2 3 4

***Dermestes maculatus* (1 and 3) larva and adult; *Dermestes lardarius* (2 and 4) larva and adult.** After Hinton.

Dermestes maculatus Deg. as an intermediate host of nematodes in Hawaii, *D. peruvianus* Cast. as host of the rodent tapeworm, which sometimes infests man in Argentina. *Dermestes*, *Attagenus*, and *Anthrenus* which have been feeding on skins of animals which have died of anthrax may occasionally be responsible for transmission of the disease. Ill-effects from irritation by the detached hairs of the larvae have also been recorded.

Three species of *Dermestes* are known to occur in Australia; these are *D. maculatus* Deg. (formerly known as *vulpinus* Fabr.), *D. ater* Deg. (often named *cadaverinus* Fab.), and *D. lardarius* Linn., the Bacon Beetle. These insects are elongate-oval in form, dull brown in colour, and with the under surface of the abdomen densely clothed (with the exception of *lardarius*) with snowy-white hairs. *D. maculatus* has the sides of the prothorax greyish, a character lacking in *ater*. *D. lardarius* is distinctively marked with a broad belt of cream across the base of the elytra.

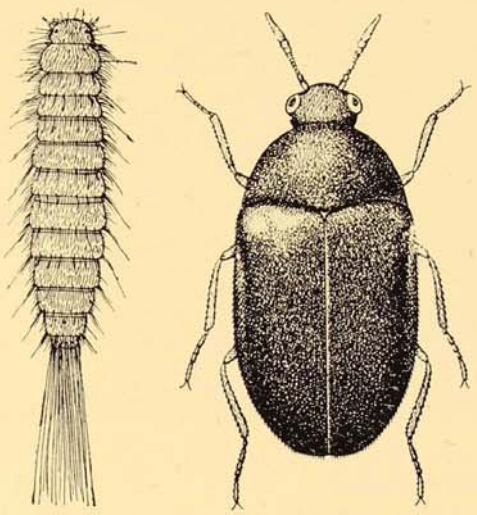
The life-history of the common *D. maculatus* may be taken as generally typical for all the species. The female deposits her eggs in batches of 3 to 20 on and in the vicinity of suitable food. The incubation period varies widely according to temperature. The larvae are elongate and densely clothed with stiff brown hairs, they are very active and shun the light. The larval period has been recorded as lasting from 35 to 238 days according to the prevailing temperature. Pupation usually takes place within the last larval skin which serves as a protective covering. Prior to pupation the larva excavates a cell in almost any substance that happens to be handy. I have seen the timber floors and fixtures, and the plaster of the walls of a factory literally riddled with these holes; a store for boxes used for the carriage of eggs was in a similar condition, while many of the wooden cases, stained with the substance of broken eggs, were damaged to such a degree as to be practically useless. Materials contaminated with fats and oils are readily bored in this manner. The earliest account of such damage is recorded in *The Last Voyage of Thomas Candish* (Hakluyt's Voyages) where there is an account "of a ship in 1593 carrying a cargo of dead penguins being nearly sunk because of the honeycombing of its sides and bottom by *Dermestes* larvae." The piercing of lead by the larvae has been recorded in the United States. Both the larvae and adults feed on substances with a high protein content, as bones, skins, carcases, ham, bacon or cheese. The distribution of this insect is cosmopolitan. The cosmopolitan *D. ater*, with a similar life-history, feeds upon much the same substances with the addition of copra, and, as recorded by Froggatt, woollen-tops. An equally wide range of foods sustains the

Bacon Beetle (*D. lardarius*), but in Australia it is usually a pest in bacon and cheese factories. Froggatt has recorded it in islands off the coast of Western Australia in the nests of terns, where it was feeding upon the bodies of young birds killed by lizards. This species is also of cosmopolitan range.

A number of small species included in the genera *Attagenus* and *Anthrenus* are popularly known as "Carpet Beetles" from the habit of their larvae working along at the base of the pile and feeding as they go, with the result that a large or small area, according to the degree of infestation, sloughs off. Areas of carpet under and protected by seldom-moved chairs and lounges are especially susceptible to attack. They are particularly destructive domestic pests since, in addition to carpets, they attack furs, woollens, and silks.

Members of the genus *Attagenus* are small, broadly oval beetles of black to reddish-brown colour, the elytra being clothed with fine hairs giving them a satiny appearance. The brown, hairy larvae bear a long tail-like brush of hairs at the rear extremity of the body. The common and cosmopolitan Black Carpet Beetle (*Attagenus piceus* (Oliv.)) is possibly the most prevalent of the carpet-infesting species found in Australia. The eggs are laid on or near suitable foodstuffs, and vary in number according to temperature and the nature of the food available, the average number being about seventy. Within 5 to 24 days, the period again being controlled by temperature and humidity, the eggs hatch. The larval length of life may range from 8 to 43 days in warm weather, or 194 to 297 days where winter intervenes in their development. About a year may be taken as the usual period for the completion of the full life-cycle.

Beetles of the genus *Anthrenus* are very small insects of almost circular form, like small ladybirds, brown in colour and marbled with irregular patterns formed by grey scales. The adult beetles are rarely seen in houses, except in spring or early summer when they may congregate



***Attagenus piceus* — the Black Carpet Beetle—larva and adult.**

After Hinton.

on window-ledges where, attracted by the light, they attempt to escape out of doors. In gardens they may sometimes be seen in numbers on the flowers of daisies, marguerites, and other composites, where they feed on the pollen. The beetles can fly readily and re-enter houses in order to deposit their eggs. As well as being known as "Carpet Beetles" *Anthrenus* are called "Museum Beetles" from their habit of destroying museum specimens.

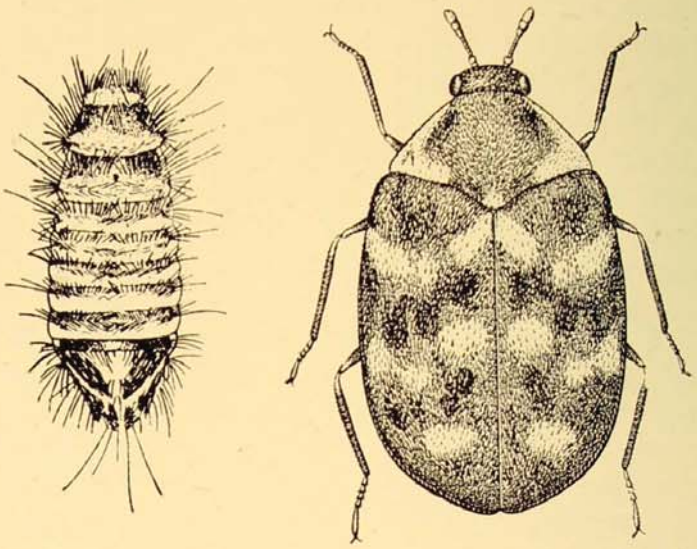
The commonest species found in Australia is *Anthrenus verbasci* (Linn.), of cosmopolitan distribution. It is brownish, liberally mottled with patches of grey or yellowish scales; the ventral surface is white sprinkled with yellow and black. The larva resembles that of *Attagenus*, but lacks the terminal brush of hairs. In other species where a brush is present it is usually sparse and narrow. The duration of the egg stage is usually about 7 to 10 days, and the average number of eggs laid is about 30. The duration of larval life is influenced by temperature, but data are not available. In Australia, the complete life-cycle occupies up to twelve months. When the pupa is formed it remains in the split larval skin until the perfect insect emerges. A wide range of animal—and even vegetable—products constitutes their food.

Another species, *Anthrenus vorax* Waterh., is extremely variable in the size and pattern of the pale areas upon thorax

and elytra. It is not as common, however, as *verbasci*. *Anthrenocerus australis* (Hope), a member of a closely allied genus, is known overseas, where it has become established, as the "Australian Carpet Beetle."

Trogoderma contains a number of small black or blackish species many of which are of Australian origin. *T. froggatti* Blkb. is common and widely distributed.

In view of the importance of Carpet Beetles as domestic pests, a few brief notes on their control may well be included here. The Department of Agriculture of New South Wales recommends that, "In trunks, chests, wardrobes, etc., which are seldom opened, naphthaline, paradichlorobenzine or camphor may be used to prevent infestation, but where wardrobes, etc., are in daily use, or under carpets or rugs, in pianos or upholstered furniture, these substances are of little value. As the above substances kill the carpet beetles by means of the fumes given off during slow evaporation, it is essential that where they are used the lids, doors, etc., should be tightly fitting so that the fumes are closely confined. Naphthaline flakes or naphthaline moth balls to be effective should be used at the rate of not less than 1 lb. to every 8 cubic feet of space. Where camphor is used twice the quantity is necessary."



***Anthrenus verbasci* — the Varied Carpet Beetle—larva and adult.**

After Hinton.

Infested carpets and upholstered furniture may be effectively sprayed with one of the commercial pyrethrum-kerosene sprays containing D.D.T. The spraying should be carried out thoroughly. Where the infested area is small, the larvae can be destroyed by covering that portion of the carpet with a wet cloth and ironing over it with a hot iron.