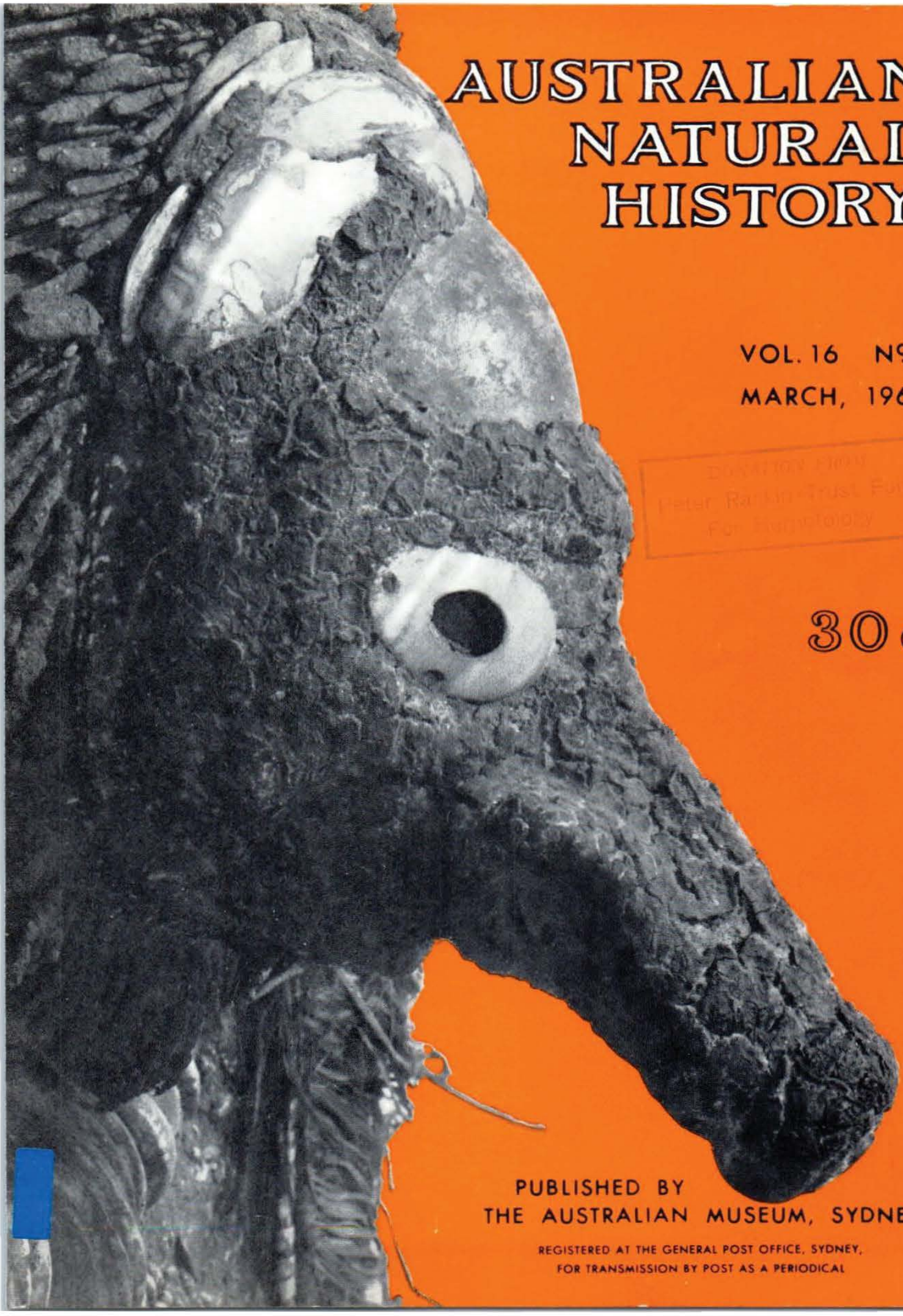

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● **FRONT COVER: Part of a ceremonial shield from the village of Ambot, on the Keram River, a tributary of the lower Sepik River, New Guinea. The pig face is moulded over a human skull, which is set in the centre of the shield. The shield is composed of a rattan framework, plastered with clay, in which cowrie shells and pig bones are set. It was probably made for a ceremony to commemorate a well-known ancestor, and would have been used to decorate the interior of the village men's house. (Photo: C. V. Turner.) BACK COVER: The Brittle Star *Ophiocoma insularia* variety *variegata*, of Australia coral reefs. This starfish has attractive blendings of greys, brown and olive. Its disc reaches a width of 1 inch. (Photo: Howard Hughes.)**

THE TURRID SHELLFISH OF AUSTRALIAN SEAS

By A. W. B. POWELL
Assistant Director, Auckland Museum, New Zealand

WHAT are turrids? One may well ask, for, although they constitute one of the largest of shellfish families, not many of the species occur abundantly in the intertidal zone. The family is of world-wide occurrence; they range to the great depths, are well represented even in Arctic and Antarctic seas, and some thousands of fossil species are known, extending back in time to at least the upper Cretaceous.

In other words, the known ancestry of turrids goes back at least 100 million years. Even so, the earliest known species, from Bald Hills, California, U.S.A., does not differ markedly from the turrids of today, and one is therefore induced to consider an even earlier origin for the family.

Turrids in general do not quite make the glamour class among the families of shells favoured by the amateur collector—the cowries, cones, and volutes. Nevertheless, one of its members, *Thatcheria mirabilis*, from deep water off Japan, is undoubtedly the most exquisite art form of all molluscan shells.

A turrid is a difficult thing to define in general terms, owing to the diversity of shapes encountered in the family; some look like cones, others superficially resemble terebrids, fasciolarids, and even buccinids. However, the one feature that is diagnostic of a turrid shell is a more or less well developed labial sinus, a siphonal slit or indentation, sometimes quite slight, in the upper part of the outer lip. The form and position of this sinus, coupled with the style of protoconch, the presence or absence of an operculum, and a specialized type of dentition, are the features upon which the family is divided into nine subfamily groups.

The Japanese deep-water *Thatcheria mirabilis* Angas, the most beautiful of all the turrids. There is an unconfirmed report of the presence of this species in north Queensland waters.

The turrid dentition

Undoubtedly there is close affinity between the turrids and cones, which is revealed by an anatomical feature common to both, the toxoglossate (poison tongue) style of dental apparatus. Most gastropod molluscs have a distinctive feeding mechanism, known as the radula, which lies back down the throat of the animal and consists of numerous rows of sharp teeth attached to a flexible chitinous ribbon.

In most gastropods food is masticated by being forced down the throat over the radular teeth, an action that has been likened not to harrowing a field but to forcing the field over the harrow. In many turrids and in all cones a very specialized state has

developed in which the teeth can be loose and in the form of slender barbed arrows. Associated with this style of radula are a poison gland and duct whereby the animal can actually shoot "poisoned arrows" into its prey.

However, not all turrids have the fully developed toxoglossate dentition, and in these, which are considered the more primitive, there is a prototypic style of radula, consisting of a central tooth, comb-like lateral teeth and slender pointed marginal teeth as well. Even in this prototypic radula, which has the teeth fixed to the lingual ribbon, there is an associated poison gland. It is assumed that, in this form of radula, the pair of marginal teeth, which are the longest, administer the poison, and the central and laterals perform the more normal function of mastication.

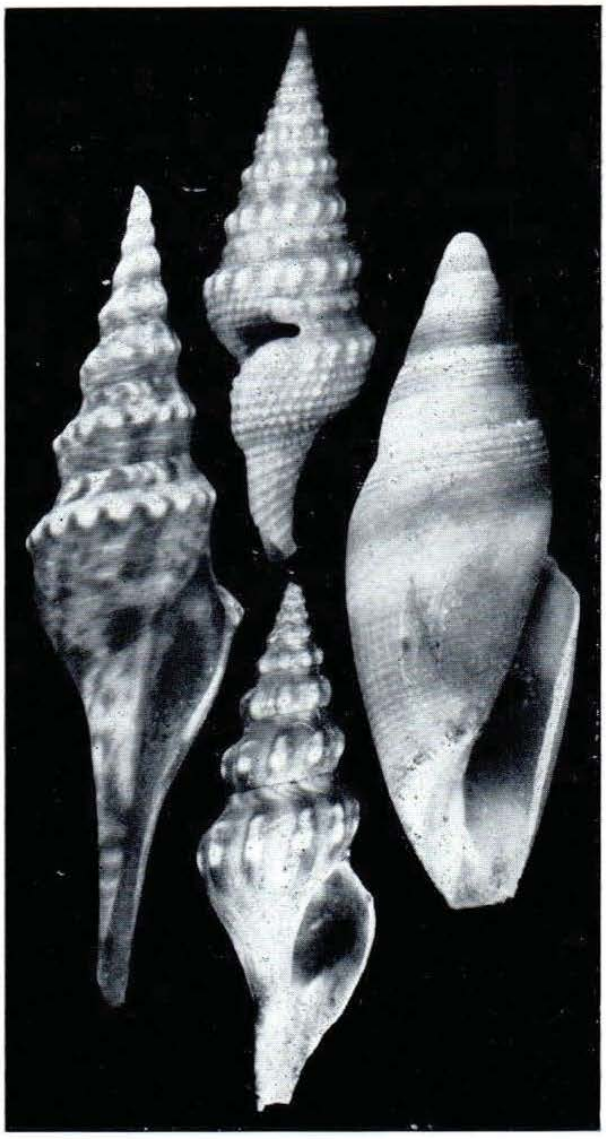
In the case of certain large tropical cones, even human fatalities have resulted from punctures received while handling the living shellfish. However, there are no cases on record of toxic bites from turrids, although it is known that they attack and narcotize other shellfish, and even small fishes, in which process they are aided by a long proboscis.

Some pointers regarding classification

To the uninitiated, turrid identification is not easy, which is understandable, for the experts are frequently similarly puzzled. The vast number of turrids that have been described—almost 10,000 of them, recent and fossil—forces one to apply a system of family subdivisions, if for no other reason than to reduce the species to manageable groups.

It is not proposed to go too deeply into the boring subject of classification, but the following pointers should help the collector to arrange specimens into subfamily groups and thus narrow down the search for the relevant genus and species.

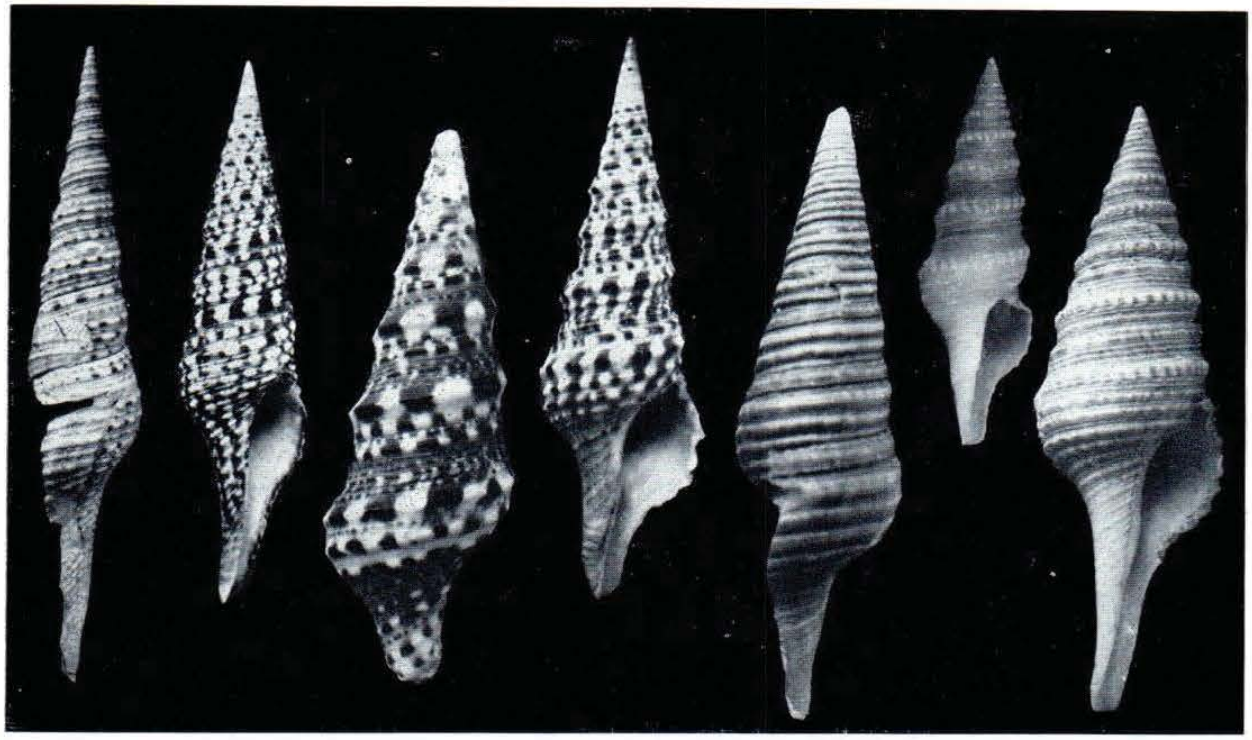
Nine subfamilies have been adopted, and their names are: Turriculinae, Turrinae, Clavatulinae, Borsoniinae, Clavinae, Conorbinae, Mangeliinae, Daphnellinae, and Thatcherinae. Of these we can eliminate two, the Clavatulinae and the Thatcherinae, since they do not occur in Australian waters. There is, however, an unconfirmed report of the latter from north Queensland waters.



Top: *Turricula nelliae granobalteus* Hedley, from Broome, Western Australia. Left: *Leucosyrinx*, a new species from deep water off Caloundra, Queensland. Right: *Benthofascis biconica* (Hedley), from the same locality. Bottom: *Comitas murrawolga* (Garrard), off New South Wales, 75 fathoms. (*Benthofascis* belongs to the Conorbiinae, the others to the Turriculinae).

For the remaining seven here are some indicators:

If the protoconch is sculptured with diagonally cancellated threads, and the labial sinus is sutural and of reversed L-shape, then the specimen is daphnellid. If the sinus is on or adjacent to the peripheral carina, V-shaped, or a deep slit, then the Turrinae is indicated, except that similar shells, but with the addition of pillar-plaits,



Well-known Indo-Pacific members of the subfamily Turrinae known to occur in Australian waters. From left: two specimens of *Turris crispa* (Lamarck), Cairns, Queensland; *Turris spectabilis* (Reeve), Capricorn Group, Queensland; *Turris undosa* (Lamarck), Tin Can Bay, Queensland; *Turris annulata* (Reeve), North Queensland; *Gemmula hawleyi* (Iredale), Port Jackson, New South Wales; *Gemmula kieneri* (Doumet), north Queensland.

belong to the Borsoniinae. A large subfamily, the Turriculinae, have a sinuous sinus, its apex upon the shoulder slope. Both the Turrinae and Turriculinae mostly have a tall spire and a long anterior canal. Members of the Clavinae have tall spires, but usually the anterior canal is short. The sinus is upon the shoulder slope and is often constricted to subtubular by an apertural tubercle. The Mangeliinae are by far the most prolific modern group. They are mostly of small size and variable in form. Most are fusiform, i.e., spindle-shaped, with a relatively weak sinus upon the shoulder slope. The operculum is generally absent, but it may also be vestigial or even fully developed. Finally, the Conorbiinae are the nearest approach to the Conidae, and, like them, have a tendency to dissolve the inner structure of the early whorls. They differ from the cones in having a tall spire and a deep sutural sinus.

Now that we have been initiated into the broad outline of turrid subfamily classification, we are in a position to attempt generic and specific identification of some of the Australian members of the family.

The Australian living turrids

There are over 400 living species of Australian turrids, and a very considerable number of fossil species have been described from the Tertiary beds of Tasmania, Victoria, and South Australia.

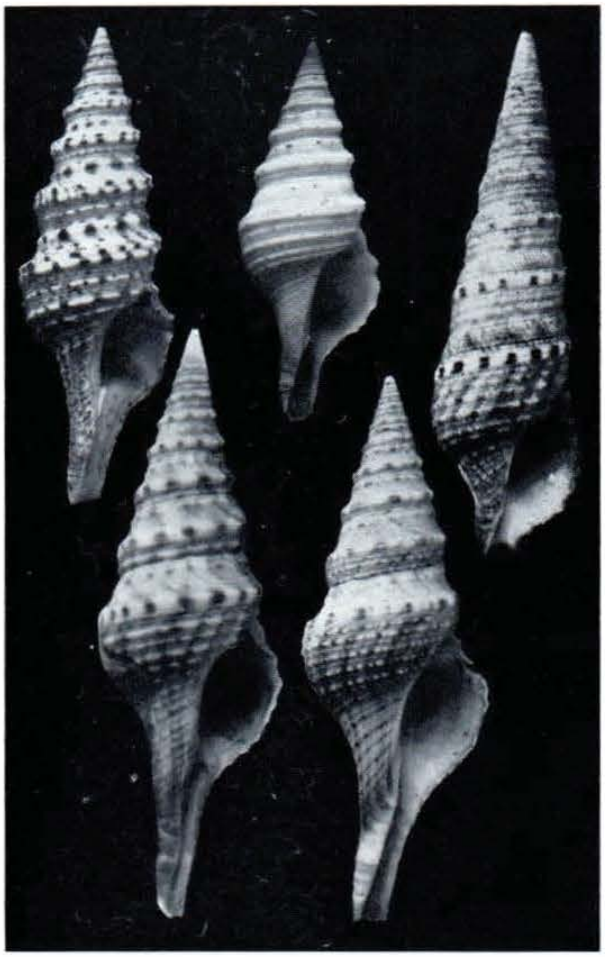
The southern species are now fairly well known, but new additions are constantly coming to light in northern waters as the result of more intensive commercial fishing. Many of these new additions are well-known species from southeast Asia and Japan.

Mr Charles Hedley, formerly conchologist at the Australian Museum, published in 1922 a comprehensive paper on the Australian turrids, illustrated with beautifully executed wash drawings by the then Museum artist, Miss Phyllis F. Clarke. Knowledge of New South Wales turrids was greatly enhanced in 1944 by the published researches of Mr Charles Laseron.

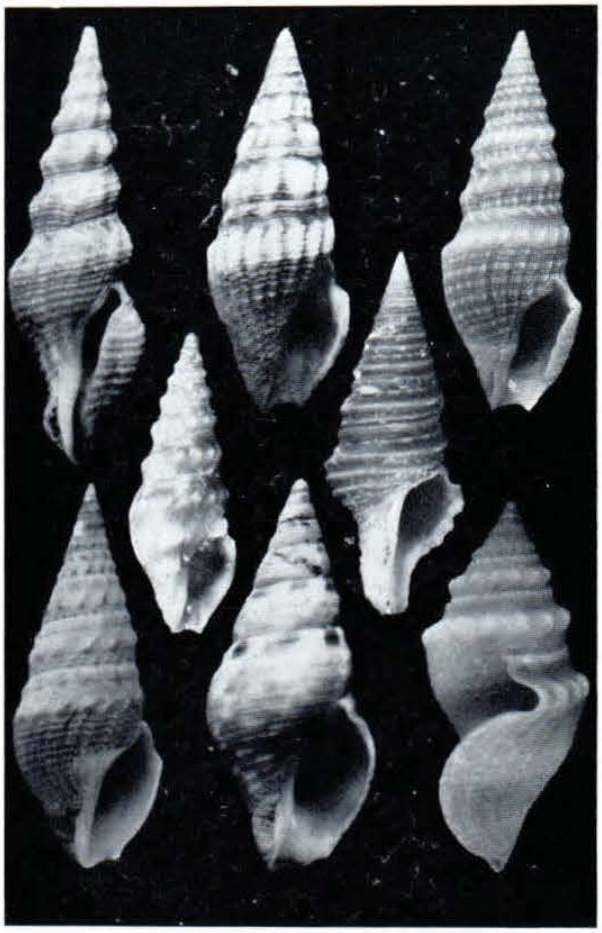
The Turriculinae

The turriculinid subfamily group is represented in Australian waters by four genera, *Turricula*, *Paradrillia*, *Comitas*, and *Leucosyrinx*. A common shell at Broome,

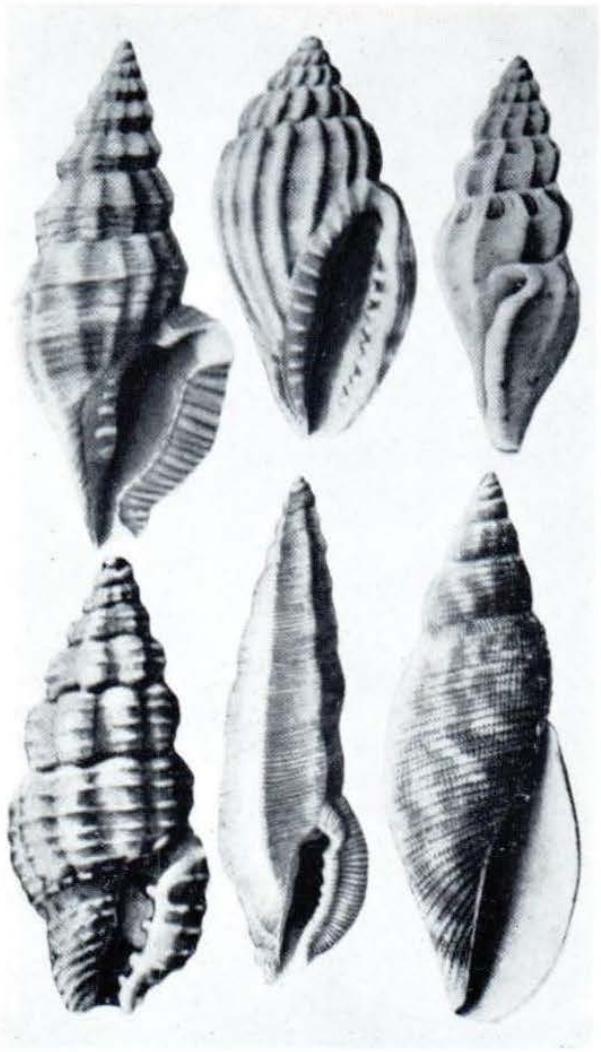
Western Australia, is *Turricula nelliae granobalteus*, a regional subspecies of the typical subspecies, which occurs at Mauritius; another subspecies, *spurius*, is widespread from the Persian Gulf to Japan. Another genus of this subfamily, *Paradrillia*, has a deceptive resemblance to a clavinid, and it also occurs abundantly in shallow water from the Persian Gulf to Japan. Quite recently a member of this genus, *P. inconstans prunulum*, has been noted from north Queensland localities. Both of the genera *Turricula* and *Paradrillia* have an operculum which is ovate with a medio-lateral nucleus, but in the genera *Comitas* and *Leucosyrinx* the operculum is leaf-shaped with a terminal nucleus. A large shell, *Comitas murrawolga*, from deep water off the east Australian coast, is most closely allied to *C. kaderlyi* from Japan. The *Leucosyrinx* is a newly discovered and spectacular species, from 70–100 fathoms in south Queensland waters, and its description and name will be published shortly by the author of this article. The type species of the genus comes from the southeastern United States, but there are members in the deep ocean basins of most seas, including the Antarctic.



Widespread members of the subfamily Turrinae found in tropical Australian waters. Top row (from left): *Lophiotoma acuta* (Perry), Moreton Bay, Queensland; pale form of same from North West Island, Queensland; *Xenuroturris cingulifera* (Lamarck), north Queensland. Bottom (from left): *Lophiotoma* (*Lophioturris*) *indica* (Röding), Mackay, Queensland, and *Gemmula* (*Unedogemmula*) *unedo* (Kiener), Queensland, a well-known Japanese and Persian Gulf shell.



Top row (from left): *Inquisitor formidabilis* Hedley, Yeppoon, Queensland; *Inquisitor sterrhus* (Smith), Moreton Bay, Queensland; *Vexitomina metcalfei* (Angas), Port Jackson, New South Wales. Centre (from left): *Splendrillia woodsi* (Beddome), off Cronulla, N.S.W., and *Turridrupa acutigemmata* (Smith), north Queensland. Bottom row (from left): *Epidirona hedleyi* (Iredale), Port Jackson; *Epidirona quoyi* (Desmoulins), Western Port, Victoria; *Bathytoma* (*Micantapex*) *agnata* (Hedley and Petterd), off Cape Moreton, Queensland, in 100 fathoms. (*Epidirona* and *Turridrupa* are Turrinae, *Bathytoma* is Borsoniinae, *Vexitomina* is Turriculinae, *Inquisitor* and *Splendrillia* are Clavinae).



Some of the drawings by Phyllis F. Clarke in Charles Hedley's 1922 paper on Australian turrids. Top row (from left): *Etrema curtisiana* Hedley, Port Curtis, Queensland; *Eucithara brocha* Hedley, Thursday Island, Queensland; *Guraleus pictus* (Adams and Angas), Port Jackson, New South Wales. Bottom row (from left): *Lienardia mighelsi* Iredale and Tomlin, north Queensland; *Pseudoraphitoma axicula* Hedley, Torres Strait; *Daphnella botanica*, Port Jackson. (All are Mangeliinae except the last-mentioned, which belongs to the type genus of the Daphnellinae).

The Turrinae

The subfamily Turrinae contains the larger and more spectacular members of the family, and quite recently new records for Australia of well-known Indo-Pacific species have been located in north Queensland waters, mostly incidental to commercial fishing enterprises. They are the slender and speckled *Turris crispa*, which attains a length of 6 inches; the brilliantly maculated *T. spectabilis*, also wide-ranging in the Indo-Pacific; the somewhat similar but shorter-based *T. undosa*, and, most recently, the heavily spirally-ridged *T. annulata*. Two of the best-known shells of this subfamily are *Lophiotoma acuta*, common on the sandy flats in north Queensland and with a very extensive Indo-Pacific range, and *Lophiotoma* (*Lophioturris*) *indica*, which is rather common in northern Australian waters and also has a considerable Indo-Pacific range. Although similar in adult features, these two shells have very different protoconchs, that of the former being multispiral and sculptured, that of the latter paucispiral and smooth. Other species, very similar to *Lophiotoma*, have the peripheral keel conspicously granose, and these, appropriately, belong to the genus *Gemmula*. A New South Wales member is the deep-water *G. hawleyi*, and in Queensland waters the well-known Asiatic *G. kieneri* has recently appeared. A deceptive member, *G.* (*Unedogemmula*) *unedo*, recently recorded from Queensland, is a common shell in Asiatic waters, particularly Japan. At first glance it appears to be a *Lophiotoma*, but has the keel of the early whorls gemmulose as in *Gemmula*. Another deceptive member is *Xenuroturris cingulifera*, which, with its truncated base, looks like a clavinid, but otherwise is close to *Lophiotoma*. Another surprise inclusion in the typical subfamily is *Turridrupa*, a small solid shell, very like a clavinid except for the sinus, which is at the end of a bisecting spiral rib on the shoulder slope. The dentition of this genus decides its position within the Turrinae. Two other genera characteristic of the deeper waters of southeastern Australia are *Epidirella* (which resembles *Gemmula*) and *Epidirona*, one member of which, *E. hedleyi*, is a common shell in Sydney Harbour. The latter genus resembles the clavinids except that both the sinus and the radula suggest location in the typical subgenus.

The Borsoniinae

This subfamily is more strongly represented in the Australian Tertiary than in the Recent fauna. A characteristic living member is *Bathytoma* (*Micantapex*) *agnata*, from the deeper waters of the east Australian continental shelf.

The Clavinae

The clavinids are represented throughout Australia by quite a number of genera, typical examples being the smooth, glossy *Splendrillia woodsi;* the small, vertically-ribbed *Austrodrillia angasi*, a common Sydney shallow-water species; and the larger Queensland shell, *Inquisitor sterrha*. In this subfamily both the prototypic and the toxoglossate types of dentition are encountered; *Splendrillia* has prototypic dentition and *Inquisitor* that of paired marginals only.

The Conorbiinae

This subfamily is represented in Australian waters by the deep-water *Benthofascis* only, a genus often referred to as the most cone-like of the turrids.

The Mangeliinae

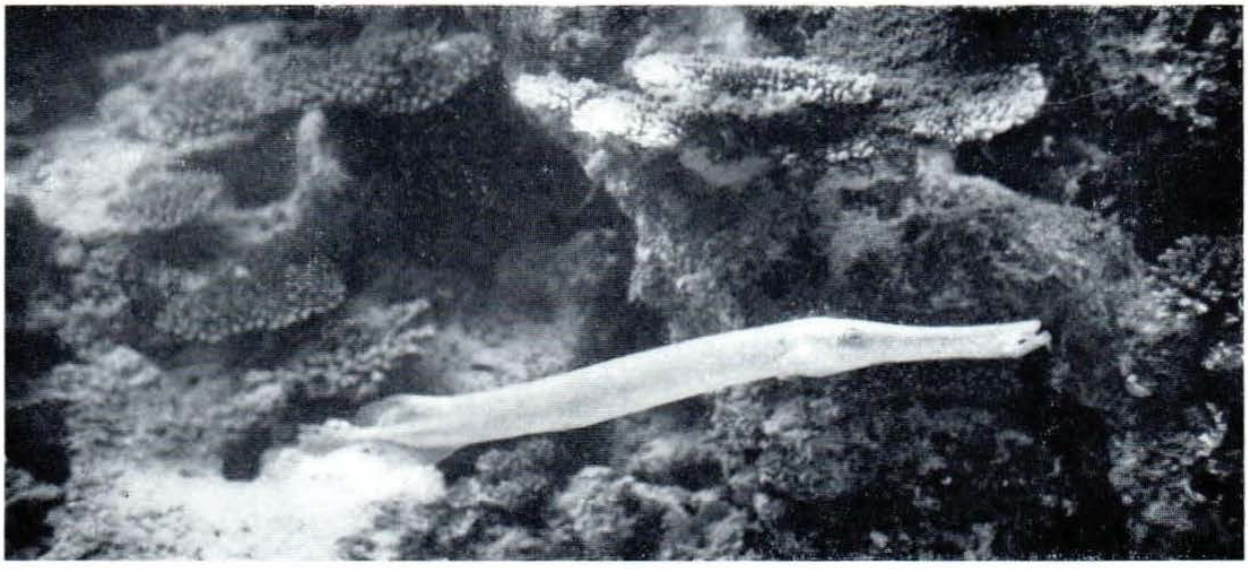
The Mangeliinae are all of small size and so variable in their features that generalization only is possible within the scope of this article. Mr Charles Hedley did excellent work on this difficult subfamily, which is composed of a large number of genera, the most commonly encountered ones in Australian waters being *Guraleus*, *Macteola*, *Eucithara*, *Pseudoraphitoma*, *Lienardia*, and *Etrema*. Some are spindle-shaped, with a thin outer-lip and a very slight sinus (*Guraleus*); others are either stout short-spired shells with a long narrow aperture, frequently armed with denticles or plications (*Eucithara*), or long slender-spired ones with a deep rounded sinus and a strengthened outer-lip (*Etrema*). The genus *Pseudoraphitoma* has a striking arrangement of its ribs, which line up from whorl to whorl.

The Daphnellinae

Again, this is a large subfamily, and one always characterized by a diagonally cancellated protoconch and a distinctive sinus which is sutural and of reversed L-shape. The attractive little *Daphnella botanica is* not uncommon in the shallow waters of New South Wales, and in addition some fourteen genera represent the subfamily in Australian waters.

[*Photos in this article are by the author, except where stated otherwise.*]

SPINY-BACKED TRUMPET FISH



Exemplifying the unusual in fish shapes, the Spiny-backed Trumpet Fish or Painted Flutemouth (*Aulostomus chinensis*) has the habit of swimming next to the dorsal profile of some larger fish, such as a parrot fish. Smaller fish, attracted to the food disturbed by the parrot fish's feeding, are then preyed upon by the Trumpet Fish, which darts out from its semi-camouflaged position. The Trumpet Fish also has the ability to change colours readily to suit its needs, some being lemon-yellow, others dull brown. This underwater photo of a specimen almost 2 feet long was taken at Heron Island, on the Great Barrier Reef, by I. Smith.

Head-hunters in the Western District, Papua

By ROY D. MACKAY
Preparator-in-Charge, Papua and New Guinea Museum, Port Moresby, Papua

RECENT newspaper and radio accounts of raids by head-hunters and cannibalism in the Nomad River area of the Western District, Papua, bring to our notice that there is still a part of the world where life is truly primitive. The stories of head-hunters which we read as boys have the ring of truth when one sees a fresh trophy skull perched on a shelf at the entrance of a house only 20 miles from a Government Patrol Post.

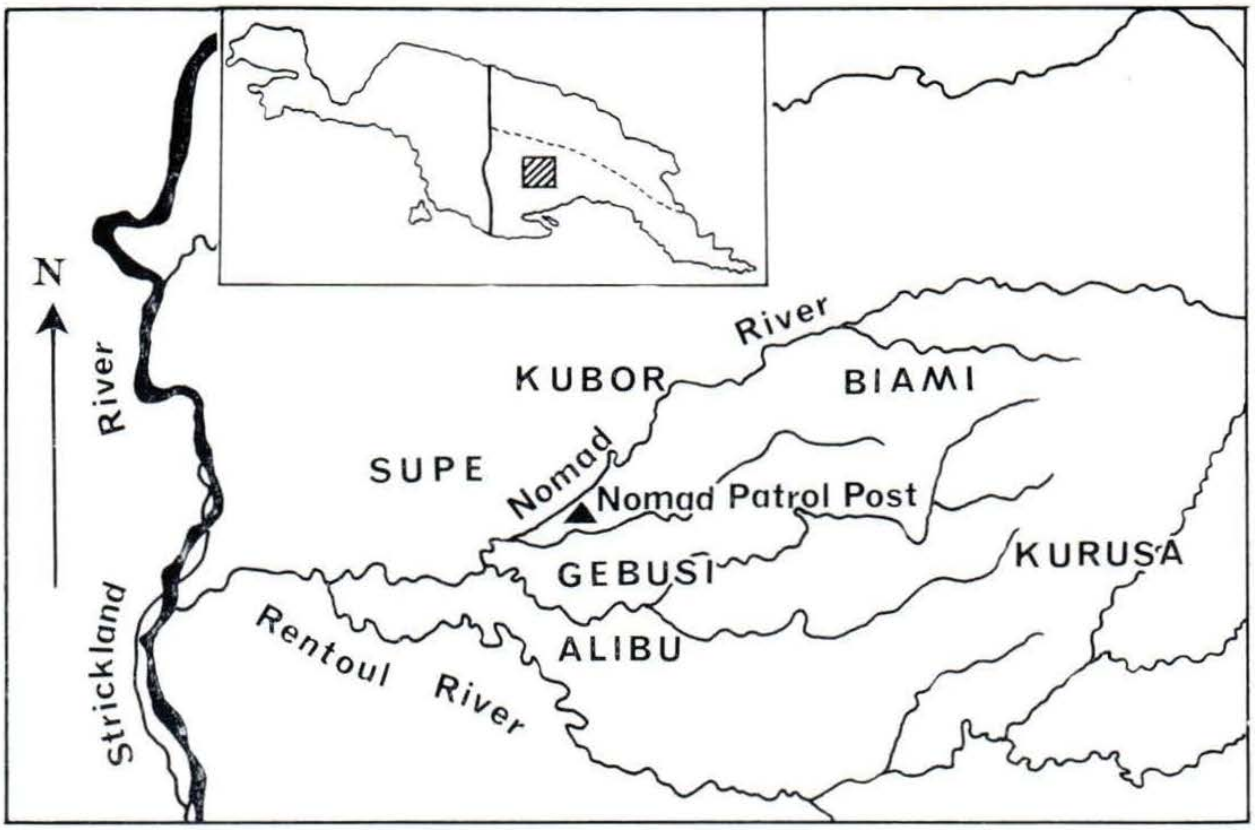
Nomad River Patrol Post was established in the heart of the head-hunters' territory only 6 years ago. It is set on the banks o the Nomad River, about 10 miles from its junction with the Rentoul, a tributary of the Strickland, and almost 200 miles from the south coast of New Guinea. From the air, an almost unbroken sea of rainforest stretches away in every direction. Near the patrol post the ground is slightly undulating and dissected by myriads of creeks and fast-flowing streams. Patches of secondary growth denote old village sites. Open spaces of up to half a mile square, where one or two communal houses and extensive gardens can be seen, are the only other breaks in the primeval rainforest. To the east and northeast the ground rises from about 350 feet near Nomad River to unmapped 9,000 feet limestone ranges on the edge of the Southern Highlands district, 40 miles away.

This area and territory to the north, west and southeast are the land of the Biami and its subtribes—the Supe, Gebusi, Bibua, Kubor, Alibu, Dinuk, Sonia, Orogo, and Karusa. Each subtribe has its own dialect of the Biami language. Many words are common to all subtribes, other words are entirely different, and others are embellished with prefixes or suffixes. Each subtribe lives in mortal fear of another subtribe, and sometimes even communities only 10 miles apart will not visit each other for fear of being waylaid on the journey.

A young head-hunter from the Nomad River area.

The village unit

Separate houses are not built for separate families. One or two communal houses make a village and may house one family or several, so that one communal house may shelter sixty or more people. The communal house is built to a standard pattern, with subtractions in the smaller hamlets. Similar



The Nomad River area, showing locations of tribal groups. Inset: the location of the Nomad River area.

houses are to be found on the south side of Mt Bosavi, 50 miles to the southeast, but they are raised off the ground and are hump-roofed. In the Nomad River area the houses are built on the ground and the roof ridge is straight. The men's sleeping quarters and discussion platform are raised to a higher level than the sleeping quarters of the women and children and are reached by a log ladder from the communal kitchen area, which is on ground-level. Small smouldering fires are kept going between sleepers at night, for the nights can be cool despite the low altitude and tropical environment. The discussion platform and lookout are usually the highest sections of the house, with a view over the gardens and approaches. The front of the house is kept clear of bushes and cover so that there is less less likelihood of being taken unawares by a stealthy enemy.

Food

The Biamis are, in the broad sense, shifting agriculturalists with a diet based on bananas, taro, sweet potato, and sago. Gardens of up to 100 acres are cut out of the forest. The larger gardens are usually maintained for several years. The smaller hamlets or communal groups with gardens of maybe 2 acres will shift to a new spot within 3 to 5 years.

Hunting and fishing are carried out on a small scale, particularly in the remoter areas, where it is unwise to venture far from home. The cassowary, Goura pigeon, hornbill, various fruit pigeons, fish, tortoises, and crocodiles are eaten with rare relish.

Birds of Paradise are in abundance in the area. The plumes do not have the same importance as they do in the highlands, and even the highlanders have not ventured into this area to trade for plumes or cassowary chicks.

Great cakes of sago are wrapped in bark sheaths or leaves and stored on shelves in the communal house, alongside taro, sweet potato, and many bamboo tubes of water.

Pigs are highly valued but are not very common in the area.

The front of a communal house in the Nomad River area. Extra logs are placed across the entrance in the evening to seal it.

The stone adze is still the main tool for garden clearing, house construction, and chopping firewood. Men will keep a particular sharpening stone for years on end and will take it with them when moving to a new house. A photograph on page 11 shows how the adze blade is held when being sharpened—not edge-away, as we sharpen a chisel. A little stone is gathered in the area for tool making, but most is traded from the north through the Strickland Gorge. A little comes through from Tari in the Southern Highlands.

Steel axes and bush knives are gradually replacing the stone adze. Steel has a very high value. One month's work at a patrol post is rewarded with a steel axe-blade. Its value may be gauged by the fact that several successful raids have been made on stores of axes and bush knives near outposts of civilization in this area.

Stone clubs are a feature here, but apparently they are not made any more. There are several styles, from simple disc-headed clubs to ball-headed, star-headed or double-star-headed clubs. No "pineapple" club heads were seen here.

Bows and arrows are the hunting weapons, with variously tipped arrows. Simple points, heavily serrated multiple points for fishing, and broad bamboo blades for pig and man killing are the main types of arrow heads. Bows are of Black Palm and "strings" are of strips of bamboo. No shields are used.

Clothing

Men wear a short grass or string sporran in front, and behind is a bustle-like skirt of successive layers of grass fibre. Sometimes the skirt is adorned with soft bark fibre tassels which are hooked onto the bark belt worn around the waist. These bark belts, about 9 inches wide, are worn partly for decoration and partly as protection against arrows. They are often decorated with fine cane binding and painted ochre patterns.

Necklaces of various kinds, using string, grass seeds, cassowary wing quills and cowry shells, are worn simply round the neck or in bandolier fashion. The shells are traded from people in the east, and it seems that they may come from the Kikori River route on the east side of Mt Bosavi. Some come from the people near Lake Kutubu.

Ear-rings are often worn. Seeds and sections of cassowary wing quills are sewn together with string or threaded onto a feather shaft and looped through a hole pierced in the ear.

For nose ornaments, the septum of the nose is pierced and, at first, a thin piece of bamboo is fitted. The smallest children may wear these. As the children grow, larger pieces of bamboo are inserted until a short length, about three-quarters of an inch in diameter, is fitted. Women also wear the nose ornament. One enterprising fellow I met had picked up one of my spent

12-gauge cartridges and fitted that in his nose septum! Cassowary leg bones used to be cut for this adornment, and the Papua and New Guinea Museum has a series of these from about three-quarters of an inch to almost 1 inch in diameter.

Women mostly wear string skirts (wogoe) in front and behind, but occasionally grass skirts are worn. Usually a bark cloak is worn either over the shoulders or over the string skirt. Women and girls are hardly ever without a string bag, the string being made from the fibres of sago palm leaf. Other fibres are used for other strings for different purposes.

Armbands are used by all. The men find them useful for tucking in tobacco leaf or a cassowary bone dagger.

On this basic dress are several variations and additions, such as headbands of seeds, string, sections of cassowary wing quills, and cuscus fur. Head-dresses are worn frequently, and especially at times of dancing and ceremonies. Bird of Paradise plumes feature little in these adornments, but the feathers of the cassowary and White Cockatoo are commonly used. Extra tassels and a stiff piece of bark, painted in reds and yellow and frayed at one end, are hooked onto the bark belt, extra necklaces and anklets are put on, and the body is painted in red, yellow, and black in long lines from shoulder to midriff; then a man is in full dress. Tortoise-shells are painted and either hung on the body or displayed by hand at the "sing-sings". Oil from a certain tree (*Campnosperma brevipetiolata*) is rubbed into the hair and over the body.

These people never intentionally wash themselves. The women "beautify" themselves regularly with oil and charcoal rubbed onto the body, arms, and legs.

Death and sorcery

The death of anyone in the community is generally regarded as the work of evil spirits, though if murder is suspected they have their methods of "bush justice" to bring the killer to the ground, literally.

The deceased is propped up inside the communal house while friends and relatives come to mourn and wail over the body. This may take a week in the case of a high personage. At this stage, of course, the corpse is bloated and festering. The mourners and wailers slough off the skin and rub it onto their own bodies, sometimes mixing it with charcoal into a paste to spread

Women and children sleep in a separate section of the communal house.

The adze blade is sharpened with the edge towards the workman.

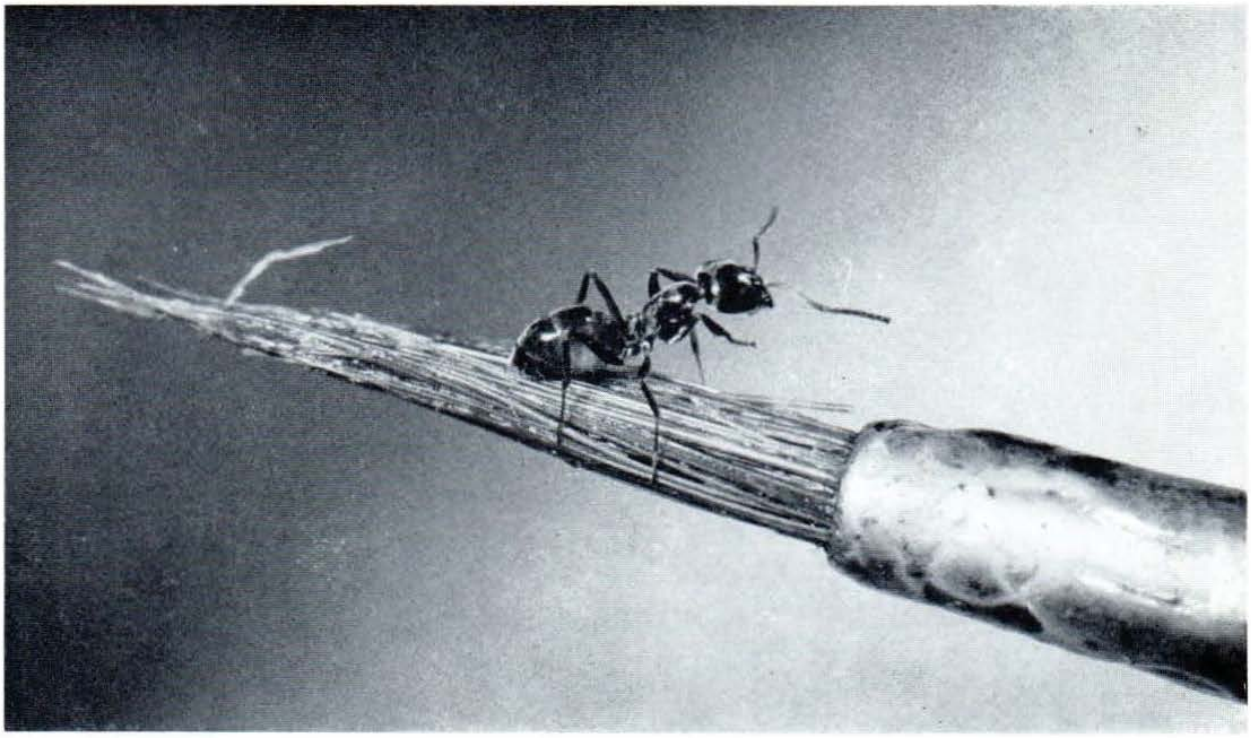
on their arms and legs. After the required time the corpse is taken outside and placed on a sloping platform several yards away from the house—though not too far. The corpse then putrefies and falls away until only the skeleton is left. The bones are collected and hung up outside the house in a string bag or in a specially made canework basket. All the worldly possessions of the deceased are then draped on a small cross-trees immediately outside the house. Bananas, sugar cane or other food is hung with these things to feed the departing spirit on its journey to the hereafter.

If a murder is suspected, everyone in the community and nearby friendly villages is asked to come and pay their respects to the departed. Theoretically the murderer, confronted by his victim, shakes with fright and urinates freely, and so gives himself away. This man is then watched and discreetly disposed of.

Sorcery is practised here as much as anywhere else in the Territory and has as many forms of operation. A man from Tserapobi village, on the border between the Gebusi subtribe and the Biami, described one of the methods of sorcery practised in this area which is akin to sorcery practices in much of western Papua. An intended victim is watched for some time until some of his faeces or hair can be collected. This is burnt and mixed with his food. He is then made aware that he has been singled out. He becomes sick, goes mad, and dies. The sorcerer, if found out, is killed by outright stabbing or beheading.

Life is very precarious at Nomad, though the peace enforced by the white man is fast bringing security to these people. No doubt within the next 5 years the children will be going to school to become the next generation of doctors, teachers, farmers, engineers, or politicians. A Biami head-hunter's child from the stone age to a highly sophisticated man in, say, 25 years? It can be done.

[*The photos in this article are by the author. The map is by the author and Elvie Brown.*]



An Argentine ant worker, magnified 10 times. [Photo: C. V. Turner.]

ARGENTINE ANTS

By G. PASFIELD
Chief Entomologist, Department of Agriculture, New South Wales

[Research results of experimental work are being prepared for publication in collaboration with Mr T. Greaves, Senior Research Scientist, CSIRO.]

ARGENTINE ants, the world's worst ant pests, are brown ants about an eighth of an inch long (the workers) which travel in well defined trails to and from their nests. They do not have a formic acid smell when crushed, but may have a rather musty odour. They are not easily distinguished from many other species of small brown ants, but the fact that the thorax is 2¼ times as long as the width of the pronotum (top of the first segment of the thorax), is a reliable guide.

The Argentine ant (*Iridomyrmex humilis*, Mayr) was first described in Buenos Aires, Argentina, in 1866, and occurs in other South American countries. Since being introduced into North America at New Orleans by coffee ships from Brazil (their native habitat, according to some research workers) about 1888, they have become a major pest in the United States of America, infesting some thousands of square miles. They are also present in Europe, Britain, Canary Islands, Madeira, South Africa, Hawaii, and Australia.

First record in Australia

Their first record in Australia was from Balwyn, a suburb of Melbourne, in 1939. In 1941 they were recorded from Perth and Albany, Western Australia. Then in April, 1950, they were found at North Auburn, a suburb of Sydney. From the extent of the infestations found in these places it was obvious that they must have been present for many years before being reported. The more than 70 square miles of infestation in Western Australia are spread widely through town and country areas of the Southwest

Land Zone. In Victoria the 15 to 20 square miles of infestation are confined largely to Melbourne, but infestations have been found in Wangaratta and Sale. New South Wales' 11½ square miles of infestation (300 separate infestations) have been in the Sydney area except for three infestations in the Wollongong area and one at Oak Flats, just south of Wollongong. One small infestation was found in a sweets factory in Hobart in 1951, but this was eradicated and no other infestations have been recorded in Tasmania.

Like other ants, Argentine ants are social insects and their colonies contain queens, males, and workers and a brood consisting of eggs, larvae, and pupae. Life-history studies in America have demonstrated that the pearly-white elliptical eggs take from 12 days to nearly 2 months to hatch, while the larval stage may take from 11 to 60 days and the pupal period 10 to 25 days. The minimum period from egg to adult is about 1 month, but it may take 4 to 5 months and averages about 2½ months.

The adult winged males, which are somewhat larger than the worker ants but much smaller than the winged virgin queens, usually fertilize the queens in the nest, as the nuptial flight which is so common with other ants is very unusual with these. After fertilization, the queens lose their wings and begin laying thirty or more eggs per day and may live for several years. The largest increase in colony population takes place in the midsummer to early autumn period and it is then that most complaints are received from householders, as the peak of activity is reached during hot, humid weather.

Nests near food sources

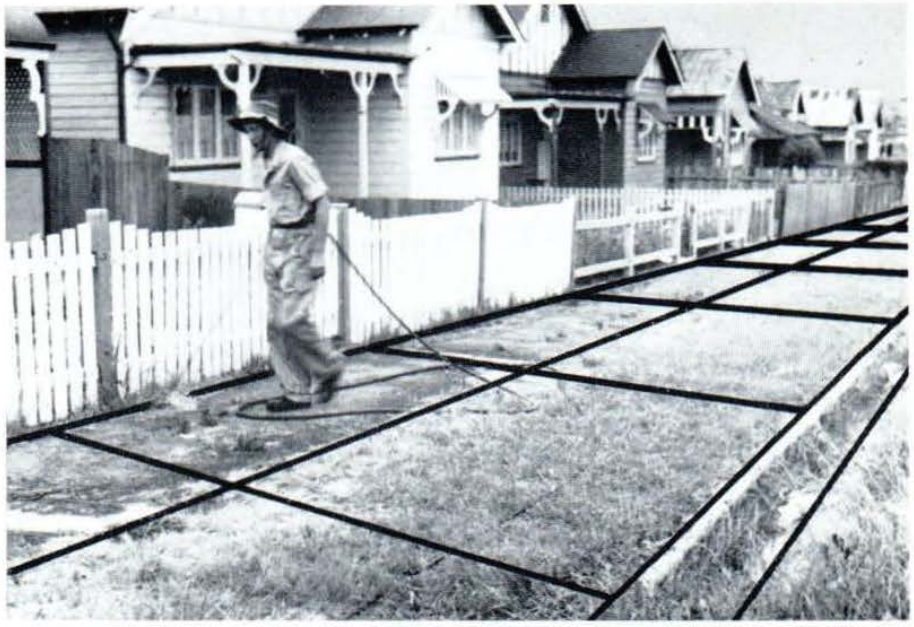
Nests, which are usually very shallow and no more than 6 inches deep, are largely found close to food sources, but they are very seldom established inside or under buildings. The most preferred sites are under pieces of iron, brick, stone, or waste cloth or paper, under garbage cans, at the base of shrubs and trees, in damaged timber, in pot plants, compost heaps, manure and raised areas of soil or sand, in garbage tips, alongside paths, gutters and kerbings, in lawns, gardens, etc. Soil types appear to have no limitation on the establishment of Argentine ants. The population of a colony may vary from a dozen or so to many thousands and the number of queens in it from one to many hundreds.

Their natural spread is fairly slow—a maximum of 300 yards per year in Sydney—and it is mainly by artificial means that they have been transported and become widespread throughout the world. They can establish themselves in a great variety of containers, materials, and goods, but it is thought that loads of soil or firewood from infested areas play a big part in their spread and establishment. It should be noted that they can survive immersion in water on floating debris for considerable periods. Investigation has indicated that it takes at least 4 years for a new infestation to build up to 1 acre in area.

Major household pest

Once they become established in a locality they will not tolerate other species of ants generally, and as their populations build up in density they move out on a front in all directions, consolidating as they go, and driving other species before them. They become extremely numerous within these well defined areas of infestation and it is because of their numbers and their great persistence that they are regarded as the

A trail of Argentine ants from a nest under a garbage bin. [Photo: A. Searle.]



Grid spraying on a footpath for Argentine ant eradication. (The lines painted on the photo show where the actual grid lines were marked on the footpath.) [Photo: A. Searle.]

world's worst ant pest and one of the major household pests.

They are practically omnivorous in their feeding habits and may infest all rooms in houses or buildings in their quest for sweet or fatty food. In the orchard and garden they protect sap-sucking insects from their natural enemies and can be a serious agricultural pest. They are also important pests of apiaries, poultry farms, and aviaries in some areas.

Following their discovery in Sydney, early research indicated that 2 per cent chlordane spray was the most promising insecticide for controlling them. Subsequent experimental work performed in co-operation with Mr T. Greaves, Senior Research Scientist, Division of Entomology, CSIRO, confirmed the efficiency of this spray and demonstrated that, when it was applied in a specially-devised, open-grid pattern, Argentine Ants could be eradicated from small areas of infestation. It was also determined that certain of their habits made them unusually favourable subjects for eradication, and these were:

- Where Argentine ants are established they become numerous and very obvious.
- The steady expansion of existing areas of infestation is easily observed. It is thus easy to determine the limits of each infestation.
- Flying swarms are rarely produced.
- Within the infested areas, the queens as well as the workers may move about freely. Consequently, efficient results can be obtained without treating each individual nest.
- Their shallow nesting habits make them susceptible to surface spray treatment with insecticides such as chlordane.

Experimental eradication campaign

An experimental eradication campaign was conducted by the New South Wales Department of Agriculture in co-operation with CSIRO between 1952 and 1959. This demonstrated the practicability of eradicating Argentine ants from large areas of infestation. Although 2 per cent chlordane spray was used initially, it was later replaced by 0·75 per cent dieldrin spray because of problems associated with the importation of chlordane at that time.

As a result of this successful experiment, the New South Wales Government passed the Argentine Ant Eradication Act in 1962, and under the provisions of the Act, which is the responsibility of the Minister for Local Government, it is proposed to eradicate Argentine ants from all infested areas in Sydney and Wollongong. Local councils contribute $2 for every $1 by the Government to finance the campaign and councils also pay for the cost of spray materials. This campaign has proceeded satisfactorily

and it is anticipated that all known areas of infestation will have been sprayed by early 1968. Since 1952 about $350,000 has been spent on eradication.

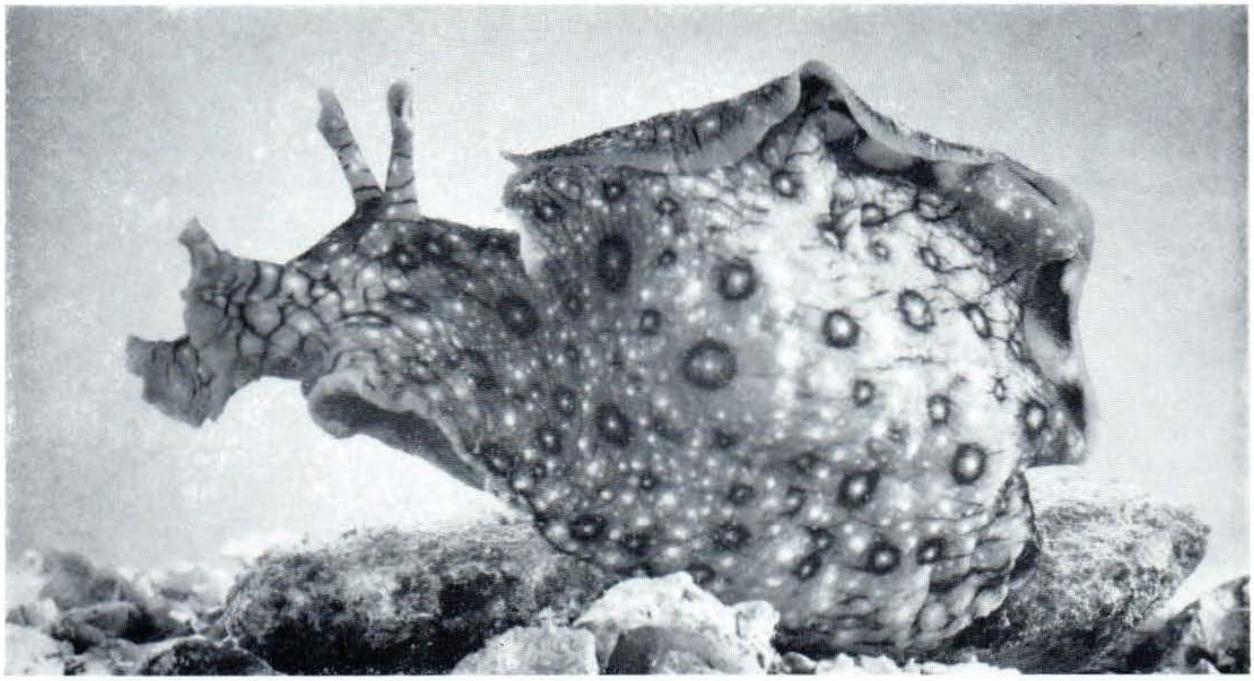
Publicity is now the most important factor; special attention is being given to it because the successful completion of the eradication campaign is naturally dependent upon finding all infested areas, as the method of eradication has been demonstrated to be practicable. Chlordane is again being used because it is safer to apply than dieldrin and can now be obtained readily.

In Western Australia some 45,000 acres or more of infestation have been sprayed since 1954 at a cost of about $1,500,000 to *control* Argentine Ants. Although eradication has not been achieved, nor was it expected, the main objective of the control campaign—to remove the Argentine ant as a general menace from metropolitan and country districts—has been achieved.

In Victoria it is understood that the Argentine ant problem has been left to the householder and local councils and is continuing to spread, but not very quickly.

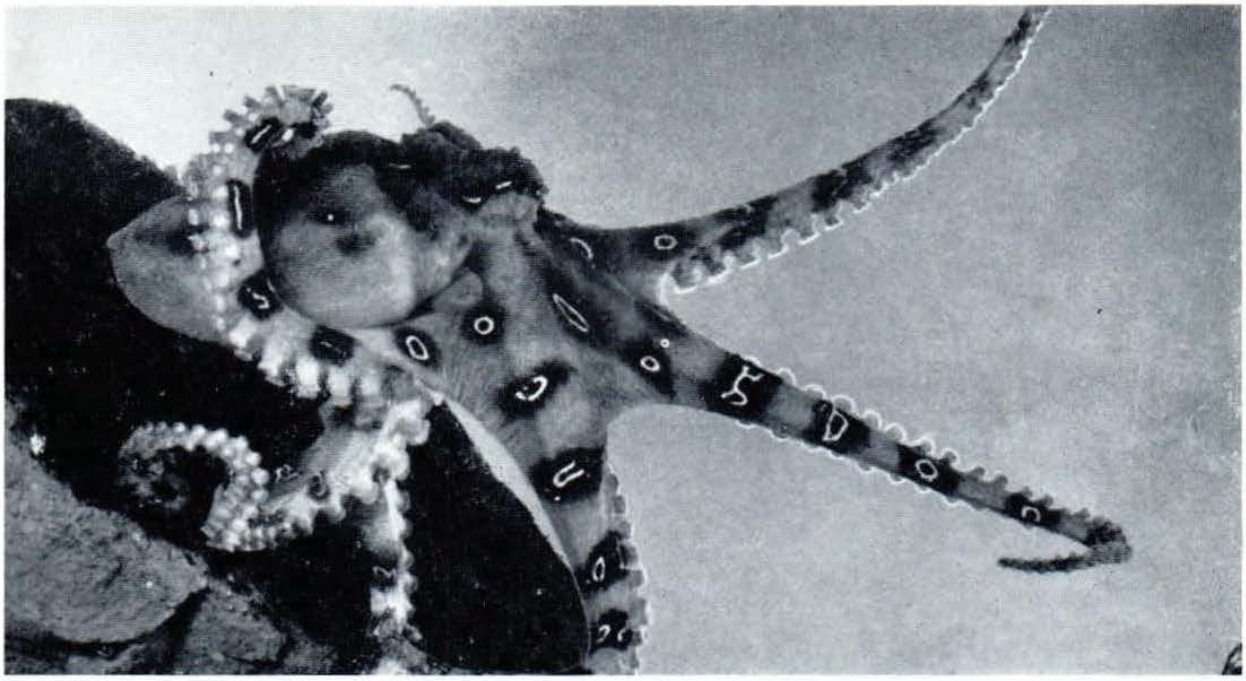
Dealing with Argentine ants is a community matter because sporadic and unrelated action, although giving some temporary relief, will not contain these persistent and annoying pests, and they can only be held at bay by householders by consistent action. The eradication and control campaigns in New South Wales and Western Australia have demonstrated that it is only by meticulous application of the recommended methods that ultimate success can be achieved with such a pest.

Sea-hare from Sydney Harbour

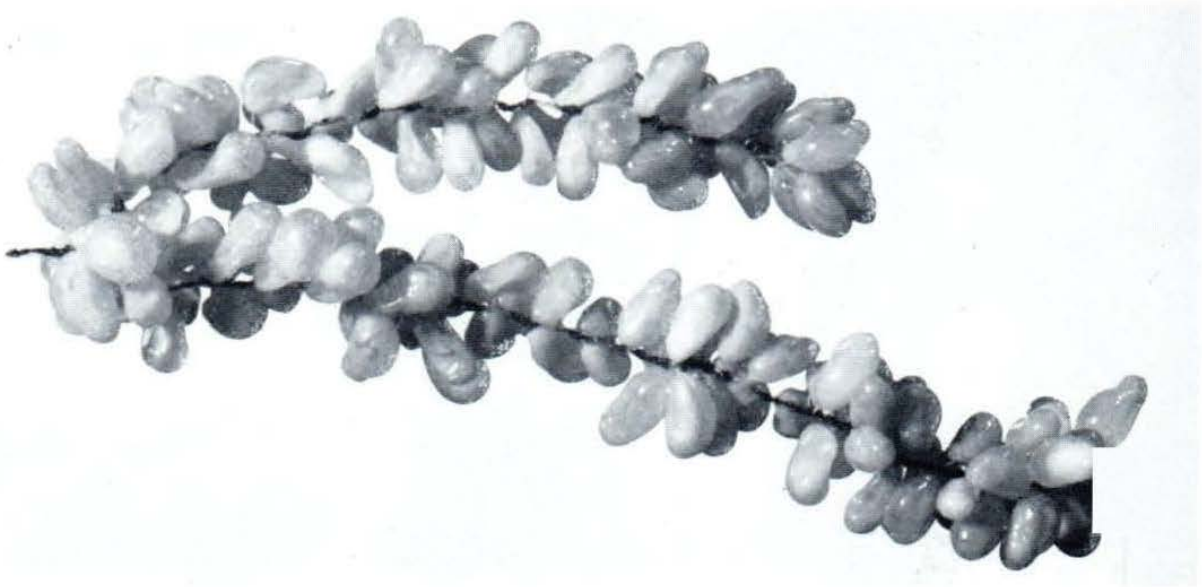


Angas's Sea-hare (*Aplysia dactylomela*), from Sydney Harbour. It is found throughout the warm seas of the world, and in Australia ranges as far south as Sydney, where it is one of the commonest species of sea-hares on the open coast. It is about 6 inches long, and is easily recognized by its dark circular markings and a dark-coloured tail. Sea-hares are opisthobranch molluscs, relatives of the sea-snails, and are so called because of their erect, ear-like rhinophores (seen at left in the above photo), which are sense organs, used to detect changes in the chemical nature of the sea-water in which they live. They have an internal, flatly-coiled, fragile shell. [Photo: Howard Hughes.]

VENOMOUS RINGED OCTOPUS



A young serviceman recently died in Sydney from the bite of a small octopus, *Hapalochlaena maculosa*, a specimen of which is seen above. The popular name Ringed Octopus has been given to this animal because the body is marked by a series of brilliantly blue rings which glow like neon lights. The adult octopus is rarely more than 8 inches across, from arm tip to arm tip, and is not uncommon near or below low-water mark on shore reefs around southern Australia, from Brisbane to Fremantle. Skindivers may find it lurking camouflaged among seaweeds. [Photo: Howard Hughes.] Below: A Ringed Octopus' egg string, which was attached by the adhesive thread at left inside the shell of a dead oyster dredged up by a fisherman in the Manning River estuary, New South Wales. [Photo: C. V. Turner.]—*Elizabeth Pope.*



A mudskipper of the genus *Periophthalmus* (possibly the species *sobrinus*) alongside its nesting burrow in northern Mozambique, east Africa.

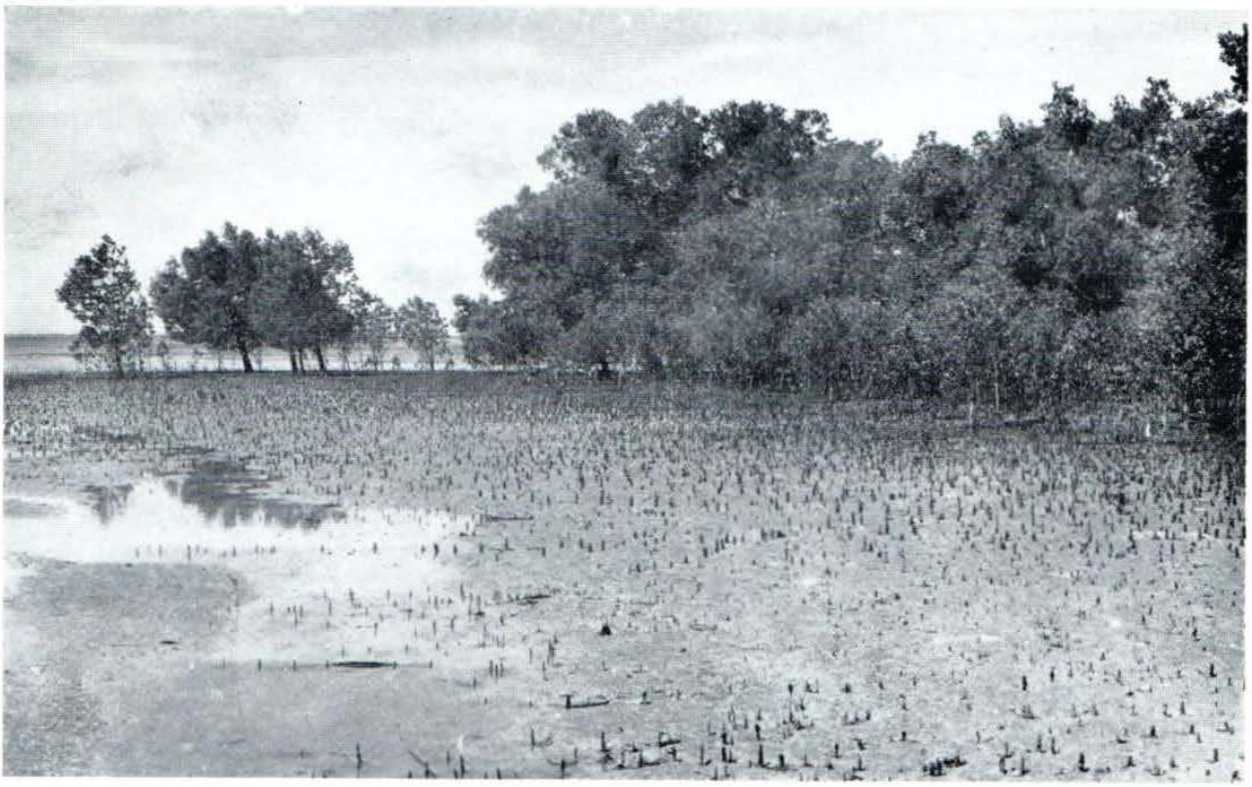
Mangroves and their Fauna

By WILLIAM MACNAE
Senior Lecturer, Department of Zoology, University of Witwatersrand, Johannesberg, South Africa

MANGROVES are trees or shrubs which grow in places submerged from time to time by the sea. They occur between high water of spring tides and a level a little above mean sea-level. They range all round the oceans in the Tropics; on African and Australian coasts and in South China and the Ryukyu Islands a few species reach beyond. They occur only on sheltered shores and penetrate estuaries as far as salt water penetrates.

Mangrove trees vary in height from giants of over 125 feet in the ever-wet of southeast Asia to scrub bushes scarcely waist-high on drought-stricken shores. Some thirty species may be found in the mangrove forests of Malaya and adjacent islands, together with several low-growing bushes and sprawling shrubs. About twenty species of mangrove occur in Queensland and northern Australia; eight reach the African coast. In Australia two species occur in Sydney Harbour and one reaches almost to Melbourne. What are presumably relic forests occur in the South Australian gulfs. In those southernmost and most isolated forests only *Avicennia marina* is present.

Mangrove trees belonging to a few genera only are specialized for their habitat. These specializations involve leathery leaves; a sap with a high osmotic pressure: in *Avicennia*, *Aegiceras*, and others, glands on the leaves to remove excess salt; in many, a range of tannins which seem to assist the tree to exclude salt; pneumatophores on the root system, either prop roots as in *Rhizophora*, knee roots as in *Bruguiera* and *Ceriops*, or pencils sticking up above the soil as in *Avicennia*, *Sonneratia* and others. Many have viviparous fruits—seeds which germinate on the tree, drop off and are ready to affix themselves in a short time when they ground. This may be beneath the parent tree, but if they fall into the high tide they may be carried on the current to grow on freshly deposited mud elsewhere.



A seaward fringe, with the mangrove *Sonneratia alba*, in northern Mozambique. The Fiddler Crab *Uca urvillei* is abundant among the pencil-like root pneumatophores. In Australia the Fiddler Crab *Uca dussumieri* would occur in a similar situation.

Animals of the mangroves

Within the canopy of the trees live animals, mostly derived from the land, including Leaf Monkeys in Malaya, Proboscis Monkeys in Borneo, and several birds. Most of the birds are fishers, such as egrets and other herons, darters, cormorants, sea eagles, and several fishing hawks and kites. Some are crab eaters, such as the Mangrove Kingfishers. Some smaller birds are insectivorous —Mangrove Flycatchers are common in some areas.

A few snails climb into the trees. These are mainly species of *Littorina* which feed on the diatoms, etc., growing on the surface of the leaves and twigs. Such snails tend to be higher in the trees in the seaward fringes than at the back of the mangrove forests.

Crocodiles and Monitor Lizards may be common, but less so than they used to be. In southeast Asia a crab-eating frog is tolerant of brackish water both as tadpole and adult, but the mechanism of adjustment is different. The tadpole adjusts in the manner of a bony fish, the adult in the manner of a shark.

Spectacular insects

Insects may be spectacular. Throughout southeast Asia from Thailand southward, through the Indo-Australian archipelago as far as New Guinea and New Britain, fireflies may show their nightly synchronously-flashing display. This is a magnificent performance, which may be continuous from dusk to dawn. It is clearly an epideictic display with each "fly" in its station and running around in a limited area on a leaf. A newcomer, flashing as he flies, may be out of step with a tree's fireflies, but as soon as he lands he quickly acquires their rhythm. A reduction in numbers flashing occurs as individuals begin to mate. The display occurs along creeks, rivers, and other flightways in the mangrove forests, but chiefly where the willow-like *Sonneratia caseolaris* edges the streams.

Sometimes insects are annoying. Mosquitoes are numerous, and some have curious habits. For example, *Aedes pembaensis* in eastern Africa lays eggs on the chelae of crabs, and the pallid larvae and pupae live in the pool at the base of the

burrow. Others, like *Aedes vigilax*, of the Indo-Australian region, breed in pools left by the tide, the larval and pupal periods being related to the time of survival of the pool. Some mosquitoes feed on mud-skippers, fish lying on the mud alongside the creeks. Tiny midges of the family Ceratopogonidae (often miscalled sandflies) live as larvae in the surface layers of the mud and emerge to annoy any visitor to the mangrove area. Tailor Ants of the genus *Oecophylla* extend into the mangrove area. They use their larvae to sew the leaves together to form the nests, of which one colony may have several in a group of neighbouring trees. They show a predilection for those trees on which scale insects are abundant, such as *Bruguiera* species, *Ceriops* species, *Sonneratia caseolaris*, and occasionally species of *Rhizophora*. Other ants, at present unidentified, live in the drier soils of the *Bruguiera* forests and plug the entrances to the burrows from within just before the tide reaches them.

Crabs abundant

On the ground, crabs are abundant; some burrow in the soil, some shelter under debris lying around on the floor of the forest, and others run around with no apparent choice of any sheltering place. The most abundant are marsh crabs of the genus *Sesarma*. Close on 150 species of this genus have been described. Some of them, like *Sesarma meinerti*, are widespread (this one extends from Pondoland in South Africa to south Queensland but not to New South Wales). Some are local in distribution, including the majority of the smaller species, which run about on the surface seeking shelter or burrowing. *Sesarmas* feed on any debris, plant, or animal, nibble germinating seedlings, and even feed on the soil, which they pick up with their spooned chelae; they manoeuvre the soil with their maxillipeds to remove edible diatoms, etc., and discard the unwanted soil as pseudofaecal pellets.

Fiddler Crabs of the genus *Uca* are abundant. These are gaily coloured crabs, of which the males have one large and one small claw. Some have bodies which are yellowish, or bluish-green, or rich dark blue, or black edged with red, or mottled in several colours; the big claw of some is pink or white, of others orange or yellow or even a bright scarlet. Fiddler Crabs are usually seen on the edges of the forest, along the creeks, or on the bare flats in open sun.

The landward mangrove fringe, with a parkland of old trees of *Avicennia marina*, at Inhaca Island, Mozambique. Under the coarse grass in the foreground is a large population of the Fiddler Crab *Uca lactea* and the marsh crabs *Sesarma eulimene* and *S. ortmanni*; on the trees clusters of the mud whelks *Cerithidea decollata* cling to the shaded sides of the trunks. Similar groves are found south of Townsville in Queensland, with a different series of crabs. *U. lactea* and *U. bellator* are common there, a *Sesarma* runs around and *Cerithidea anticipata* clings to the trunks.

The males are conspicuous with their large claws; the females are less so, for in them both claws are equal in size, similar to the small claw of the male. The large claw is used in territorial display and defence, to threaten wandering males, and to attract potential partners; a little dance usually accompanies the display. All this waving and dancing may be simple or complex, depending on the species. Fiddler Crabs feed by scraping soil particles between the second and first maxillipeds, the soil being picked up by spooned chelipeds and, after scrubbing, being discarded in the form of pseudofaecal pellets. Each species can, as a result of the form of the spooned hairs of the maxillipeds, deal with one size of soil particle, and so each species comes to be restricted in its distribution to one grade of soil. The tolerance of the crabs to temperature also limits distribution. In general, one may say that crabs of the bare open flats are more tolerant of exposure than those which live in the shelter of the trees.

The Fiddler Crab *Uca inversa* beside a heap of its pseudofaecal pellets in Mozambique. This crab was 1 inch across its carapace.

Along the creeks and occasionally in burrows in the forest the swimming or mud crab *Scylla serrata* may be found. This is the best eating of all crabs. It is common all round the Indian Ocean and in New South Wales, and many hundreds of miles up the Yangtse River, China. Everywhere it is the gourmand's choice. In South Africa it reaches up to 9 inches across the carapace, and it reaches a similar size in Queensland. In Ceylon it rarely reaches more than 3 inches, so much is it sought after. Such crabs have been recorded in deep water off Madagascar, and possibly they migrate there to breed.

Another member of the mangrove fauna is the strange mud-lobster *Thalassina anomala*, which is the subject of another article in this issue.

Mudskippers

Four genera of gobioid fishes, commonly known as mudskippers, occur in association with mangroves. *Scartelaos viridis*, the Eel Skipper, occurs on very soft mud towards low water in the bottom of creeks. These are least adapted to an out-of-the-water existence. *Boleophthalmus boddaerti* may be very abundant; it is recorded from Malaya to Australia. This animal is a herbivore, feeding on the diatoms and other algae which live in the surface layers of the mud. It emerges from the water and moves slowly over the mud with a characteristic side-to-side movement of the head as it skims off

A forest of the mangrove *Rhizophora* in peninsular Thailand, at mid-tide. The large trees are *Rhizophora mucronata*, about 150 feet high. Note the abundant regeneration beneath.

A male mudskipper (*Periophthalmus chrysospilos*), in the foreground, turns to display before a female. He then continued on his way towards the camera and into his nest burrow. Photographed in Mozambique by Ivan Polunin.

the surface layers. Then it returns to a pool of water, where it may be seen to wash the material, swallow, and return to the skimming. *Scartelaos* is an omnivore, grabbing little mouthfuls of the surface layers, which contain not only algae but also copepods, etc., of the interstitial fauna. The difference in feeding techniques is of interest. Both these animals show behaviour patterns where they confront one another, but the significance of this is not understood.

Periophthalmodon and *Periophthalmus* are both carnivores. *Periophthalmodon schlosseri* is an ardent hunter which migrates into the mangrove forests as the tide rises. The species of *Periophthalmus* fall into two groups—one with fused pelvic fins and the other with partially fused or unfused pelvic fins. The former group, of which the type species is *P. chrysospilos*, is characteristically found at the seaward fringes and does not penetrate into the forests. As the tide advances they climb up into the trees, clinging in a vertical position to twigs and branches. When about to be submerged they skip off over the surface of the water to another perch. The members of the second group, of which *P. kalolo* is the typical species in the Indo-west-Pacific, cannot do this, but they retreat from the advancing tide into the mangrove forests.

At the nests these groups also behave differently. *P. chrysospilos* (and *Periophthalmodon schlosseri*) excavate "bowls" or "saucers" in the soft mud alongside creeks. *P. kalolo* and others of the group build "turrets"—sometimes single, sometimes twin—further back within the mangrove forests. Both have characteristic display patterns in which the colours of the dorsal fin and of the underside of the chin are conspicuous.

Man's use of mangroves

But what of man, the explorer, the hunter, the modifier, the destroyer? What does he with mangroves? Many remain unexploited, but some have been put to man's service.

The Javanese discovered that they could cut out the trees, use them as firewood, and, where the trees were, create ponds in which fish and prawns could be cultured. These ponds produce the highest return of protein per acre of any area of cultivation in the world. This type of fish culture has spread to the Philippines and other places.

In Malaya mangrove timber is cut in rotation and used as fuel, usually converted to charcoal. A few species only, *Lumnitzera littorea* (as a rosewood) and *Xylocarpus moluccense* (as a mahogany) are used for furniture. In east Africa mangroves were cut by Arab dhow crews and taken to Arabia where, because they are resistant to termite attack, they have formed the basis of an architectural form. The poles, some 15 feet long, form the ceilings of one storey, and, on that ceiling, rubble, etc., is placed to form the floor of the next storey above. This trade is now almost finished.

But with all, we know little about the mangrove association. We know what trees are there, we know some of the animals associated. One wonders why some crabs, snails, and mudskippers extend from Pondoland in southern Africa to Queensland and why others are purely local. Will man really exploit the mangroves' potential to the full or will he scratch, both literally and metaphorically, on the edge?

[*Photos in this article are by the author except where otherwise stated.*]

The mud-lobster (*Thalassina anomala*), showing the large flattened claws used in burrowing. [Photo: Mrs L. Marsh.]

THE MUD-LOBSTER

By ISOBEL BENNETT
Professional Officer, School of Biological Sciences, University of Sydney

ONE of the most characteristic animals of the mangrove swamps of the tropical Indo-Pacific region is the so-called mud-lobster (*Thalassina anomala*). From Malaysia to northern Australia (south to central Queensland), westward to India, and eastward across the Pacific Ocean to the Fijian and Samoan Islands, its large mounds of mud, up to about 2 feet in height, may be seen dotted across the mangrove flats.

This animal belongs to the group Thalassinidea of the class Crustacea, coming between the prawn- and lobster-like marine decapods and the hermit crabs. Along the temperate estuarine shores of eastern Australia a related species, *Callianassa australiensis*, occurs in enormous numbers where the sandy mud is suitable for its burrowing activities. *Callianassa* is highly regarded as fish bait and is captured by means of a specially made hand-pump which is placed over the holes in the sandy mud. A core of mud is sucked up and then pumped out, usually with two or three ghost shrimps, or "yabbies" as the fishermen sometimes call them, being brought up in the mud. (See "They're Good Bait", by T. S. Hailstone, *Australian Natural History*, Vol. XIV, No. 1, March, 1962, page 29.)

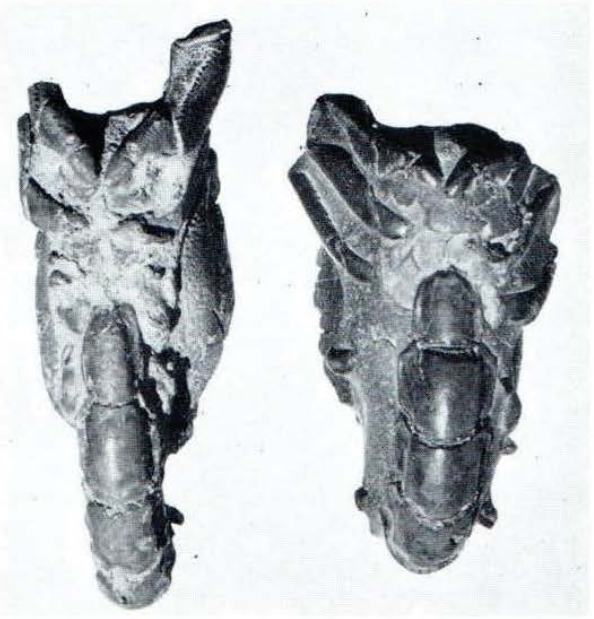
Thalassina is a much larger animal, reaching a length of 10 to 12 inches, and usually reddish in colour. Its activities have a spectacular effect on the surrounding scenery, as may be gathered from the photo of the mounds. The presence of these mud-lobsters must have a marked effect on other

Above: Large mounds of mud thrown up by mud-lobsters on a tropical mangrove flat on the west coast of Viti Levu, Fiji. [Photo: Author.] Below: Two sub-fossil *Thalassina* from northern Australia, viewed from the under side. These are typical of specimens usually found washed out of late Pleistocene to Recent raised beaches, and clearly show the segments of the jointed abdomen bent around under the body. [Photo: Mr Justice Myers.]

animals which normally inhabit this kind of locality, since the substrate is considerably altered by the enormous amounts of mud which these animals turn over in the course of a single year. The burrows beneath the mounds are stated to reach 3 or 4 feet or more below the surface, and the animals remove the mud with their well-developed, flattened and partially claw-like first pair of legs.

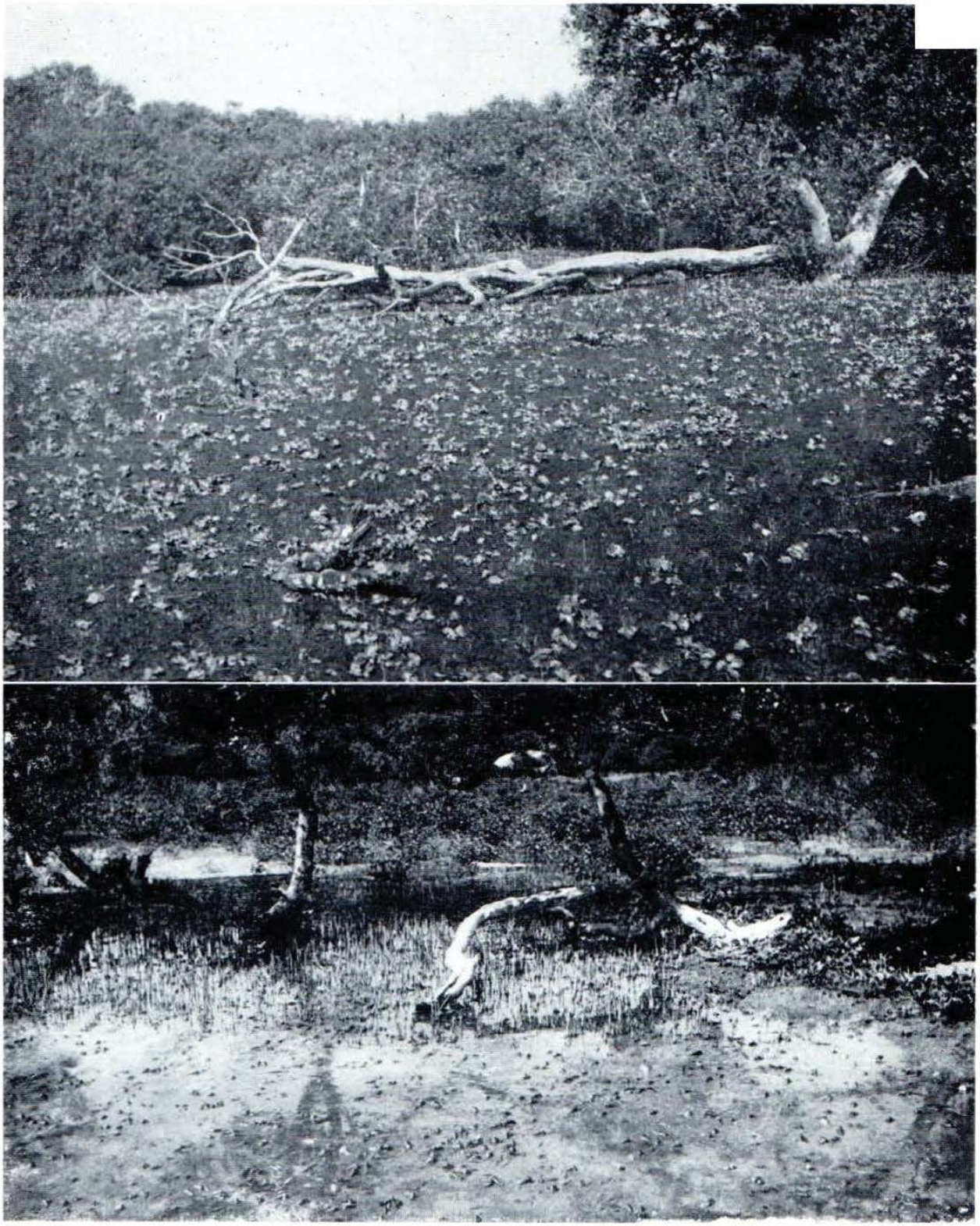
In countries like Malaysia where large areas of land have been converted into culture ponds for fish and prawns, the mud-lobster is regarded as a pest, for it undermines the bund walls of dammed-up areas, considerably weakening them.

Since the animal is seldom seen to venture from its burrow in daylight, except perhaps on rainy days, it is difficult to capture, or to observe its habits, and practically nothing whatever is known of life-history, breeding and feeding. Some authorities have stated that it feeds on terrestrial vegetation, but this has been disputed, for, although the animal has legs well adapted for burrowing, on land its progress is very clumsy and its legs are so placed that they are too weak and helpless to enable it to move far. On the other hand, its mouth-parts are well



adapted for mud-feeding and it appears far more reasonable to assume that, in turning over the huge amounts of mud, the animal is obtaining from it a plentiful supply of organic particles and small living organisms.

Although mud-lobsters are obviously very common in the mangrove flats of northern Australia, it is a curious fact that almost



Mangrove swamps of the warm temperate coast of New South Wales. Tree Mangroves (*Avicennia marina*), with many short vertical breathing roots, and Black Mangroves (*Aegiceras corniculatum*) are seen in both photos, with abundant Rock Oysters (*Saxostrea commercialis*) in the upper photo and with Sydney Whelks (*Pyrazus ebeninus*) in the lower—a very different fauna from that associated with the tropical mangrove swamps frequented by mud-lobsters. [Photos: Author.]

all the published data on this group appears in geological rather than zoological papers.

The first semi-fossilized decapod crustacean recorded from Australia was a mud-lobster described by Professor Thomas Bell, of King's College, London, in 1844, the specimen having been collected by Lieut J. B. Emery, R.N., an officer of H.M.S. *Beagle* during the ship's cruise along the northern and western coasts of Australia between 1837 and 1843.

Since then, many sub-fossil *Thalassina* have been found from northwestern Australia to central Queensland, and it has been these, rather than the living animals, which have supplied the little that is known of their distribution in Australia.

Should any readers find or be able to collect present-day or fossil specimens, or supply any information concerning these animals, the Curator of Crustacea at the Australian Museum would be very pleased to hear from them.

Trapped Butterfly

This Wanderer Butterfly (*Danaus plexippus*), which had settled on a yellow hibiscus flower for the night, was trapped when the flower closed prior to dying off. When removed from the flower the butterfly was found to be one which had been tagged as part of the Australian Museum's study of butterfly migration. [Photo: Athol D'Ombrain.]

BOOK REVIEW

MARINE FISHES OF NEW ZEALAND, by Eric Heath and John Moreland. Published by A. H. and A. W. Reed, Artarmon, New South Wales, 1967. Fifty-six pages, more than 100 coloured figures. Price $2.65.

This book gives an excellent idea of 100 of the sea fishes likely to be encountered in New Zealand. The names, habits, size, food, and fishing methods are itemized for each species by John Moreland, ichthyologist. The coloured illustrations are by the well-known New Zealand artist Eric Heath. Whilst these are not fussily particular as to the exact numbers of rays and spines and scales, as in scientific papers on fishes, they give a dashing idea of the fishes' appearance in life. People in more countries than New Zealand will be grateful for this, because many of the species have not been featured in colour before. Figure 89 shows the Northern Kingfish and 90 the Albacore, not as transposed in the text. Figure 44 of the Yellow Eel seems to have the dorsal fin too far back for a *Gymnothorax*.

Australian and overseas as well as New Zealand readers will benefit from the instructive text. Less than one quarter of all the known marine fishes of New Zealand are dealt with, but we learn that 22 per cent of the whole are native to New Zealand while 31 per cent are shared with southeastern Australia. The deep-sea fishes, cosmopolitan types, and south temperate forms make up the other 47 per cent of which nearly half are species of great depths, only rarely seen. An independent analysis by this reviewer agrees broadly with Moreland's, but awards approximately 35 per cent each to "natives" and the group of cosmopolitan or deep-sea types or stragglers from the tropics.

—*G. P. Whitley.*

VENOMOUS STARFISH IN SYDNEY HARBOUR

By ELIZABETH POPE
Curator of Worms and Echinoderms, Australian Museum

A member of the Australian Museum's staff recently reported that she had been "stung" by a starfish while skindiving in Sydney Harbour.

It happened while she was helping underwater photographer Kevin Deacon to make close-up shots of the rather spectacular species *Plectaster decanus*, known locally as the Mosaic Starfish. This name describes the appearance of the upper surface, which consists of irregular crimson-reddish areas separated from each other by a network of small yellowish spines arranged in close-packed bunches of from twenty to thirty-five or so, all ending bluntly and being the same length.

The Mosaic Starfish is sometimes taken by skindivers near Sydney.

In the living animal the crimson-reddish colour is seen to be due to the presence of numerous soft, fleshy, finger-like projections (papulae) which stick upwards through rounded holes in the tough membrane bridging the areas between the spiny meshwork. Examination of both wet preserved and dry specimens of the starfish has failed to disclose pedicellariae (tiny pincer-equipped organs), sharp spines, or any other organs which might pierce human skin.

However, the victim certainly suffered a tingling sensation in the hand, and the area which had been in contact with the starfish showed a few reddened spots along the inside of the thumb and index finger, where the animal had made contact with the skin. The period of contact was somewhat prolonged, as the starfish had been held while close-up photographs were taken. All this was done under water. The victim was not aware of any "attack" by the starfish until she left the water some 20 minutes or so later. Her fingers began to swell slightly, and itchiness remained for several days and then gradually subsided. There were no after-effects. She was not aware of having handled any animal other than this starfish during the dive.

Plectaster decanus belongs to the echinasterid family and occurs only in the temperate waters of Australia. It is endemic. In this family of the spinulose starfishes the pedicellariae are absent, so one is left guessing as to the means of introduction of venom into the victim. Many starfishes of this family produce toxic mucus, however, and the somewhat prolonged contact with some of this mucus may have irritated the victim's nerve-endings, as evidenced by the reddened spots on the skin.

HONORARY ASSOCIATES

Six new Honorary Associates of the Australian Museum have been elected. They are: Professor N. W. G. Macintosh, Professor of Anatomy at the University of Sydney; Mr Peter Woodhead, Scientific Director of the Heron Island Marine Station; Dr R. Catala, Director of the Aquarium of Noumea; Mr H. O. Fletcher, former Deputy Director and Curator of Fossils at the Australian Museum; Dr D. F. McMichael, former Deputy Director and Curator of Molluscs at the Australian Museum and now Director of the Australian Conservation Foundation; and Mr W. McReaddie, of Gilgandra, New South Wales.

Experiments on the Effects of Radiation on Ants

By S. H. SKAIFE
Past President of the Royal Society of South Africa

TWO grave dangers threaten the world today. One is the population explosion, and the other a nuclear war. Perhaps the one problem may be the answer to the other. If human beings are so insane as to indulge in an atomic war, then the over-population problem will certainly be solved. Bertrand Russell has stated in the House of Lords that, in his opinion, it is a fifty-fifty chance whether anybody will be alive on this earth by the end of the present century—so pessimistic is his view of the results of a major war today.

In the meantime, scientists in various parts of the world are studying the effects of radiation, the effects of those invisible rays that can kill as well as cure. We know today that vertebrate animals—mammals, birds, reptiles and fishes—are much more susceptible to radiation than are the invertebrates. Insects, for example, can withstand doses of several thousand rontgens, whereas a man is killed by a dose of only 400 or 500 rontgens, and we would like to know precisely why.

Ants X-rayed

Five years ago I carried out some experiments on the effects of radiation on ants. These insects are very suitable for such work. They are numerous everywhere and easily collected and kept alive in artificial nests. Their queens, eggs and young stages, as well as workers and soldiers, can be exposed to the harmful rays all together at the same time. Two species were used—the Argentine Ant (*Iridomyrmex humilis*) and the Black Cocktail Ant (*Crematogaster peringueyi*). These were chosen because both are abundant in the neighbourhood of my home at Hout Bay, South Africa. Several small colonies, each consisting of a queen, workers and brood, were made up and housed in plaster of paris nests, and they were well fed on a balanced ration of honey, sugar and glucose solution, scraps of raw meat and dead insects. (Anybody interested in the methods used should consult my book, *The Study of Ants*, published by Longmans in 1961.)

The effects of X-rays on the ants were tested in collaboration with Dr P. M. L. le Roux, the Senior Physiotherapist at Groote Schuur Hospital, near Cape Town. I took my nests to the hospital and Dr le Roux gave them doses of X-rays, putting them under the machines when they were not in use for patients. Various dosages at different rates were given. For example, one colony received 100 rontgens at the rate of 5 rontgens a minute for 20 minutes, while another, placed under a more powerful machine, was dosed at 444 rontgens a minute for 11½ minutes. The ants showed no signs at all of distress while exposed to the rays; they were apparently unaware of them. After treatment the colonies were taken back to my laboratory and carefully tended and watched.

In brief, they showed no signs of having been harmed by the exposure. The queens went on laying normally and the eggs hatched and developed into healthy adults; there were no visible mutations or monstrosities. Only one thing that might be significant was noted. Two lots of about 1,000 worker Argentine ants and two lots of about 500 worker Cocktail ants were made up. One each of these pairs was exposed to a dose of 5,000 rontgens, the other lot serving as a control. Six months later about half the Argentine ants that had been X-rayed were dead, whereas few had died in the control. The death rate among the Cocktail ants was about the same in both lots. It seems, then, that powerful doses of X-rays may shorten the lives of adult ants, but this needs confirmation.

Tests with radio-active iodine

Dr A. M. van Zyl, of the Medical School, University of Cape Town, is a specialist in diseases of the thyroid. He kindly provided me with some radio-active iodine in aqueous

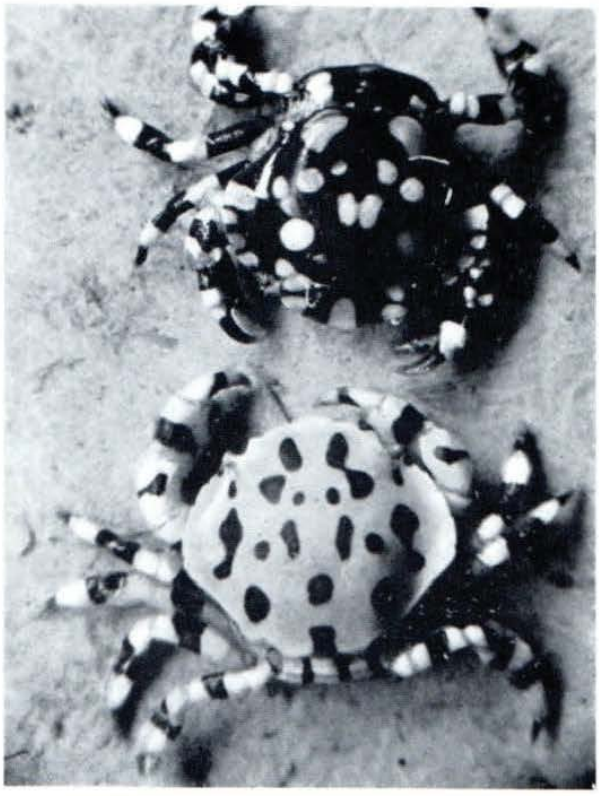
solution. When I added sugar to this solution I found that the ants would eat it freely and in that way they were made radio-active: the Geiger counter ticked away briskly when held over them. Some of them were killed and placed on sensitive film, and the rays from their bodies made imprints on the film. But they showed no signs of any ill-effects. Unfortunately, this experiment could only be carried out for a few weeks owing to shortage of supply of the radio-active iodine.

A few years ago Dr H. B. Kettlewell, of Oxford University, spent a year at Cape Town University experimenting with radio-active phosphorus. He grew some maize plants in pots, using the phosphorus as fertilizer. Then he fed grasshoppers on the radio-active maize and made them radio-active in turn. His idea was to label them with the isotope so that he could trace their movements on the veld. Unfortunately, coming from England, he was unaware of the menace of the Argentine ants and he failed to protect his cages against their attack. The ants got in and killed and ate the grasshoppers. When the Geiger counter was held over the trails of ants near the laboratory it ticked away merrily; the only result of nearly a year's hard work was to make the ants on the campus radio-active.

Will ants inherit the earth?

It seems, then, that if we are guilty of the incredible folly of an atomic war, the higher animals, including ourselves, will be killed off, but the humble creatures of this earth, especially the insects, will survive. If this happens the ants will inherit the earth, for they are the aggressive, dominant invertebrates. Just think for a moment about the Argentine ant. This tiny insect was first discovered 100 years ago near Buenos Aires in South America. It was described and named and then nothing more was heard of it for 25 years, when it was reported as a nuisance in New Orleans, U.S.A., far away from its original home. After this it spread rapidly round the world until today it is a major nuisance in the United States, southern Europe, South Africa and Australia —and it is still extending its range. (An article on the Argentine ant appears on page 12 of this issue.)

"POSITIVE AND NEGATIVE" CRABS



The two harlequin-like, particoloured crabs above were found associated on the surface of a large, black-spotted, brown holothurian or bêche-de-mer, probably *Holothuria marmorata*, at One Tree Island, Capricorn Group, Queensland, by Julie Booth, in October, 1965. The mated pair, a black-patterned white male (below) and a white-patterned black female (above), are small, half-inch-wide, specialized, commensal members of the otherwise largely free-living group, the portunid "swimming crabs", which includes such well-known large commercial forms as the "blue swimmer" and the "mud-crab". The species illustrated here is *Lissocarcinus orbicularis*. It has been recorded intimately associated with several different species of holothurian (either on the outer surface, among the oral tentacles, in the gut, or within the cloaca of the host) from many parts of the Indo-Pacific area, ranging from the east African coast to Hawaii in the eastern Pacific, and from southern Japan in the north, south to Moreton Bay in Australia. The "positive" black-on-white pattern of the male shown here appears to be the more usual coloration, but the "negative", reverse, white-on-black pattern has also been recorded, though the two patterns have apparently not been observed together in the one pair before. In life the black of the harlequin crab is tinged with reddish-brown, and this colour appeared most striking among the large, white-ringed, black spots of the One Tree Island holothurian. [Photo: Julie Booth.]—*J. C. Yaldwyn, Curator of Crustaceans and Coelenterates, Australian Museum.*

The head of a male Ross Seal. [Photo: M. Thurston.]

The Ross and Other Antarctic Seals

By JUDITH E. KING
British Museum (Natural History)

AN article in *Australian Natural History* (March, 1967) dealt with the order Pinnipedia—the seals, sea-lions, and walruses of the world—listed the animals and their distribution, and made particular mention of those that occur around Australian coasts. It was noted that the resident animals on Australian coasts are eared seals, belonging to the family Otariidae, but that some of the earless or true seals of the family Phocidae are occasional visitors. These true seals belong to the subfamily Monachinae, separated from the remaining subfamily Phocinae by numerous skeletal characteristics.

Apart from the more tropical Monk Seals, the Monachinae includes those seals that are normally restricted to the sub-Antarctic and Antarctic regions of the world—the Ross Seal, Weddell Seal, Crabeater Seal, Leopard Seal, and Elephant Seal. Of these, the Leopard Seal (*Hydrurga leptonyx*) is a not infrequent visitor to the shores of New Zealand and Australia, the Elephant Seal (*Mirounga leonina*), Crabeater Seal (*Lobodon carcinophagus*), and Weddell Seal (*Leptonychotes weddelli*) are much less frequent, there being hardly more than a total of a dozen records of them, and the Ross Seal (*Ommatophoca rossi*) has never yet been recorded so far north. All five seals are circumpolar, but only four of them may be counted as truly Antarctic. The Leopard Seal lives among the outer fringes of the pack ice, the Crabeater Seal in the

more southerly drifting pack ice, the Ross Seal in the heavy pack ice, and the most southerly Weddell Seal within sight of the Antarctic continent.

New fact-finding techniques

Their distribution in the more difficult regions of the world has meant that these seals were not among the first to be known. After the circumnavigation of Antarctica by Captain Cook, the Antarctic continent itself was probably first sighted in 1820, and the voyages of exploration that swiftly followed resulted in, among other things, the discovery and naming of the Antarctic seals—the Leopard Seal first in 1820, the Weddell Seal in 1826, the Crabeater Seal in 1842, and the Ross Seal in 1844. Thus they have been known for over 120 years, and during this time a considerable amount has been discovered about them, such as their distribution, body-size, appearance, food, and general life-history. At first, this was all the information that it was possible to get from simple observation, and skulls and sometimes skeletons were brought home for museum collections. At present, specialized techniques are being evolved—for instance, skindivers are attaching depth recorders to Weddell Seals and finding that they are able to dive to the astonishing depth of over a third of a mile. But there is relatively little that has been done on the anatomy of these seals, and this is understandable when one thinks of the problems involved in preserving, storing, and transporting the 9-foot-long bodies.

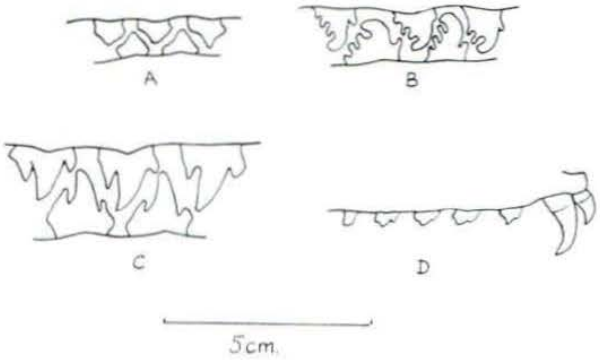
Of all the Antarctic seals it is perhaps the Ross Seal about which least is known. The first specimens were brought back from the voyage of the *Erebus* and *Terror*, 1839–43, and published accounts of Antarctic voyages during the following 100 years show that twelve voyages brought back six complete skeletons, twenty-nine skulls, and a few skins, and these are now scattered throughout the museums of the world, from London to Sydney, from Trondheim to Adelaide. Of the soft parts of this seal, only the kidney has been described, and the only other record of one being cut up at all was with gastronomic, rather that scientific, intent, as Sir Edward Shackleton, during the voyage of the *Endurance* in 1914, noted that the animal made little more than a square meal for twenty-eight men. It is only recently that a pair of Ross Seals, sent frozen from the Antarctic, has been available for dissection, and many interesting features have come to light. Some of these are seen for the first time in this seal, but though it is likely that the Ross Seal may be the most specialized of the Antarctic animals, it is unlikely to be alone in all its specializations.

Ross Seal's head

The characteristic appearance of the Ross Seal head is known from a few photos. It is very short and wide, with a small snout, bulging eyes, and a very deep throat, as seen in the accompanying photo. The generic name of the seal, *Ommatophoca*, was based on the enormous orbits in the skull, far larger than in any other seal skull of similar size, and yet there are some published papers that say the eyes are large and others that say they are small. The confusion has arisen because of the words used: the eye opening—the palpebral fissure—is unremarkable in size, but the eyeball itself is enormous. Its horizontal diameter is $2\frac{2}{5}$ inches, compared with about $1\frac{3}{5}$ inches in seals as diverse as a Common Seal (*Phoca*), a Baikal Seal (*Pusa*), and a Californian Sea-lion (*Zalophus*). The size of the cornea in these three seals is approximately the same as in the Ross Seal, but in the latter animal it is the hinder part of the eye behind the lens that is enlarged. This would result in an increase in the size

New Exhibition of Melanesian Art

A gallery of art from Papua and New Guinea and other parts of Melanesia is being prepared in the Australian Museum's new wing. Many superb items collected as early as the 1880's, which have never been on public display, will be incorporated in the new exhibits. One of these is illustrated on the front cover of this issue of *Australian Natural History*. This gallery will be opened to the public in the middle of this year.



The teeth of a Weddell Seal (A), Crabeater Seal (B), Leopard Seal (C), and Ross Seal (D). Only upper cheek teeth 2–4 and lower teeth 3 and 4 of the three first-mentioned seals are illustrated, and the full set of upper cheek teeth of the Ross Seal.

of the image relative to the size of the eye, which would be very useful to an animal hunting swift-moving and slippery prey in the Antarctic gloom beneath the ice.

Feeding habits and teeth

The differences in the feeding habits of the Antarctic seals have at least one reflection—in the shape of their teeth, as seen in an accompanying diagram. The Weddell Seal feeds mainly on fish, which it swallows whole, and it has small cheek teeth. The Crabeater Seal sieves the shrimp-like krill through the complicated system of cusps on its interdigitating teeth, while the Leopard Seal usually eats larger prey, such as squids and penguins, and has strong three-pronged teeth.

The Ross Seal has very small cheek teeth that are often loose in their sockets, but the upper and lower incisors and canines are slender, with sharp backwardly-curving tips. Little is known with certainty of the feeding habits of this seal but it is believed to eat large cephalopods, and one of the beaks found in the stomach suggested a squid about 2 feet 6 inches in length and weighing about 15 pounds. Earlier reports said that this seal fed on seaweed, but these fragments were battered remains of squid pens. Some of the modifications of the head may perhaps be put down to the need for dealing with this large prey. The mouth is very wide, particularly at the limiting points of the coronoid processes, and, although the cheek teeth are small and weak, the muscles operating the lower jaw are large. The temporal and masseter muscles that would close the jaw are particularly thick, and the attachments of the digastric are such that it could pull the jaw open very wide. Thus the mouth can be opened wide to receive the prey, clamped firmly shut, and the needle-sharp anterior teeth would help to anchor a slippery and possibly wriggling squid.

Within the mouth there is a very short hard palate, but a particularly long soft palate. As the normal relationship of the posterior end of the soft palate and epiglottis is preserved, the epiglottis is further back in the throat, and a very long and compressible mouth area results, which must be able to accommodate the bulky food. All the muscles in the throat concerned with gripping and swallowing the food are very well developed in the Ross Seal, and their attachments are more complicated than in the Common Seal (*Phoca*), for instance. A very large food mass passing down the oesophagus could perhaps press on, and damage, the trachea. Some seals have complete cartilaginous rings in the trachea, and in some the rings are incomplete dorsally. But it is interesting that in the two seals that are known to swallow large objects, the Leopard Seal and the Ross Seal, the cartilage in the trachea is reduced to ventral bars, so the trachea can be compressed quite flat (see diagram).

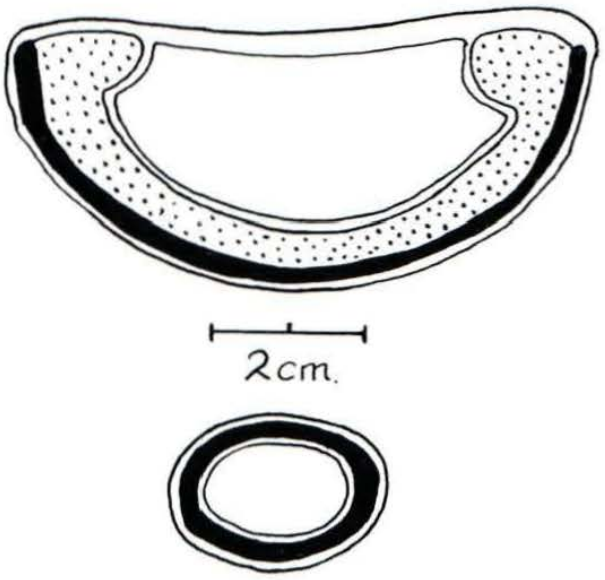
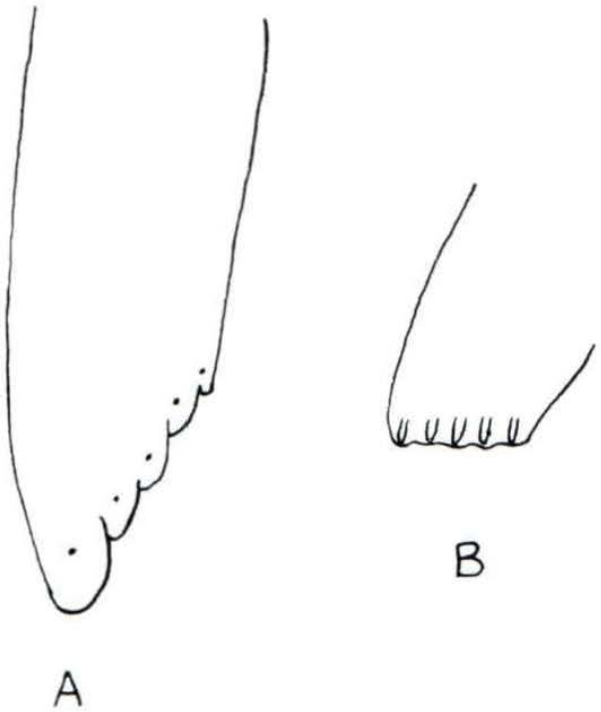


Diagram of a section through the anterior part of the trachea of the Ross Seal (*Ommatophoca rossi*), above, and the Common Seal (*Phoca vitulina*), below. The cartilage is shaded black, and internal to this in the Ross Seal is a thick layer of fibrous tissue (the spotted area).



Difference in fore-flipper shape and in size of claws between the Ross Seal (A) and the Common Seal (B). The small spots on the Ross Seal flipper indicate the claws.

Locomotion and food-catching

These are some of the modifications that seem to have arisen in the Ross Seal for dealing with food. There are other changes in structure that appear to be more designed for efficient locomotion and the catching of food. The normal phocid method of progression in the water is by lateral movements of the hind end of the body, aided by the alternate strokes of the hind flippers, the fore flippers being held against the body except when changing direction. But there is a considerable change in the shape of the fore flipper from the relatively unspecialized *Phoca* to the undoubtedly specialized *Ommatophoca*. The fore flipper of *Phoca* is a "paw", a short broad structure armed with five strong claws, the bones of the digits are not particularly elongated, and all are of approximately the same thickness. All members of the Phocinae have "paws" like this, but within the Monachinae there is a change, the flipper getting longer and the claws getting smaller. The Weddell Seal, for instance, still has large claws, the Leopard Seal has smaller claws, and in the Ross Seal the claws are reduced to small nodules. They are so small that they can no longer be used for scratching, the soft tissue is extended beyond them, and, in the first digit at least, this extension is supported by a lanceolate piece of cartilage four-fifths of an inch long. The increase in length of the first digit is also achieved by a lengthening of the bones, and these are also stouter than those of the other digits, forming a strong leading edge to the flipper. The fifth digit is shortened by the reduction in length of the intermediate phalanx, and this results in a front limb of quite different shape from that of the "paw" of the Phocinae; in *Ommatophoca* the leading edge is long and strong and the other digits decrease rapidly in size (see diagram). Another characteristic of the Ross Seal flipper is the very elongated epiphyses to the terminal phalanges—quite different from the normal-sized epiphyses on the other phalangeal bones, and also serving to elongate the flipper.

There is evidence in the shape of the articular surfaces that the Ross Seal has less power of interphalangeal movement in its fore flipper than have the seals of the Northern Hemisphere; it may perhaps act more in one piece, like the front flipper of a sea-lion. Certainly, the arrangement of some of the muscles is not unlike that of a sea-lion.

No one has yet seen a Ross Seal swimming, but one can perhaps assume that the method is not exactly the same as in the northern seals. In the same way even the few characteristics mentioned here indicate that the Ross Seal is a more complicated animal that the better-known seals of the Northern Hemisphere, and it, together with its Antarctic relatives, would repay more investigation.

[*Diagrams in this article are by the author.*]

THE AUSTRALIAN MUSEUM

The Australian Museum's field is the animal kingdom, minerals, fossils, and anthropology. The Museum is open free, daily, at the following times: Tuesday to Saturday, and public holidays, 10 *a.m. to* 5 *p.m.; Monday,* 12 *noon to* 5 *p.m. (during school holidays,* 10 *a.m. to* 5 *p.m.); Sunday,* 2 *p.m. to* 5 *p.m. It is closed on Christmas Day and Good Friday. Special facilities for study are available to schoolteachers and pupils on application to the Education Officer. A rooftop cafeteria is open daily, except Sundays, from* 10 *a.m. to* 4.30 *p.m.*