



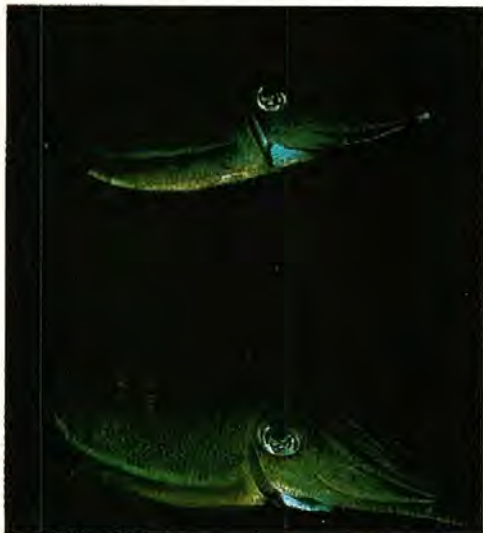
# AUSTRALIAN NATURAL HISTORY

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Vol. 20 No. 5  
1981 \$2.20

# AUSTRALIAN NATURAL HISTORY

PUBLISHED QUARTERLY BY THE AUSTRALIAN MUSEUM, 6-8 COLLEGE STREET, SYDNEY TRUST PRESIDENT, JOE BAKER, MUSEUM DIRECTOR, DESMOND GRIFFIN VOLUME 20 NUMBER 5 1981



Cuttlefish, *Sepia plangon*, swimming in midwater in Sydney Harbour and showing the translucent colour of the body and mantle. Photo C. Watson-Russell.



A western brown snake, *Pseudonaja nuchalis*, preparing to strike prey. Photo by Paul Webber.

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Annual Subscription: Australia, \$A8.00; New Zealand, \$NZ11.50; other countries, \$A9.50. Single copies: Australia, \$A2.20, \$A2.65 posted; New Zealand, \$NZ3.00; other countries, \$A3.40.

New Zealand subscribers should make cheque or money order payable to the New Zealand Government Printer, Private Bag, Wellington.

Subscribers from other countries please note that moneys must be paid in Australian currency.

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# FROM THE INSIDE



A flatback turtle, *Chelonia depressa*, heading towards shore at Heron Island. Photo by Keith Gillett.

Above right, wedge-shaped orange-red heulandite crystals from Tambar Springs, NSW. Photo by J. Wolfe.



The recent announcement from the NSW Government of the formation of a migratory bird reserve on approximately 2000 hectares of prime waterfront land in the Port of Newcastle is indeed welcome news. The area concerned includes 840 hectares of Kooragang Island and all the adjoining Fullerton Cove in what will become a nature reserve for a large number of migratory birds from Siberia and Japan. The land would have been particularly valuable for the Government as it is one of the last pieces of land in the Hunter River estuary with a deep water port frontage.

The Government made a responsible decision and rather than opt for short-term monetary gain from commercial interests, created a valuable nature reserve for future generations. While the Government made the decision, the responsibility and foresight for the maintenance of a reasonable amount of our remaining coastal areas must be accepted by commerce and industry and supported wholeheartedly by all Australians.

With the 1979-81 drought covering most of eastern Australia, farmers in particular, have been paying closer attention to clouds and their potential as rain-producers. In the next issue of *Australian Natural History*, Julian Hollis will examine clouds and their effect on weather. The advent of satellite photography of cloud cover appearing nightly on television weather forecasts has led to a new appreciation of large-scale weather circulation systems and their significance in weather forecasting.

Also in the next issue, David McAlpine writes on the orchids of southern Australia. Australia's orchids are remarkable not so much for the splendour of their flowers, as for their adaptation to the Australian environment and the intricate mechanisms by which the flowers are fertilised. In contrast, Bob Harden, a Research Officer for the NSW National Parks and Wildlife Service, will take a close look at the controversial subject, the dingo.

As one of the widest reaching vehicles for The Australian Museum, *Australian Natural History* tries to encourage interest in conservation by presenting informative articles showing the rich variety in nature, its complexity and its beauty. We have received many letters with good suggestions for the further improvement of the magazine since the change in format. The editorial staff wish to thank all those readers who took the time to write and hope many others will be encouraged to submit their comments.

Roland Hughes  
Editor



# 'THE TALK IS ALL TURTLES'

Where does a baby turtle go once it has launched itself into the sea for the first time? How old must a female be before laying her first clutch of eggs? Turtle biologists have been asking these and similar questions for years. The prohibitive cost and difficulty of keeping these reptiles in captivity means that researchers must make the most of the comparatively brief period when turtles are close inshore. For many years Col Limpus of the Queensland National Parks and Wildlife Service has been studying the breeding turtles at Mon Repos Beach. His work there attracts many volunteer helpers. Such a volunteer is Vicki Seal, who each summer makes the trip from Melbourne to Bundaberg to participate. Here she tells of her experiences in the turtle research programme.

by Vicki Seal



Above, a loggerhead turtle, *Caretta caretta*, digging a nest on Heron Island. Photo by Keith Gillett.

Left, a green turtle, *Chelonia mydas*, climbs over the rocks at Heron Island. Photo by Anthony Healy.

There are seven species of sea turtles. These are the green turtle, *Chelonia mydas*; the flatback, *Chelonia depressa*; the loggerhead, *Caretta caretta*; the hawksbill, *Eretmochelys imbricata*; the ridleys, *Lepidochelys olivacea* and *L. kempi*; and the enormous leatherback, *Dermochelys coriacea*. Although turtles are protected in Australian waters, they face a bleak future in many parts of the world unless measures are taken to control the slaughter for food and by-products such as leather and tortoise shell.

Current research in Australia and overseas is directed towards the feasibility of farming sea turtles. So far it has proved virtually impossible to induce farm-reared sea turtles to breed in captivity. Managers of the turtle farm in the Cayman Islands, started in 1968, have yet to reconcile the complex life cycle of the migratory green turtle to a sedentary existence in rearing pens.

The only time one can be sure of seeing adult turtles out of the water is during the breeding season, when the females come ashore to lay their eggs. Hence much biological information can be gained by intensive turtle-watching throughout the nesting season, and I have been involved in this absorbing work. Our camp is a caravan park at Mon Repos Beach near Bundaberg—eastern Australia's most important mainland beach for nesting turtles.

Our working 'day' begins in the evening, when the big communal tent becomes the base of our activity. Everyone takes a hand at tea time, doling the meal onto plastic plates. We sit on upturned dustbins, boxes of equipment or a lower bunk to eat, and the talk is all turtles. Col Limpus, looking at the graph which shows how many turtles nested on a particular night, says, "That flatback should be up tonight."

Col has been coming to Mon Repos Beach to watch turtles since he was a boy. Now he is in charge of the research programme run by the Queensland National Parks and Wildlife Service. Each year between November and March, a cluster of tents is pitched by Col and his assistants to house the people taking part in his research. Many are university students furthering their studies of animal behaviour, while others, including, myself, make the annual trip to Mon Repos from a single-minded

interest in turtles. And once you're involved, you're hooked!

We work in two shifts—from tea till midnight, and from midnight till morning. Those on first shift begin to gather their equipment—belts, with a holster for the tag gun, and battery for the miner's torch worn around the head. Canvas shoulder bags are used to hold data board, biro, dive-bag to carry hatchlings and smaller plastic bags for unusual or unidentified barnacles from a nesting turtle's carapace (upper shell). The barnacles may give some clue to the area the turtle has been inhabiting. Some of us carry heavy gas lanterns as we make off for the beach, tape measures flapping around our legs.

Those on second shift boil water to tackle the dishes before getting a few hours' sleep. We sleep in an overcrowded tent, in sand-filled sleeping bags on equally gritty air mattresses. Most of us sleep in our clothing and make a trip to the amenities block to recover the rudiments of human dignity. Luckily everyone is in a holiday spirit, because in this enforced intimacy it's virtually impossible not to tread on someone's clean clothes or scuffle sand into their face once in a while.

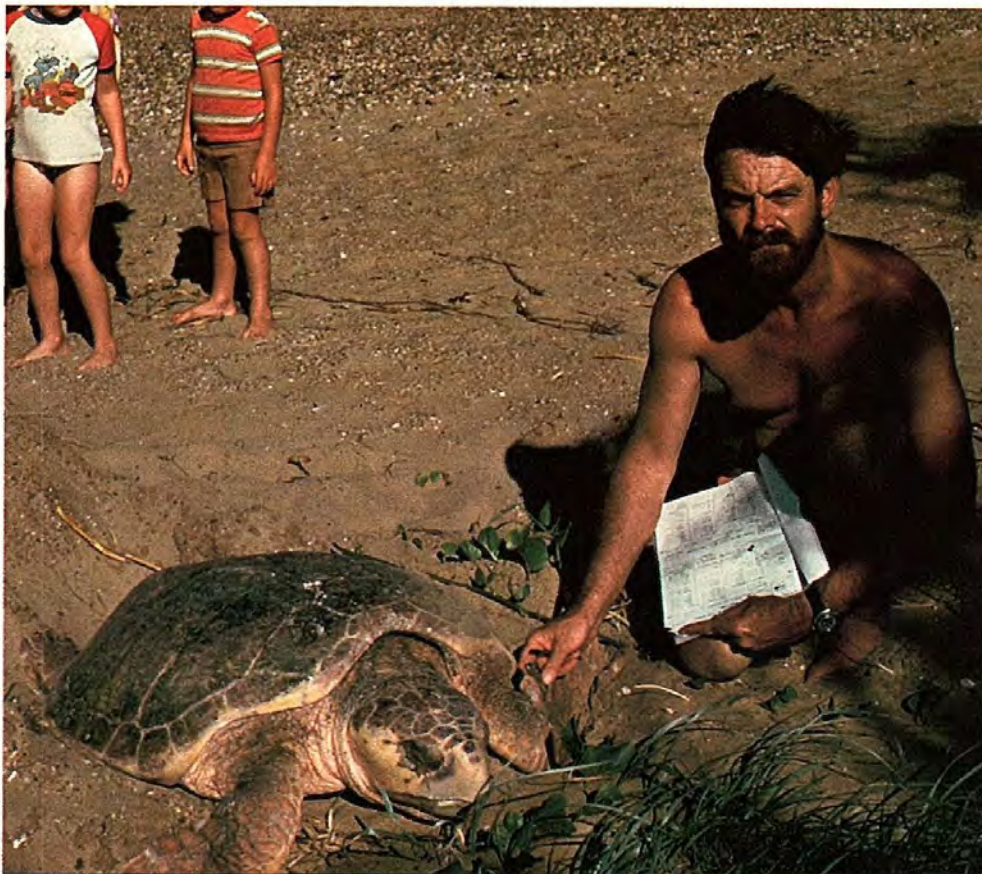
The beach expeditions are not without humour. There are quite a few 'mock turtles' here—large rocks lying at the water's edge which look remarkably like beaching turtles and to the observer peering through the darkness, even seem to move about. We hesitate to turn on a torch for fear of frightening the turtles away. Turtles are very easily disturbed as they heave their way up the beach past the high-tide mark and begin to dig the nest.

Once a turtle has begun to lay her eggs she is oblivious to all around her, and we can then put on our lights to collect data. Each nesting turtle is fitted with a non-corrosive tag on the left front flipper to ensure she can be individually identified on subsequent sightings. The tag is made of monel metal and is the same as a cow ear tag, applied with a standard cow ear tag application. Busily laying her clutch of 100 or more eggs, the turtle shows little reaction to being tagged.

Most of the nesting turtles at Mon Repos are loggerheads, but early in the season there



Above, a volunteer recording information from a nesting loggerhead turtle at Mon Repos Beach, Bundaberg, Queensland.



Col Limpus, left, from the Queensland National Parks and Wildlife Service and head of the research project recording information from a loggerhead at Mon Repos Beach. Photos by courtesy of Col Limpus.

are a handful of flatbacks, and, more rarely, a green turtle. The adults are measured over the curve of the carapace, most of them measuring about 95 cm. Those under 85 cm are considered sub-adult, and if we catch them nesting we send word back to camp for the weighing equipment. We have yet to determine how long it takes for these turtles to reach sexual maturity. The young female is overturned when she has filled in the nest and tied by all four flippers to scales suspended from a pole. Untrussed and set upright, she makes for the sea.

Mon Repos Beach is 1.3 kilometres long, terminating at each end in large rocks. The beach is marked off into 50-metre sections to help us in recording data. As the night wears on and the tourists—with their amazing questions!—give up and go home, we patrol the beach in pairs or singly with no sound but the surf, and no light unless we are actually recording data. It is pleasant to sit in the dunes with a cool breeze blowing, waiting for a female loggerhead to finish digging her egg chamber and start laying. Each rear flipper alternately delves into the sand to bring out a neat handful, then the other is brought across to flip away the crumbling sides of the hole. If the turtle has just begun to dig it will be a while before she is settled and begins to drop her eggs from the cloacal opening at the base of the tail.

A turtle's deep, straight track stands out clearly against the smooth surrounding sand. A single upward track indicates a turtle is somewhere in the dunes and must be investigated. Although it is often difficult to see the turtle, different sounds provide clues to her activity.

The slow, regular digging scrapes cease several times for short rest periods before the egg chamber is completed; a longer silence indicates that the turtle has begun to lay her eggs. If the latter is the case, or if she is already filling in the hole, we can put on a torch to record data. We note her tag number (if she has a tag), species, shell dimensions, precise location on the beach, any damage to the flippers, occurrence of barnacles on the shell, and date and time of nesting. If she has no tag, she is fitted with one. The tag number and date are written on a strip of plastic which is dropped in with the egg mass. This done, we score a heavy line across her track to avoid the same turtle being recorded twice.

In the latter part of the season, we have to be alert for tracks of turtle hatchlings. These spidery lines are not as easy to spot as the deeply furrowed marks of the adults. Novice observers have trouble distinguishing them from crab tracks. Often one baby turtle will leave the nest before the others, a 'scout' perhaps, and the single delicate track leads back to a slight depression in the sand.

The hatchlings have been out of their eggs for a couple of days, scabbling madly so that by concerted movement they have worked their way up to just below the surface of the sand. There they wait for the cooler temperatures of the night before bursting out in a flurry of flippers, thereby avoiding heat exhaustion on the beach. It seems that the baby turtles become torpid at higher surface sand temperatures, and activity within the nest recommences when temperatures drop. Cooling rain will sometimes be sufficient to encourage emergence during the day—but turtles

emerging in the day are very much more susceptible to predation by gulls and fish than turtles which emerge by night.

On emergence, the hatchlings immediately head for the strongest source of light, which is usually the sea. But if they happen to hatch on Mon Repos Beach when a turtle researcher is walking by, chances are they will mill around his gas lamp while the remains of the nest are dug up.

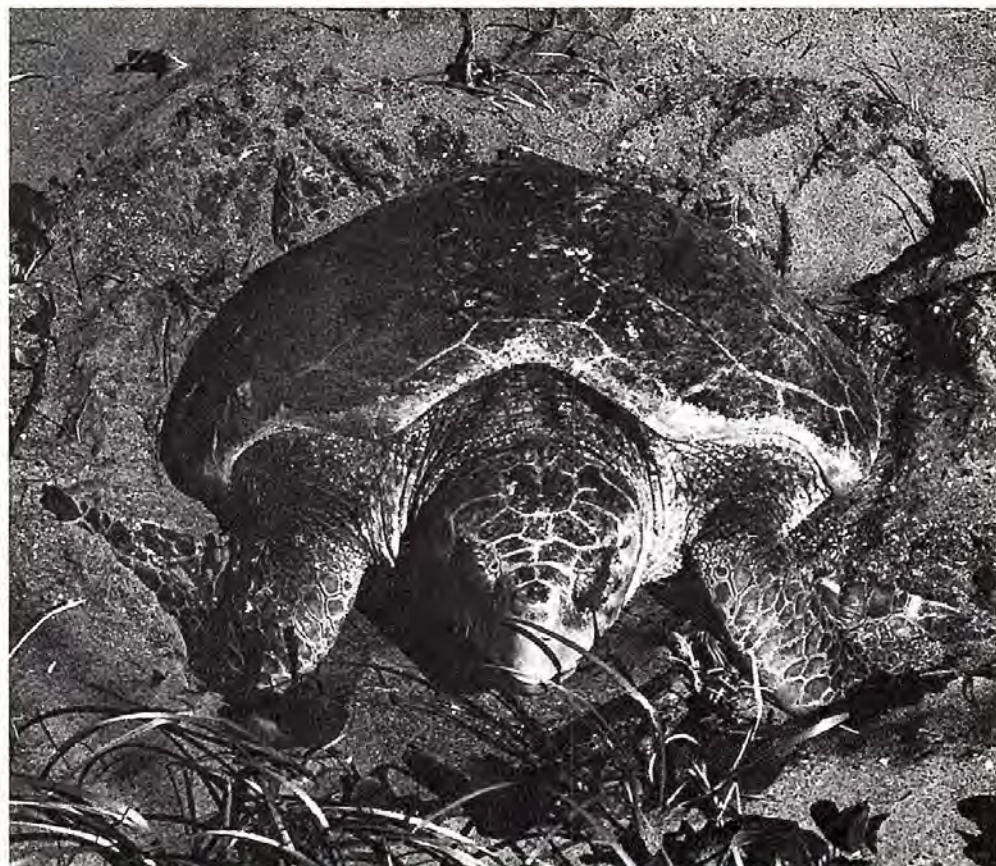
Digging up the nest is not a particularly pleasant task. The nest may contain undeveloped eggs which have been buried in warm sand (about 30 °C) for up to nine weeks producing a revolting smell.

Turtles lay eggs with soft, leathery shells, and the hatchling uses its pointed snout to rip open a slit and escape, leaving the eggshell in one piece. We count the shells to see how many hatchlings have emerged and note the number of unhatched eggs. These eggs are opened. Some contain a deformed embryo—albino, two-headed, with 1, 2 or 3 legs, or undersized. Others contain a partly formed embryo which for some reason has stopped growing, or no discernible embryo at all. The number of unhatched eggs varies greatly from nest to nest. Strong winds may shift a lot of sand, leaving eggs too close to the surface so that they 'cook'; others may be adversely affected by abnormally high tides which wash over the area and rot the eggs.

Often a handful of young turtles will remain in the nest, deformed in some way or too weak to climb out. These are released in the sea, or if the deformity is particularly odd, taken back

Right, a loggerhead heading up Mon Repos Beach. Photo by courtesy of Col Limpus.

Below, a close-up of a hawksbill turtle, *Eretmochelys imbricata*. Photo by Harold Cogger.





Volunteer measuring a loggerhead turtle in front of tourists on Mon Repos Beach. Photo by courtesy of Col Limpus.

for Col to examine. In most nests, the strip of plastic is dug up with the eggs, bearing the mother's tag number and the date on which the clutch was laid. In these cases a sample of ten hatchlings is then placed into a separate bag with the identifying marker for weighing back at the tent. The others are placed in large net bags, to be marked and released into the sea that same night.

There are many difficulties in marking a hatchling turtle with a carapace length of perhaps 5 cm. Obviously a turtle that size can't swim with the same sized tag as an adult, and a correspondingly smaller tag would be lost or invisible by the time it came back attached to a full-sized turtle. For this reason the shell itself is marked; we clip out a portion of the upper shell with a leather punch—clipping in different positions on the shell provides unique combinations to denote the particular beach and season to which the hatchling belongs. Over the last five years 72,000 babies have been marked in this way at Mon Repos—and we're still waiting for one to haul herself up the beach as a nesting adult.

Mon Repos Beach is backed by sand dunes, and lights in the caravan park behind are deliberately kept low. On other nearby beaches the turtles are not so fortunate. Development has occurred so close to these beaches that hatchlings are disoriented by adjacent domestic lights and end up, dehydrated, in someone's back yard. In some places stone walls prevent the female turtles from climbing high enough to nest safely, so that the next high tide washes over the area and rots the eggs. I have seen many female loggerheads attempt unsuccessfully to nest among rocks and vegetation on these other beaches. Our studies now show that one or two turtles are switching from those unproductive beaches to Mon Repos. If only all the others will do the same.

return, we lack evidence in this Queensland study that a nesting turtle will return to the beach on which it hatched. But it is known that an adult will favour one particular area each time she nests.

Turtles at Mon Repos have never been found nesting in two consecutive years. Researchers in America claim that the green turtle nests on a two, three or four-year cycle, although Col Limpus points out that a turtle recorded as being in a four-year cycle may have nested two years previously and simply not have been sighted. The work at Mon Repos suggests that many loggerheads there breed only once in their lifetime. In that one season of about ten weeks, however, the female will return to the beach approximately every fourteenth night to lay a clutch of on average 120 eggs, sometimes up to 150.

At about five this morning I was sharing a shower with some green frogs which inhabit the amenities block as if it had been built for them. Somewhere off the Bundaberg coastline the subjects of the night's work—500 or so newly clipped hatchlings—were setting out on the first day of their enigmatic life.



Green turtle returning to the sea after nesting on Heron Island. Photo by W. Gladstone.

Until some of our clipped hatchlings



# SECOND ANNUAL WHITLEY AWARDS

"In 1970 the CSIRO and the Melbourne University Press ended the forty years of disgrace of the Australian publishing industry by publishing their magnificent *The Insects of Australia* and covered themselves with glory by releasing an up-to-date supplement in 1974," Arthur Woods told winners and guests at the presentation ceremony for the 1980 Whitley Awards.

Presented annually, the awards are given for books on the natural history of Australian animals. The awards, inaugurated by the Royal Zoological Society of NSW in 1979, commemorate and in part are funded by a bequest from Gilbert Percy Whitley (1903-75), Councillor of the Society for forty-five years, editor of its publications for thirty years, and three times president. Whitley was also Head of the Department of Ichthyology in The Australian Museum for forty years and in that time was the author of five books and more than 500 papers.

Arthur Woods in his address went on to elaborate "today, however, I wish to praise the publishers, not bury them for they and their authors, artists and photographers have presented us with several fine entries and among them are certain volumes which promise well for the amateur and professional zoologists of Australia".

Dr Gordon Grigg presented the 1980 Whitley Medal to *Freshwater Fishes of South-Eastern Australia*, edited by R. M. McDowall and published by A.H. and A.W. Reed. This, the top award, is given to the book judged to have made the best contribution to a better understanding of Australian animals and their environmental or evolutionary relationships or to the history of zoological studies in Australia. Categories for the other awards include the best field guide, natural history book, children's book, zoological history book, and illustrated book. There is also a special award for a significant contribution to the zoological literature of Papua New Guinea.

"I am particularly encouraged by this year's crop," Arthur Wood said, "I know that McDowall's *Freshwater Fishes of South-Eastern Australia* deservedly won the top award, and I was delighted that the award was given to a book that is a workable guide to the identification of fishes in the region."

Mr Wood also stressed, "I would like to give special attention to Smith and Kershaw's guide to non-marine molluscs . . . because it is the first of its kind on a group of great importance both to the naturalist and to the livestock industry.

"We have reached a stage in Australian zoology when the publishers should be providing us, professionals, and amateurs, with more than a thousand photos in search of an author. There is no reason why many such books should not also be entertaining to the general reader. Rupert Russell in his *Spotlight on Possums* has shown that it is possible to write appealingly and still include new scien-

tific information that will satisfy even the most hardened professional."

Mr Wood suggested that publishers not be held wholly responsible for funding low-selling specialist books by proposing they persuade government to provide funds for publishing Australian natural history books. To support his suggestion, Mr Wood provided the example of government support for Australian novelists.

"I am sure that a committee of scientists from the CSIRO, the museums and the universities with representatives from the publishers could certainly select a few worthwhile authors who could produce valuable monographs," he said.

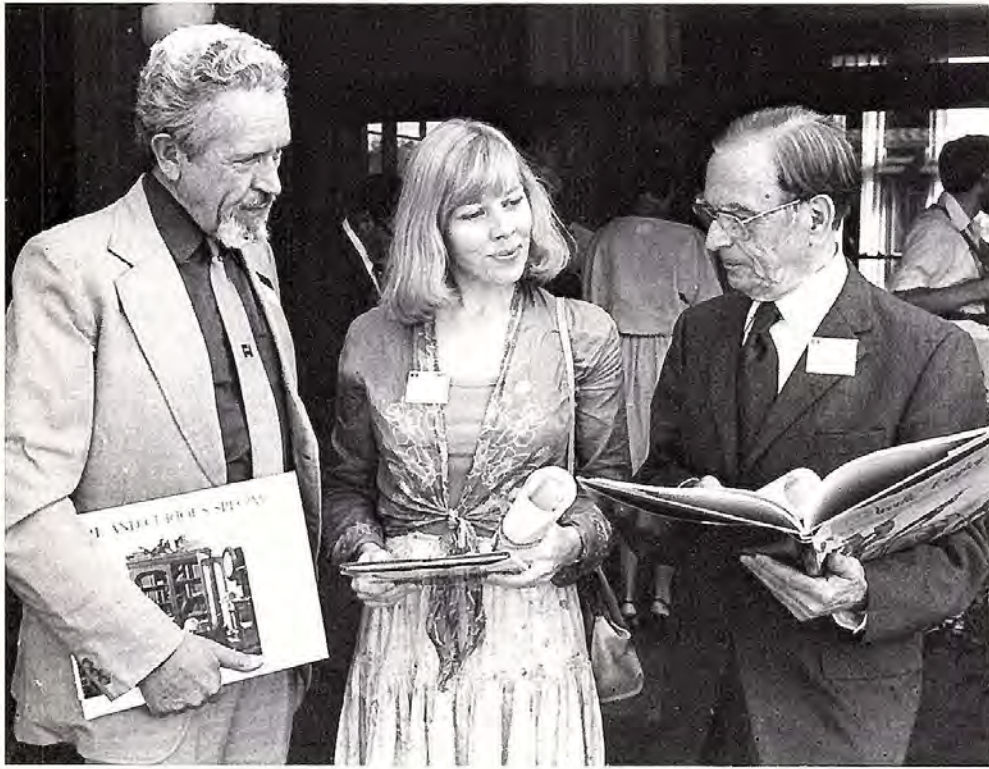
To conclude his address Arthur Wood stated some of the natural science subjects not covered by books.

"It is impossible to find a guide to earthworms in Australia . . . there is nothing on soil organisms comparable to William's freshwater book. It is difficult to identify most of the common animals found on Australia's sea shores. There are scarcely any works, apart from papers in learned journals, on Australian ecology—and by ecology I do not mean extreme environmentalist literature. We still have to use American and English texts as a basis for our lectures on Australian environments and Australian population dynamics.

One of the problems of Australian fauna and flora guides, claimed Arthur Wood, is that they do not mention introduced species. "I have in mind an excellent guide to the wild flowers of south-east Australia. It's comprehensive apart from its complete omission of introduced plants but when I use it in the field I do not find that the aliens have little labels saying they do not belong here."

"On another problem let us not be afraid of giving complete face lift to an old book just because its author was once a great name. There is nothing more irritating to me to find that a new edition is little more than the old one with metres instead of feet, and new scientific names instead of the old, especially when I know that the revisers, given their head, would have produced a work that would be far more useful to today's naturalists who are far more sophisticated than those of forty years ago."

"There is great interest in Australia, her fauna and her environment but unless we get modern books, and books on a wider range of organisms, it will stultify. There is still a place for the attractive coloured books with discursive, anecdotal texts but these alone will not satisfy our modern naturalists," Arthur Wood said.



Ronald Strahan, Kilmeny Niland and J. H. Prince after the presentation at the Education Centre, Taronga Zoo, Sydney. By courtesy of the *Manly Daily*.

## RARE AND CURIOUS SPECIMENS



An Illustrated History of The Australian Museum 1827-1973

By Ronald Strahan

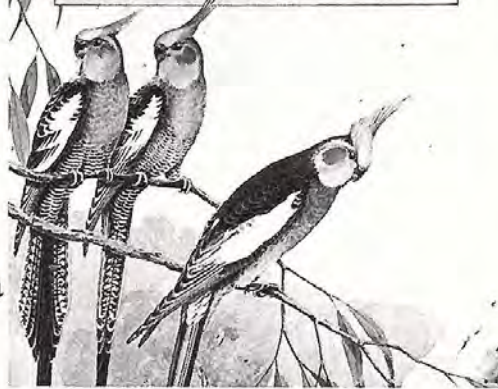
## Field Guide to the Non-Marine Molluscs of South Eastern Australia



Brian J. Smith and Ron C. Kershaw

## Neville Cayley

HIS ROYAL ZOOLOGICAL SOCIETY OF NSW COLLECTION OF PARROTS AND COCKATOOS OF AUSTRALIA



## HANDBOOK OF NEW GUINEA RODENTS

By J. I. Menzies and Elizabeth Dennis



## Award winners

**Whitley Medal Winner—*Freshwater Fishes of South-Eastern Australia***. Edited by R. M. McDowall. Published by A. H. and A. W. Reed.

**Best Field Guide—*Field Guide to the Non-Marine Molluscs of South Eastern Australia***, by Brian J. Smith and Ron C. Kershaw. Published by Australian National University Press.

**Best Book on Natural History—*Spotlight on Possums***, by Rupert Russell, illustrated by Kay Russell. Published by Queensland University Press.

**Best Children's Book—*Feathers, fur and frills***, by Kilmeny Niland. Published by Hodder and Stoughton.

**Best Zoological History Book—*Rare and Curious Specimens***, by Ronald Strahan. Published by The Australian Museum, Sydney.

**Best Illustrated Book—*Neville Cayley, his Royal Zoological Society of N.S.W. Collection of Parrots and Cockatoos of Australia***, by J. H. Prince. Published by A. H. and A. W. Reed.

**Special Award for a significant contribution to the Zoological literature of Papua New Guinea—*Handbook of New Guinea Rodents***, by J. I. Menzies and Elizabeth Dennis. Published by the Wau Ecology Institute.

# IN REVIEW

## FRESHWATER FISHES OF SOUTH EASTERN AUSTRALIA

(New South Wales, Victoria and Tasmania)



EDITED BY R.M. McDOWALL

*Freshwater Fishes of South-eastern Australia* (New South Wales, Victoria and Tasmania) edited by R. M. McDowall, A. H. & A. W. Reed, Sydney 1980, 208 pages, illustrated, \$19.95.

Australia has very few freshwater fishes when compared with other continental areas; fewer than 200 species spend most of their life in Australian freshwaters, while more than 8,000 species live in the freshwaters of the rest of the world. Our freshwater total is also strikingly low when compared to the approximately 3,000 species of Australian marine fishes. However, this limited fauna has been the subject of three books in the last ten years.

Unlike the two earlier books by John Lake, this work by McDowall and his co-authors covers only a portion of the fauna, some 90 species from the southeastern corner of Australia, including those species about which we know most.

The introductory portion of the book includes a section on the study of fishes, an illustrated glossary explaining technical terms and a key to the different families of fishes covered. Each of the 29 chapters covers a separate family and is written by a different author or combination of authors. These 18 co-authors include experts specialising in particular groups of fishes in various fisheries departments, museums and universities. Within each family chapter is a key to the species found in southeastern Australia. Accounts of each species include a black and white drawing, a description of the distinctive features of the species and its colour, with comments on

size, distribution and abundance, natural history, utility, similar species and other names. An additional colour photograph illustrates 70 of the 91 species. A final two-page chapter lists marine fishes that may enter freshwater. The book is completed by a large list of references and an index.

This volume is primarily for those wanting to identify our freshwater fishes, from the anglers who will probably utilise the figures to the students and research workers using microscopes to count gill rakers and fin rays. The wealth of black and white drawings, many from McDowall's previous book on New Zealand fishes, makes this an excellent guide for student use.

The reproduction of most colour slides is good, but the quality of some of the originals was not outstanding, and a few, like that of the bullrout on page 114, could have been omitted. In a few instances cropping has not only damaged the aesthetics of the photos, but reduced their value by leaving tail shape to the imagination of the reader. These deficiencies are generally rectified in the black and white drawings, most of which come from previous publications.

The book has a few errors, the most serious of which are the misidentification of figures. On page 140, Fig. 22.1 is the marine gerreid *Parequula melbournensis*, while the colour plate on page 126 labelled *Hypseleotris klunzingeri* is of a new species in that genus.

Considering the multiplicity of authors, the

family treatments are relatively even. It is apparent that more information is available about some species, such as the Murray cod, than others like the newly discovered galaxiids from Tasmania. Nevertheless, I would have liked more information on natural history, where known. For instance, considerable details are known about the fascinating life histories of our freshwater eels—the climbing of dam walls by elvers, the considerable changes in morphology and physiology immediately before their long marine migration for reproduction, the evidence indicating breeding sites in the Coral Sea. Hopefully, the next edition can be expanded to include such details.

It is gratifying to see a book with the

### Apology

Due to the unhappy circumstance of Jan Nesbit's death and the subsequent changes in the staff, the article on 'Midwife to a Seastar' in Vol. 20 No. 3 was published without the author, Geoffrey Prestedge, completing a final review.

The editorial staff apologises for any embarrassment or inconvenience caused by this oversight.

widespread utility and appeal of this one resulting as a spin-off from grant funds (in this case from the Australian Biological Resources Study) to conduct more basic research on the taxonomy and distribution of freshwater fishes. I think the editor, co-authors and publisher should be congratulated. Although the 32 pages of colour plates have doubtless increased the cost considerably, the book will be used with profit by all those wanting to identify our freshwater fishes or to know more about them. Students, anglers and professional biologists alike will find the book well produced and functional. I recommend it to all.—*John R. Paxton, Curator of Fishes, The Australian Museum.*



A colourful softspined rainbowfish, *Rhadinocentrus ornatus*. Photo by G. Schmida.

*A Field Guide to the Seabirds of Australia and the World.* Tuck, G. S. and Heinzel, H. 1980, pp. 276, 48 colour plates, 297 maps and 56 line drawings. Sydney: Collins, \$19.95.

Seabirds are not restricted to the Australian landmass and can arrive from any point in the world at any time. These straying individuals or groups can wander from their range for any number of reasons. While the accredited field guides of Australian birds, supplemented by the New Zealand guide, can be used by the maritime observer to identify these and any local species, it is best to have the one book identifying all species within the same cover.

*A Field Guide to the Seabirds of Australia and the World* is the first guide since W. B. Alexander's *Birds of the Oceans* in 1954 to cover the world's seabirds as a whole. Seafaring bird watchers will be eager to acquire



An eastern little galaxias, *Galaxiella pusilla*. Photo by R. M. McDowall.

this unique book which is written by Gerald Tuck and neatly illustrated by Hermann Heinzel.

Alexander's original guide was re-issued several times and lacks the colour plates which observers and readers now expect from field guides. So Tuck and Heinzel's book comes as a much needed addition to the stable of field guides, having 48 colour plates at a size where the user can easily see the relevant points to aid identification. To be able to study a whole group of lookalike species and see and read about individual identification is a step in the right direction.

The book's size allows easy field handling and the solid binding supports this use. The only problem envisaged is that the choice of a white cover leaves some problems of soiling from continuous handling in the field.

Today's observer has progressed beyond possession of just an interest in birds, books and the connecting illustrations. As a result some of the inaccuracies which are present in the book should be made known to the prospective buyer. One example is the lack of definition in the colour between the bills of the two giant petrels. The bill of the northern giant petrel *Macronectes halli* is tinged reddish. This is neither mentioned in the text nor illustrated. Colour variation in breeding and non-breeding crested terns *Sterna bergii* (in the book called *Thalasseus bergii*) is not described by Tuck.

Other inaccuracies occur with the range maps showing world distribution, especially in the Australian region. Examples are no coverage of whiskered terns and gull-billed

terns on the east Australian coastline; no inland coverage of caspian terns, silver gulls, little pied cormorants, little black cormorants, and pelicans; no mainland coverage of common terns nor Pacific records of long-tailed skuas. This only mentions a few of the book's shortfalls. Other uncommon to rare species of the Australian east coast are not mentioned.

Do not be misled by the title as the book was originally written for the European reader. However, with the prospect of world distribution the publisher decided on a change of title and the addition of a special chapter written by local workers, in this case D. L. Serventy. An eleven-page supplement at the rear of the book by Serventy discusses two important aspects of Australian sea-watching: 'Seabird migration and the visiting seabirds' and 'Hazards to seabirds', the former giving an idea of what might be expected, allowing for aid in identifying that problem bird, the latter stressing the problems encountered by birds caught in manmade situations and natural disasters. Hidden at the back of the book this chapter is an important addition to the book that can be easily overlooked. With this added Australian section the book becomes a useful introduction to the birds of the oceans for Australian naturalists. With the necessary corrections and alterations which should be forthcoming in subsequent editions, the potential of the book is excellent.

The book is a thorough guide to the nearly 300 species of seabirds in the world and is recommended as a valuable part of any observer's aids to identifying some of the most difficult of the world's birds.—*N.W.L., The Australian Museum.*

## A Field Guide to the of Australia and the World

Gerald Tuck  
Hermann Heinzel



A comprehensive guide: 781 birds painted in colour, 138 line drawings, 298 maps

# ZEOLITES—A VERSATILE MINERAL

Zeolites are a versatile group of silicates which have applications in radioactive waste disposal, sewage effluent treatment and in the removal of sulphur dioxide from industrial gas stack emissions. Simon Pecover, a geologist and mineralogist with The Geological and Mining Museum, which is part of the Department of Mineral Resources, NSW Government, has been involved in zeolite research for a number of years. Simon, who is particularly interested in the applications of the special qualities of zeolites for pollution control, has been working on a particularly large deposit at Tamba Springs. To date exploration for suitable zeolite deposits in Australia has been largely overlooked despite zeolites' big demand and major use in the United States and Japan.

by Simon Pecover



The volcanic landscape of Tamba Springs, NSW, where Simon Pecover has been working on a particularly large deposit of zeolite. Photo by S. Pecover.

Of the many minerals utilised by man none perhaps have such enormous potential for diversity of use as the aluminosilicate minerals known as zeolites. First discovered in 1756 by the Swedish mineralogist, Baron Cronstedt, the zeolites were named from the Greek *zein* and *lithos*, meaning boiling stones, in allusion to their tendency to froth and to give off water when heated in an open tube.

There are over 40 distinct species of natural zeolites and they occur in rocks of diverse age, type and geological setting. Once thought to be confined mainly to basaltic igneous rocks as well as forming accessory minerals in cavities, zeolites are now known to occur as major constituents of many bedded volcanic fragmentary rocks and in slightly metamorphosed rocks. Research into the exchange of charged elements (ions) and adsorption of molecules in natural zeolites has led to a multitude of industrial applications especially in the areas of pollution control, energy conservation and agriculture.

To the amateur collector and serious research scientist, natural zeolites represent some of the most beautiful and varied minerals in nature. Their crystal habits range from long needle-like structures arranged in spectacular hemispherical arrays (typical of the zeolites natrolite, mesolite, scolecite and ferrierite) to blocky wedge-shaped zeolites (typical of heulandite, chabazite and stilbite). Crystalline cavities found in basaltic igneous rocks may contain colourful fairylands of several intergrown species of zeolite minerals.

Zeolites are crystalline hydrated aluminosilicates containing positively charged metallic ions (cations) of the alkali and alkaline earth elements in an infinite three-dimensional framework. Some of the silicon in the structure is replaced by aluminium, giving it a net negative electrical charge. This is balanced by the presence of cations such as sodium, calcium, potassium, magnesium, strontium or barium. Although chemical compositions of the various zeolites are similar each species has its own unique crystal structure and thus its own physical and chemical characteristics.

Zeolites occur in a variety of geological settings including igneous, metamorphic and sedimentary environments. They may be formed by burial metamorphism, hydrothermal

activity or weathering of surface deposits, or in hydrologically open and closed systems in bedded deposits of volcanic origin. Zeolites in igneous rocks are most common in the cavity fillings of lavas such as basalts. These zeolites include stilbite, natrolite, mesolite, low silica chabazite, laumontite and analcime.

Basaltic lava piles often show stacked horizontal zones, with upper zones lacking zeolites and lower zones containing increasing amounts of zeolitic material. This zonation appears to be due to early changes during burial with the lower zones undergoing basalt-water reactions with increasing temperature and pressure. Zeolite occurrence in basaltic igneous rocks can also be attributable to hot springs activity in and around areas of volcanic activity and is the result of localised hydrothermal alteration of the lava.

Zeolites also occur extensively in metamorphic rocks formed by the effects of burial of thick accumulations of fragmentary volcanic deposits at elevated temperatures. Deposits up to 12 kilometres thick have been recorded displaying horizontal zones of zeolites and associated minerals.

By far the largest and potentially most valuable zeolite deposits are those formed in the open and closed water systems of fragmentary volcanic deposits. Open system-type deposits are those formed by reaction of volcanic glass with sub-surface waters that originated as rainwater. The original volcanic material may have been deposited in marine or river environments or as air-laid deposits on the land surface.

Open system zeolite deposits formed in thick tuffaceous strata also commonly show zones of locally crystallised minerals reflecting the chemical change in rainwater as it moved through the system.

Upper layers of burial metamorphic deposits are mineralogically similar to those of the open hydrologic system-type, however in the open system-type a sharp contact may separate the unaltered glass zone from the zeolitic zones where in burial crystallisation the contact is more gradual and a thick transitional zone may be present.

Reaction of volcanic glass with water



Blocky white chabazite crystals on basalt.  
Photo by D. Barnes.

trapped during sedimentation in saline, alkaline lake deposits forms deposits of the closed system type. The saline brines generally have strong alkalinity resulting in rapid solution of vitric glass and precipitation of zeolites. The locally crystallised silicate mineralogy can be correlated with the salinity in this type of deposit. For example, the Pleistocene vitric tuff deposits of Lake Tecopa in California show sideways zonation into the basin with increasing salinity and alkalinity. They pass from unaltered glass to zeolites and then to potassium feldspar. Of the 40 or so zeolite species known here only six are common in saline alkaline lake deposits, namely analcime, clinoptilolite, modenite, erionite, chabazite and phillipsite.

Zeolites are characterised by their ability to lose and gain water reversibly and to exchange constituent cations without major structural change. Although the crystal structure of each member of a group is unique, all are characterised by networks of channels or pores leading into sizeable central cavities. When the zeolite is hydrated the cavities are filled with cations such as sodium, potassium, calcium, magnesium, strontium, or barium, which are surrounded by water molecules.

When the water is removed by heating (100°-400°C) the cations attach to oxygen atoms on the inner surface of the cavities. Provided the channel dimensions are large enough, molecules up to several angstroms in diameter can enter the dehydrated structure, where they are adsorbed into the vacant cavities. Molecules with diameters larger than the channel apertures are excluded from entering the cavities, allowing the zeolite

structure to be used as an effective molecular sieve. Void volumes in natural zeolites can be as high as 50% making them excellent adsorbents.

The surface area available for adsorption ranges up to several hundred square metres per gram and some zeolites are capable of adsorbing up to 30% of their own dry weight. The temperature at which a zeolite can be effectively dehydrated without major structural change is dependent upon its thermal stability.

The cations in the zeolite structure are only loosely bonded to the silicon-oxygen framework, and can be removed or exchanged by washing the zeolite with a strong solution containing another ion. The framework of a zeolite controls selection between competing ions and different structures offer different sites for the same cation. The capacity of a zeolite for "ion-exchange" is a function of the degree of substitution of aluminium for silicon in the framework structure. The greater the substitution the greater the charge deficiency and hence the greater the number of alkali and alkaline earth cations required for electrical neutrality. The electrical charge on the cation and its size directly affect its acceptance by the zeolite structure, as do its concentration in solution and the temperature at which the reaction takes place.

Adsorbed ions and molecules can be removed from the zeolite structure by pressure decrease, temperature increase, displacement by another adsorbent or a combination of these. As long as the decomposition temperature of a given zeolite structure is not exceeded during regeneration,

the cycle of adsorption, desorption, ion-exchange and molecular sieving may be repeated indefinitely. These properties give rise to exciting possibilities for a wide range of industrial applications and in pollution control programmes.

Zeolites may be used in radioactive-waste disposal, sewage effluent treatment and in the removal of sulphur dioxide from industrial gas stack emissions.

Clinoptilolite has been used for the selective removal of radioactive cesium and strontium from low-level waste waters in some American nuclear installations. The radioactive ions can be extracted and stored indefinitely by the zeolite structure or recovered by chemical means for later recycling. Another method being considered for the safe disposal of nuclear waste is to deposit drums of concentrated waste in holes lined with several metres of packed clinoptilolite. The clinoptilolite would then act as a filter trap in the event of radioactive leakage from the drums or glass blocks used to store the waste.

Minerals such as chabazite, stilbite, and clinoptilolite have been found to be highly ammonia selective giving rise to the possibility of using these zeolites for the removal of ammoniacal nitrogen from sewage and agricultural effluents. Municipal and industrial waste water effluents because of their high concentration of ammonium ions are often responsible for the rapid growth of algae which leads to the over-enrichment of lakes and streams.

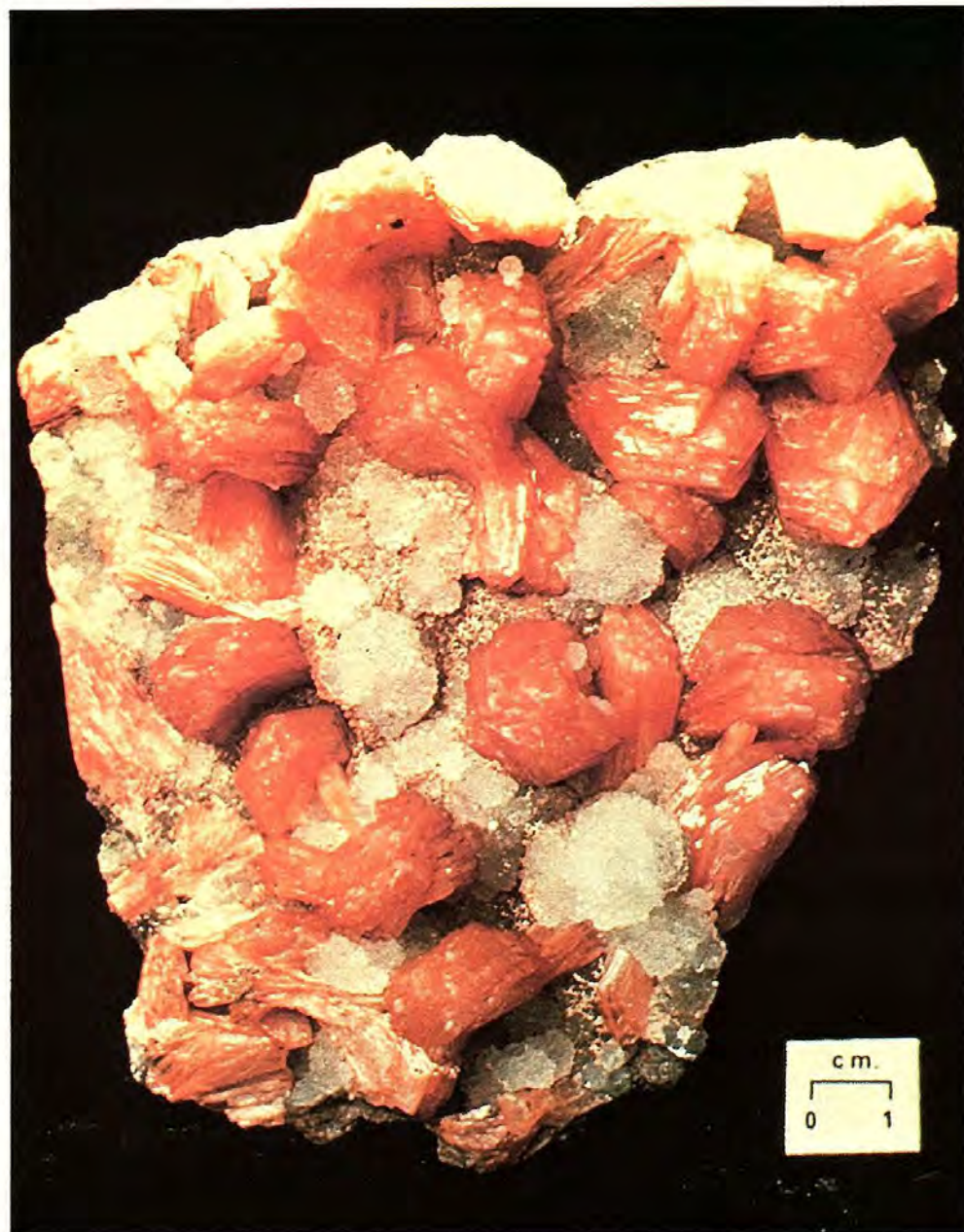
At present plans are going ahead in the United States of America for the development



Top, stilbite crystal specimens are being extracted from a cavity one metre in height in basalt at Tamba Springs. Photo by S. Pecover.

Needles of white ferrierite crystals (above) intergrown with blocky transparent brown clinoptilolite crystals on basalt. Photo by D. Barnes.

Right, "church door" habit orange stilbite crystals with white drusy quartz crystals. Photo by J. Wolfe.



of clinoptilolite ion-exchange sewage treatment plants that will be capable of removing up to 99% of contained ammonium for sewage effluents.

If these plants are successful they may be particularly useful for the treatment of sewage that is pumped into the sea from many Australian coastal towns and cities.

Another area of pollution control that uses natural zeolites is the removal of sulphur dioxide and other pollutants from the gas emission stacks of oil and coal burning power plants. It is estimated that about 25 million tonnes of sulphur is dumped into the atmosphere each year by power stations in the United States alone. Natural mordenites and clinoptilolites are capable of selectively adsorbing up to 200 mg of sulphur dioxide per gram and the greater thermal stabilities of these zeolites permits their use under higher temperature conditions.

Natural zeolites are finding increasing use in a variety of energy conservation applications including petroleum production, purification of natural gas and as heat exchangers in some processes using solar energy.

Catalytic cracking of hydrocarbon fuels consumes a large volume of zeolites employed commercially although the majority of these zeolites are synthetically produced, and are designed for specific processes. However, natural zeolites such as mordenite, chabazite and offretite also have high cracking activity. The hydrogenation of aromatic hydrocarbons and the oxidation of methanes can be catalysed by metals supported within zeolite frameworks.

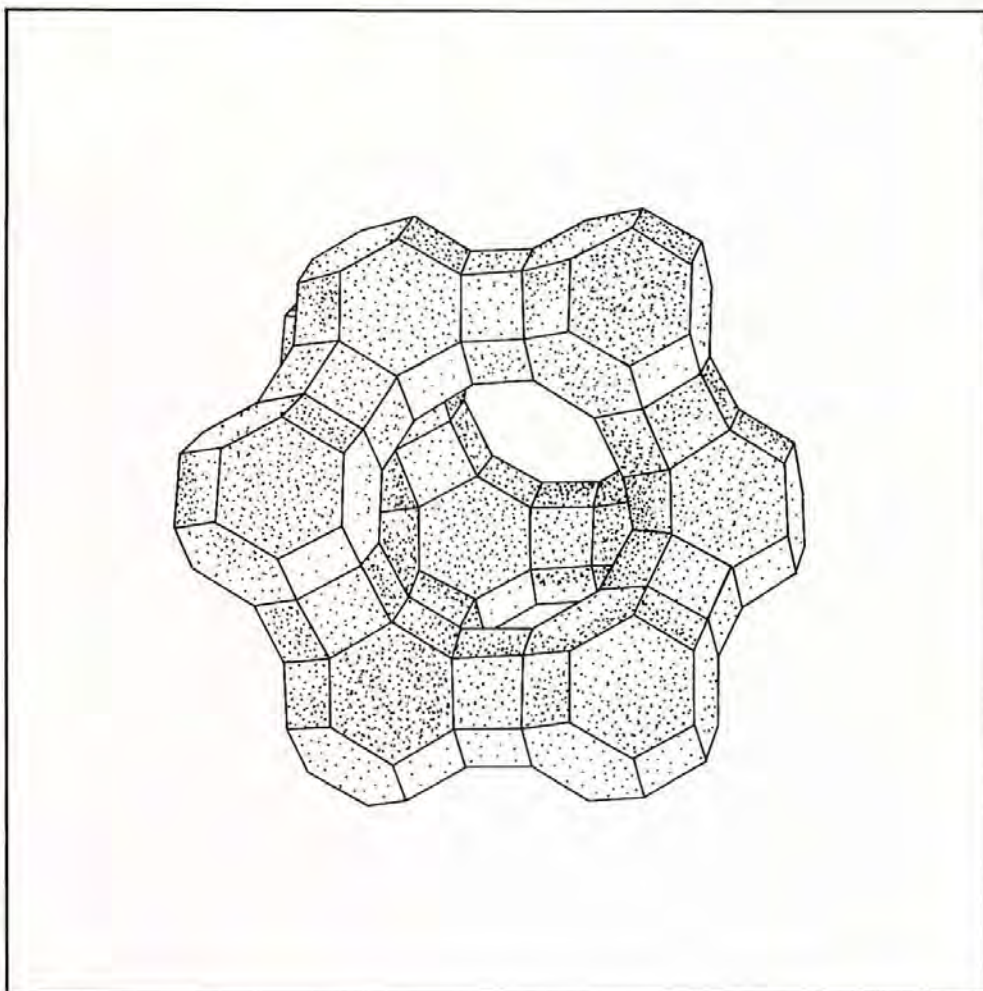
The breakage of large, long chain hydrocarbon molecules to give smaller short chain molecules needed for petrol, is an essential step in oil refining. Because of the molecular sieving properties of zeolite structures, a great

deal of selectivity can be achieved in separating hydrocarbon molecules of different size. Experimental research suggests that zeolite catalysts could play an important role in boosting the production of high-octane petrol in conventional refineries by simultaneously cracking large hydrocarbon molecules and reforming smaller ones to give a product rich in the molecules of high-octane petrol.

As exploration for oil and gas continues throughout the world zeolites may find increasing use in the purification of natural gas, allowing exploitation of contaminated deposits previously thought to be unrecoverable.

Natural zeolites have been used to extract up to 25% of carbon dioxide, hydrogen sulphide and water from well gases in Los Angeles, California. Purification of methane generated from landfills and the digestion of human and animal wastes may also open up economically viable alternative energy sources

The idealised open framework structure of the zeolite faujasite which is made up of simple polyhedra of silicate and aluminate tetrahedra (the centres of which are located at the corners of each square in the illustration). Drawing by S. Pecover after Mumpton, 1977.



previously left untapped. For example methane produced from decaying organic matter in the Palos Verde sanitary landfill in Southern California has been purified with a mixture of chabazite and erionite to remove moisture and hydrogen sulphide thereby providing up to 1 million cubic feet of usable methane gas per day.

Certain zeolites are able to selectively adsorb nitrogen from the air to produce oxygen-enriched gas streams. Research is at present underway on the future use of such oxygen-enriched gas streams to exploit deep-lying unminable coal seams by *in situ* coal gasification, thereby greatly increasing the exploitable reserves of this valuable fossil fuel.

Solar energy is perhaps the most abundant and least exploitable form of energy available. Efficient use of the sun's energy is commonly hampered by the lack of efficient heat exchanges. Chabazite and clinoptilolite, because of their capacity to take up and release large amounts of water reversibly, are able to exchange enough energy to cool small buildings.

Agriculture is beginning to benefit from the capabilities of natural zeolites for adsorption ion-exchange and molecular sieving. The pronounced ammonium selectivity of clinoptilolite has been exploited in the preparation of chemical fertilisers which improve the nitrogen-holding power of soils by increasing the bulk ion-exchange capabilities and by promoting slower release of ammonium ions from the zeolite. Zeolites "doped" with nutrient elements such as iron, manganese, molybdenum, copper, cobalt or zinc may be used as soil conditioners, to facilitate slow and continuous release of necessary trace elements into the soil. In the same way zeolites may be used to carry pesticides, fungicides and herbicides which are less likely to be prematurely flushed from a system, thereby

allowing greater control in pest eradication programmes, and reducing damaging environmental side effects.

Clinoptilolite and mordenite have been used in Japan and the United States of America as dietary supplements for pigs and chickens, resulting in significant increases in feed conversion and in the general health of the animals. The ammonium selectivity of clinoptilolite suggests that it may act as a nitrogen reservoir in the digestive system of the animal. This allows a slower release and more efficient use of ammonium ions enabling digestive tract microorganisms to synthesise cellular protein continuously for easy assimilation into the animal's digestive system. Zeolite particles might also stimulate the linings of the stomach and intestinal tract, causing the animal to produce more antibodies and thus help to inhibit diseases such as scours. The use of zeolites in this capacity could also cut back the use of prophylactic antibiotics normally used to control intestinal diseases in farm animals.

Natural zeolites are also finding increasing use in the selective removal of ammonium ions from fish hatchery waters and recirculating fish culture systems using clinoptilolite ion-exchange columns. Ammonium is extremely harmful to fish in concentrations exceeding a few parts per million and leads to a variety of gill diseases. Up to 98% of dissolved ammonium can be removed from such sys-

tems using clinoptilolite providing a viable alternative to biological oxidation processes which are difficult to manage. As world food production increases fish farming will provide a valuable source of protein thus ensuring the need for large tonnages of natural zeolite material for aquacultural filtration systems.

Research into these amazing and versatile silicates will certainly uncover new applications as the demands for increased energy conservation and a cleaner environment continue to grow. Because of the high cost of producing synthetic zeolites, deposits of naturally occurring zeolites are assuming greater importance as alternative sources for these important minerals.

To date exploration for suitable zeolite deposits in Australia has been largely overlooked and the potential exists for their discovery and exploitation in this country. Once thought of as mineral curiosities, zeolites are now set to take their place as potentially some of the most valuable mineral commodities of the future.

#### FURTHER READING

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 Mumpton, F. A., Ed., 1977, *Mineralogy and Geology of Natural Zeolites*; Min. Soc. of Am. Short Course Notes; Southern Printing Company, Blacksburg, Virginia.



# CENTREFOLD NO. 8

## Purple Queenfish

*Anthias tuka*

by Gerald R. Allen



The main habitat of the purple queenfish is the coral reefs of the western Pacific Ocean where it is most frequently found at the reef's seaward edge in depths ranging from five to 20 metres. Photo by W. Gladstone.

The brilliant purple queenfish, *Anthias tuka* (Herre), is a common inhabitant of western Pacific coral reefs. Huge aggregations which include up to several hundred individuals form an integral part of the fish community in the northern portion of Australia's Great Barrier Reef. It is most frequently encountered in the crystal clear waters at the outer or seaward edge of reefs at depths ranging from about five to 20 metres. Because of its small size (up to 8 cm) the species is of little importance to mankind, although live specimens fetch a good price in the marine aquarium trade. It is a popular fish with hobbyists in Europe and America. Most aquarium stocks have their origin in the Philippine Islands.

The purple queen is a member of the grouper or coral cod family (Serranidae). This group is found in all tropical and temperate seas. In Australia about 100 species are known, mainly from northern seas, making this the fourth largest family of fishes after gobies, wrasses and damselfishes.

Serranid fishes are tremendously diverse in size, shape and colour. The range includes tiny species such as the purple queen, numerous less colourful varieties of medium-sized coral cods and trouts, and the gigantic Queensland grouper, the largest member of the family which grows to three metres and may weigh more than one tonne.

Most members of the family are bottom dwelling fishes which exhibit relatively sombre colouration and have a typical grouper shape including a large cavernous mouth. However, members of the subfamily Anthiinae, sometimes called fairy perchlets, have abandoned the typical serranid bottom dwelling life style. Instead they form large schools which swim high above the bottom in search of planktonic food. The purple queenfish belongs to this specialised group which contains about 10 Australian species. They are among the most spectacularly coloured reef fishes exhibiting a striking array of reds, pinks, and yellows.

One of the most unusual aspects of the life history of the grouper family is the phenomenon of sex reversal. Some species possess both male and female reproductive organs, and can function as either sex or both sexes at the same time, producing their own fertilised eggs. The fairy perchlets, including the purple queenfish, are capable of reversing sex. An individual first develops into a functional female and later may become a male. Generally the sexes have different colour patterns and the sex transformation is often accompanied by a dramatic change in appearance. Purple queenfish juveniles and females are overall purplish with a bright swathe of orange along the back.

Females usually outnumber males by a large margin in the purple queenfish and other species of perchlets. A single dominant male is surrounded by a harem of females which exhibit a sort of hierarchical social organisation, or 'peck order'. If the male is experimentally removed from the group or eaten by a predator, the dominant female member of the harem changes into a male over a period of several days and assumes control of the group.

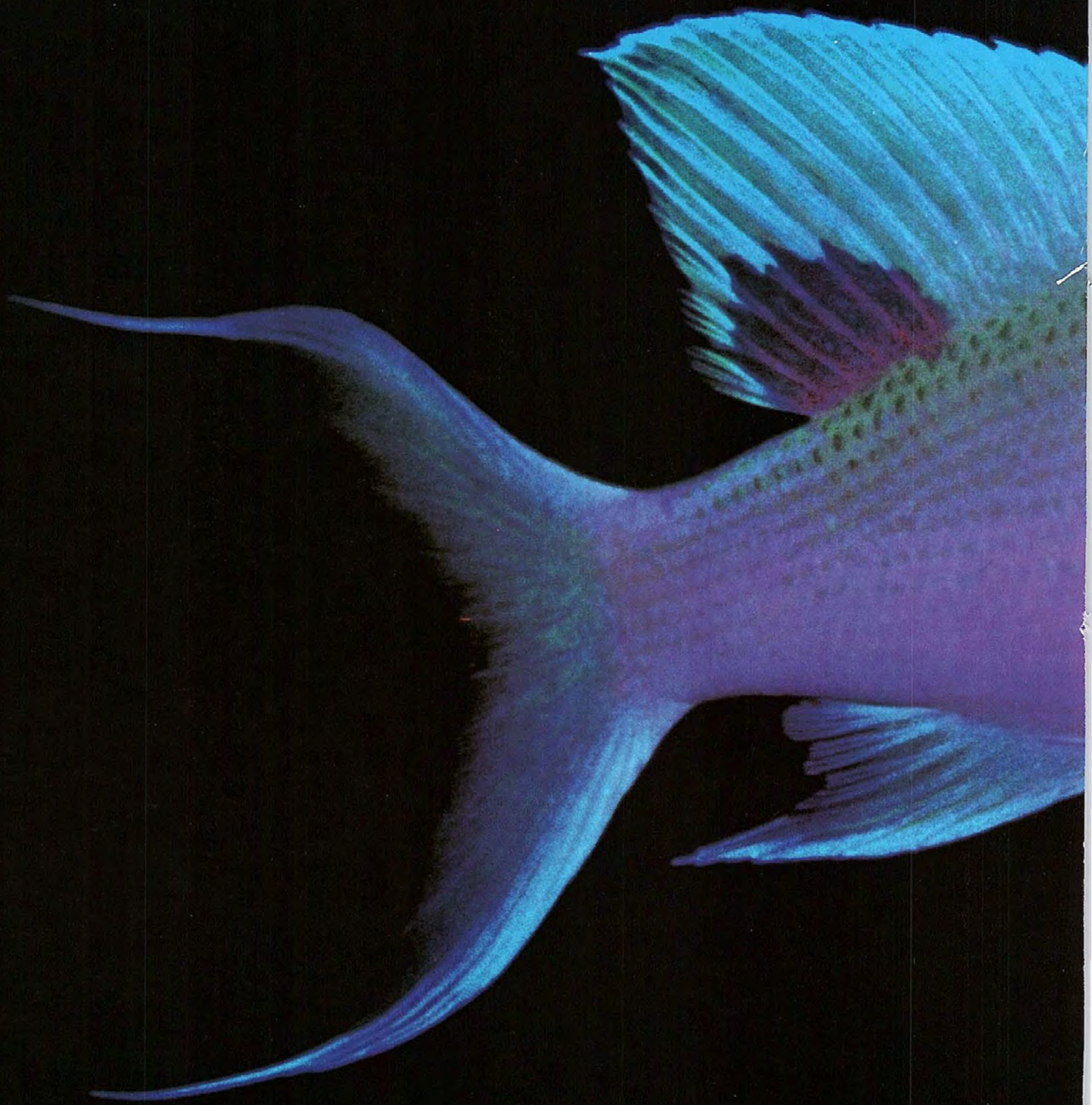
During courtships and spawning the male purple queenfish performs a ritualised display designed to attract gravid females. This behaviour consists of rapid swimming movements and chasing of females interrupted by stationary displays in which the dorsal, anal, and pelvic fins are fully extended. The colour pattern is greatly intensified during this period. The nuptial male is so preoccupied that it can be approached and photographed easily at close range. The dominant male is capable of spawning with several members of the harem during a single spawning bout which may last up to an hour or more.

As far as is known all groupers and perchlets release tiny, spherical eggs which are buoyant and float immediately to the surface. Unlike several other species of reef fish, parents do not care for the eggs or young.

Groupers are a conspicuous feature of many coral reefs, from sandy areas with only occasional rocky outcrops to rich beds of living coral. Their depth distribution ranges from tidepools to the deep trawling grounds of the continental shelf. Each species is confined to a relatively narrow habitat zone. In the case of the purple queenfish this consists of clear water coral reef areas.

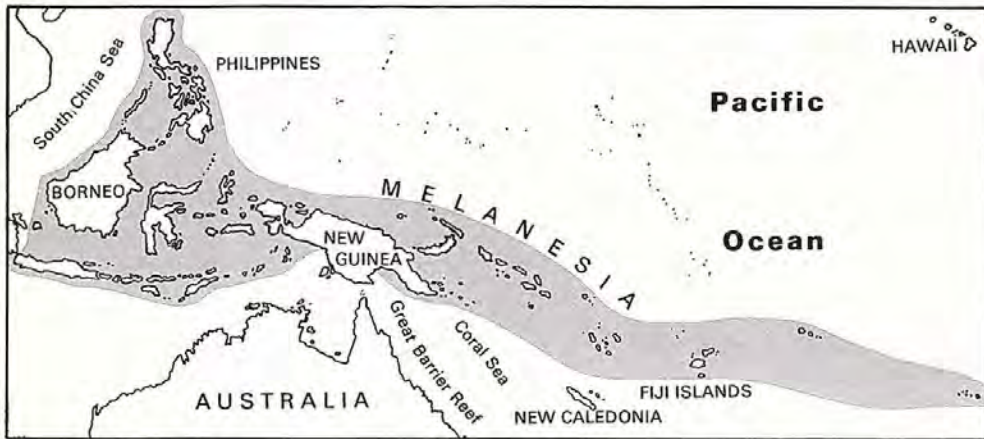
Serranids comprise one of the major groups of predatory fishes. Diet consists of a wide variety of small fishes and invertebrates. Fairy perchlets, including the purple queenfish, favour microscopic animals or zooplankton. The larger grouper species do not normally pose a threat to divers in spite of their size, but Queensland groupers have been known to inflict occasional bites. Their teeth are relatively small and arranged in several rows. Nevertheless, they can inflict rather severe lacerations.

The purple queenfish is also known from the Philippines, Indonesia, and the western portion of the Melanesian Archipelago. A closely related species, *Anthias pascalensis* (Jordon & Tanaka) occurs throughout much of western Oceania ranging north to Japan. The males of the two species are similar in colour, but females and juveniles of *pascalensis* lack orange on the back.



An adult male purple queenfish, *Anthias tuka*, erects its dorsal fin during courtship. Photographed on the Great Barrier Reef off Cairns by Roger Steene.





The range of the purple queenfish.

Class: Pisces  
 Order: Perciformes  
 Family: Serranidae  
 Subfamily: Anthiinae  
 Genus: *Anthias*  
 Subgenus: *Mirolabrichthys*  
 Species: *A. tuka*  
 Common Name: Purple Queenfish

### Fish anatomy (as shown by carp)

Fig. 1

1. Upper lip; 2. Barb; 3. Nasal opening; 4. Eye (the segment from the upper lip to the front edge of the eye is designated the snout); 5. Cheek; 6. Nape; 7. Lower lip; 8. Throat; 9-12. Gill covers; 13. Back; 14. Dorsal fin; 15. Thorax; 16. Pectoral fin; 17. Belly; 18. Pelvic fin; 19. Lateral line; 20. Anus; 21. Anal fin; 22. Caudal peduncle; 23. Caudal fin.

Fig. 2

1. Premaxillary; 2. Maxillary; 3. Dentary; 4. Lacrimal; 5. Orbital; 6. Frontal; 7. Operculum; 8. Cleithrum; 9. Coracoid; 10. Scapula; 11. Pectoral fin rays; 12. Pelvis; 13. First to third vertebrae; 14. Ribs; 15. Radiala.

Fig. 3

1. Gill elements; 2a. Anterior swim bladder compartment; 2b. Posterior swim bladder compartment; 3. Esophagus; 4. Liver; 5. Intestinal tract; 6. Anus; 7. Kidney; 8. Urinary bladder; 9. Testes; 10. Atrium; 11. Ventricle; 12. Bulbus arteriosus.

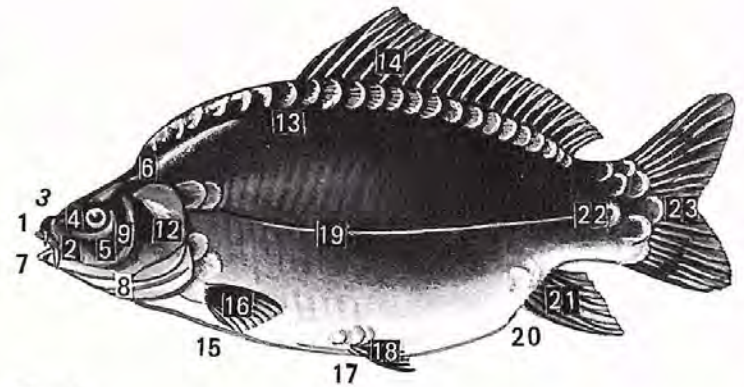


Fig. 1

Drawing by A. Hudson, after Grzimek.

Fig. 2

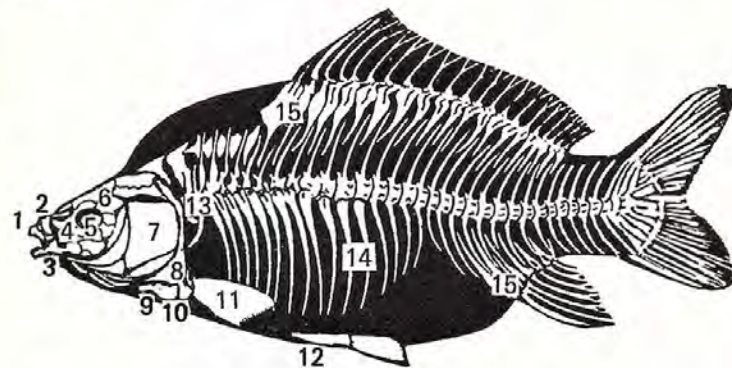
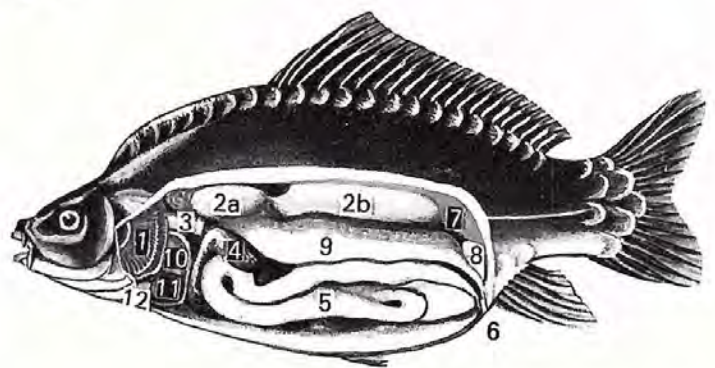
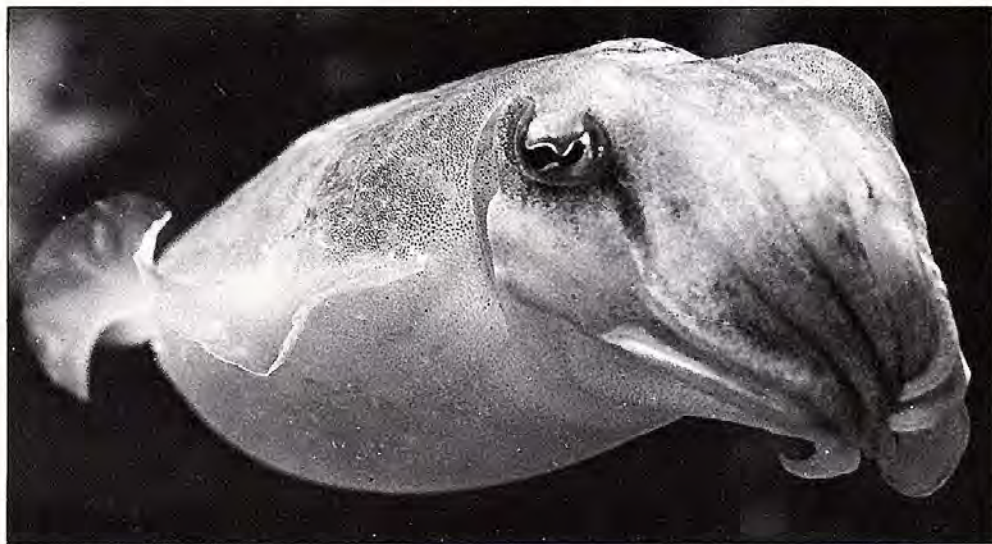


Fig. 3



# CUTTLEFISH OF SYDNEY HARBOUR



by Charlotte Watson-Russell



The author underwater collecting specimens. Photo by Jock Young.

Typical swimming pose (top right) of a cuttlefish. Photo by Harry Millen.

White, chalky and relatively soft, the backbone of the cuttlefish is often found washed up on beaches during a change in tide. Many bird fanciers buying cuttlebones do not realise the source of the substance that does their bird's beak so much good. The little-known cuttlefish has an amazing repertoire of colour displays and interesting behaviour patterns. Charlotte Watson-Russell joined The Australian Museum's marine staff in early 1975 and remained as a technical officer for five years. Her underwater scuba diving, exploration and photography helped to provide this comprehensive story of cuttlefish of Sydney Harbour.

Being molluscs cuttlefish belong to the class Cephalopoda, which also includes octopus, squid, *Spirula* and *Nautilus*. Cuttlefish are oval-shaped animals with narrow lateral fins extending the length of the body, have eight short arms with suckers and two longer club-shaped tentacles used for catching food. The tentacles can be retracted into pouches lying on each side of the beak. The cuttlebone, seen among beach debris and sold in shops for budgies to nibble on, is used by the cuttlefish to control its buoyancy and consists of thin calcareous layers.

Cuttlebones—or sepions, as they are more scientifically known—have characteristics enabling them to be distinguished to species, and the taxonomy of cuttlefish has been based traditionally on study of the dry cuttlebone. Often, little or nothing is known of the live animal itself. Also, the geographical distribution of most species of cuttlefish is based mainly on collected cuttlebones, but since these can be transported by ocean currents over great distances, their presence in a certain locality does not reliably indicate that the animal really lives there.

Available literature on live cuttlefish is based on observations of the European species *Sepia officinalis*. Little is known of the individual or population biology of Australian species. Indeed, only very recently certain species have been described for the first time, based on preserved animals with the sepiion intact.

A growing number of collections, observations and photographs have now been made by naturalists, divers and fishermen, particularly on the shallower dwelling cuttlefish of Sydney waters. This information on their habitats, fantastic colour displays and associated hunting, feeding, fighting and courtship behaviour adds another dimension to the study of cuttlefish. It also means that identification to species can be made underwater by careful observation without destroying the animal.

Cuttlefish have an amazing repertoire of colour displays. Chromatophores, which are responsible for colour changes in cephalopods, are spread out in a regular pattern over the animal's skin. They contain colour pigments in an elastic sac that can expand or contract through the operation of muscles under nervous control. Thus the variations in colour intensity and hue intricately reflect the animal's well-being. Cryptic and warning colours in cuttlefish have important survival value by protecting the animal against such predators as large fish, cormorants and penguins, as well as concealing the cuttlefish as it stalks its own prey such as small fish and crustaceans. Succeeding flushes of colour and skin texture changes help to alter the outline of the body. Juveniles and adults stay close to the substrate during the day and, even when newly hatched, are able to closely mimic their backgrounds.

The common European cuttlefish, *Sepia*



A male *Sepia plangon* in full courtship regalia (top). Taken in Sydney Harbour this male shows the characteristic zebra pattern, bulging of eyes and attenuation of the body. Photo by C. Watson-Russell.

The secretive *Sepia mestus* cuttlefish which has a broad head and the characteristic yellow-orange eye socket. Its oval body has a bluntly rounded mantle which reaches level with the beginning of the eye. Photo by R. Kuiter.

*officinalis*, has been described as burying itself in the sand during the day. Observations of local Sydney cuttlefish, particularly *Sepia plangon*, both in the field and in aquaria, indicate that it does not bury itself completely, but excavates a shallow depression by blowing water from its funnel and displacing the sand. The animal rests horizontally with arms tucked down in front of the head, each arm curled in a tight circle at its extremity. The dorsal surface of the resting cuttlefish is covered with small erect papillae and assumes the colouring of its background.

Observations of *Sepia mestus* show that this animal props itself up on the sand with the posterior ventral part of the body stretched into two 'keels' with the two outer broad arms wrinkled at the edges but fully stretched out, supporting the head. *S. mestus* often assumes a mottled pattern on its upper surface while resting on the sand with lacy brown banding often visible on its sides below the lateral fin.

Juvenile cuttlefish exhibit a 'flamboyant' display when disturbed. Observations of *Sepia plangon* show they go through a repertoire of changing colour from a cryptic pattern to a translucent brown, smoothing the papillae and raising and curling the middle arms, followed by lowering of the two outer broad arms to the substrate. Culminating this display is a change back to a mottled pattern, an exaggerated erection of the papillae and an extensive wrinkling of all eight arms. If threatened further, the small animal turns pale and rapidly shoots off backwards, ejecting a small puff of ink to one side as it jets over the bottom.

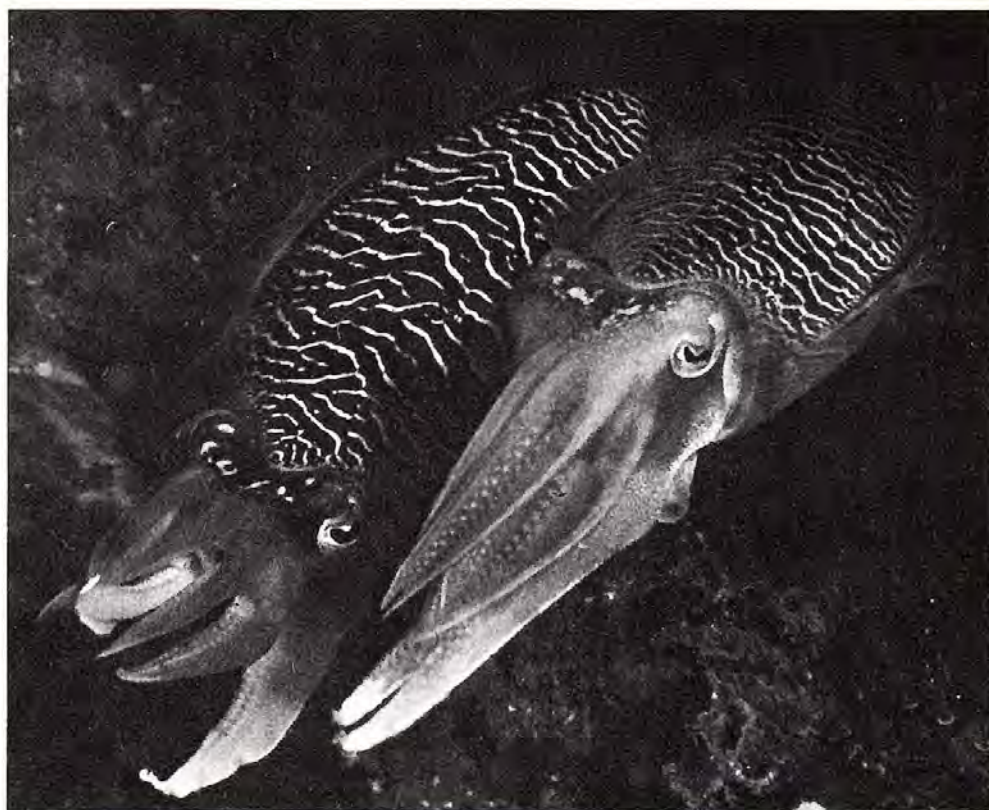
Aggressive or warning behaviour in adult cuttlefish is also accompanied by a sequence of colour and skin pattern changes. Juvenile and adult *S. plangon* have been observed hanging in midwater (sometimes just under the surface at dawn) waiting for their prey with the two front arms raised and the two long tentacles concealed. When the cuttlefish sees a fish or shrimp its body goes through a series of dark flushings of colour and raising of papillae prior to attack. When within range, the tentacles are suddenly shot out and then retracted holding the prey which is then bitten by the beak and at the same time injected with poison. The dark maroon colour is maintained while the cuttlefish eats its prey which is held firmly by the two web-like, broad outer arms. Underwater photographs taken both during the day and at night show a similar red colouration, ranging from shades of pink to deep rose, when the animal is active and swimming off the bottom.

When disturbed while eating or swimming, cuttlefish become alternatively mottled and wrinkled with the appearance of two prominent black spots on the back, then pale and smooth with flashing dark rings under the eye. If further disturbed, the cuttlefish becomes uniformly white, takes off midwater and often ejects a cloud of ink as a decoy to the pursuer. The flashing of dark spots and rings against a pale background has been called a 'dymantic' display, and undoubtedly serves to startle predators.

Perhaps the most spectacular colour displays in cuttlefish are those seen during courtship and mating. In *S. plangon* this occurs from October to January in Sydney Harbour, and may be seen during the day and at dusk when adults congregate in small numbers near rocky reefs and over adjacent sand. Males about to pair exhibit black and white zebra stripes with the fourth left arm extended and often a curious stretching out or attenuation of the body, together with a bulging of the eyes. If two such males meet, squabbling, biting or attempted copulation may follow until one retires. If the second cuttlefish is a female, it may display a less brilliant colour pattern, or more usually, will quietly swim away pursued by the male. Multiple matings occur, not always between the same pair.

B. C. Cotton described mating in *Sepia* thus: "The larger of the pair threw itself upon the smaller; the first pair of arms were raised, the fourth pair depressed, the others interlaced, and the two animals embraced mouth to mouth for several minutes. Their eyes, usually narrowly contracted, became circular, largely dilated, and kept a fixed stare, with the pupil jet black and brilliant . . . The sexual excitement seemed to endure longer with the female than with the male, for the dilation of her eyes still continued, while his had resumed their usual form." (*South Australian Mollusca*, 1940)

While in the mating embrace, the male's hectocotylous arm—his modified fourth left arm—places spermatophores within a groove on the inner side of the membrane surrounding the female's mouth. The female lays her eggs a few days after mating. They are laid one by one, and some *Sepia* species spray the naked white egg with ink or sand grains. The eggs



Aggressive display (above) between two male *Sepia plangon* in Sydney Harbour. Zebra stripe body colouration and bulging of the eyes is a typical reaction.

*Sepia plangon* juvenile (right) showing flamboyant display which occurs in response to threat and involves raising the body papillae and stretching and wrinkling the arms.

Eggs of *Sepia mestus* (below) attached to the ceiling of rotting wood. Photos by R. Kuiter.





Colour and skin pattern changes in cuttlefish result from aggressive displays or warning behaviour, camouflage and finally and perhaps the most vivid examples of colour displays during mating. Above an unidentified species of tropical cuttlefish shows a sequence of rapid colour change. Photos by W. Gladstone.

resemble clusters of grapes with two strands for tying at one end and have been photographed in Sydney Harbour attached to supports such as rotting wood and sponges. How the female ties the eggs onto the support is unknown. Unlike the common octopus the mother does not look after the eggs.

The life cycles of the various Australian species of cuttlefish are poorly known. However, the regular appearance of large numbers of *Sepia apama* cuttlebones washed up on beaches south of Sydney during the late winter months suggest a possible one or two year life span for this species.

Research and more observations on the behaviour of cuttlefish are needed to fill in the many gaps in our knowledge. These fascinating and beautiful animals deserve further study by fishermen, divers and naturalists alike.

There are approximately fourteen species of cuttlefish belonging to the genus *Sepia* found along the east Australian coast. Seven species occur along the central New South Wales coast, four of which are commercially trawled by fishermen. Cuttlefish live in a variety of habitats—among the sheltered sea grass beds in shallow bays and estuaries, on exposed rocky reefs, and offshore to depths of 200 m along the sandy and muddy bottoms of the continental shelf.

The following is a brief description of those species found in Sydney waters. Ranges, except where specified otherwise, are based on the presence of the cuttlebone. Size is based on measurement of the largest animals present for this study.

*Sepia apama* Gray, 1849

This is the largest cuttlefish found in near-shore southern Australian waters, possessing a long, broad body with a wide lateral fin and three distinct flat membranous papillae behind the eye which are usually held erect in the live animal. Size: Up to 60 cm.

Habitat: Adults are trawled by Sydney fishermen in depths of 30 to 50 m on sand adjacent to rocky bottoms off the coast between Sydney and Ulladulla, NSW, and are often sighted by divers in similar depths under rocky overhangs or near rocky reefs. Juveniles can occur in dwarf kelp stands in

coastal bays and under jetties in depths as shallow as 5 m.

Range: Based on live specimens, *Sepia apama* has been found from Port Jackson, New South Wales, to Point Cloates, Western Australia.

Cuttlebone: In small specimens the broad, oval cuttlebone has a well-developed inner core with a straight, short spine. As the animal grows, the bone becomes longer and more pointed, losing the spine and acquiring a V-shaped callous formation in the inner cone. The dorsal surface is coarse and granular.

Note: Unlike the smaller, generally shy cuttlefish, *Sepia apama* is very curious, a favourite trick being to loom up behind a diver's shoulder or face him directly without showing any signs of fear. It has been reported as nibbling at divers' fins and in one case even successfully stole a diver's knife. *Sepia apama* is a powerful animal, capable of biting a chunk out of a fisherman's rubber boot.

*Sepia mestus* Gray, 1849

This secretive cuttlefish has a broad, oval body with a wide lateral fin; the margin of the mantle is bluntly rounded and reaches the level of the beginning of the eye. The head is broad with a characteristic yellow-orange eye socket. Size: 20 cm.

Habitat: Sandy and rocky drop-offs, 10 to 18 m, and has been also observed under rotting wharf pilings and rock ledges in Sydney Harbour during the day and on rocky reefs in Port Hacking and bays south of Sydney.

Range: Southern Queensland to southern New South Wales.

Cuttlebone: The dorsal surface is bluish to white, the ventral surface having a large, white inner cone. This broad ovoid cuttlebone has a strong backwardly produced spine.

*Sepia plangon* Gray, 1849

This small estuarine cuttlefish is commonly seen by divers in Sydney Harbour. Both the males and the slightly broader females can be recognised by a characteristic projecting dorsal (upper) margin of the mantle that reaches

the mid-level of the eyes. A bluish tinge to the eye socket is often present. Size: 10 cm.

Habitat: Shallow bays, 3 to 9 m, in harbours. Juveniles found in sea grass beds and adults seen near small rocky reefs and dwarf kelp, *Ecklonia*, stands and over the sand.

Range: Southern Queensland to southern New South Wales.

Cuttlebone: Often found in large numbers on beaches north and south of Sydney. Slender elongate shape with a deep central groove on the ventral (lower) surface and a small spine.

*Sepia rex* Iredale, 1926

This animal was described as recently as 1979 by W. Adam from specimens collected from the Western Australian coast and is marked by a strongly protruding dorsal margin of the mantle that reaches beyond the mid-level of the eye. Size: 17 cm.

Habitat: Abundant in deep water—fishermen have reported catches of 200-300 kg in a single shot in depths of 140 to 160 m off Botany Bay.

Range: All Australian States including Lord Howe Island.

Cuttlebone: Distinctive salmon-coloured dorsal surface with three strong longitudinal ribs and granulose texture.

*Sepia rosella* Iredale, 1926

This animal was first described in part by W. Adam, 1979, from poor specimens collected off La Perouse, New South Wales. Size: 20 cm.

Habitat: This is another common species trawled offshore in locations and depths similar to *Sepia rex* and is brought into Sydney fish markets in large numbers.

Range: Southern Queensland to New South Wales including Lord Howe Island.

Cuttlebone: The limbs of the inner core are a distinctive rose colour, and the keeled, thick spine has a ventral notch at its base. Also, three faint longitudinal ribs appear on a pink dorsal surface.

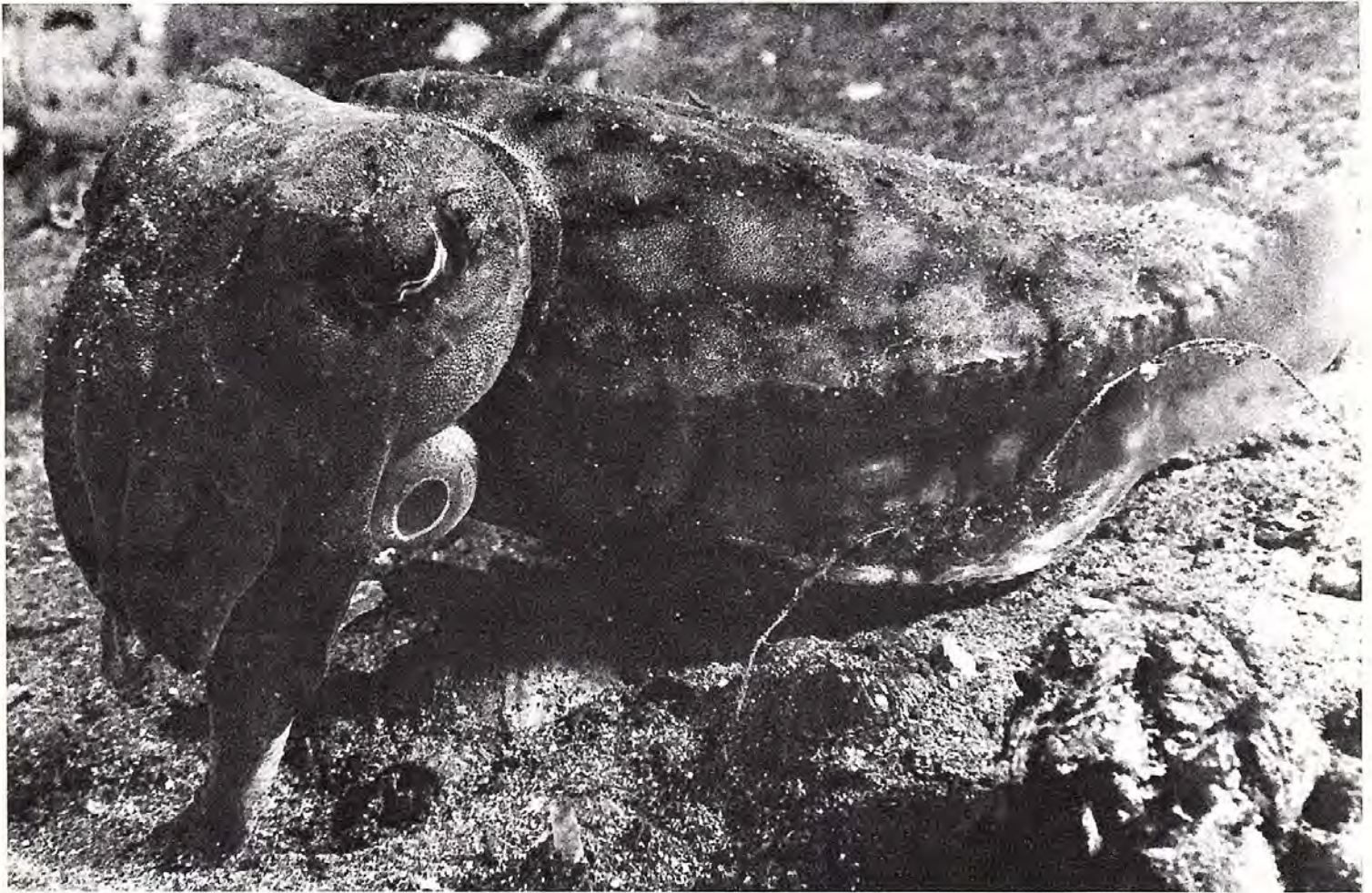


*Sepia apama* juvenile in seaweed and showing the three prominently raised papillae above the eyes that are a characteristic of this species.

Two *Sepia mestus* (centre) both showing aggressive display. The two dark spots shown up against the pale red background serve to startle predators.

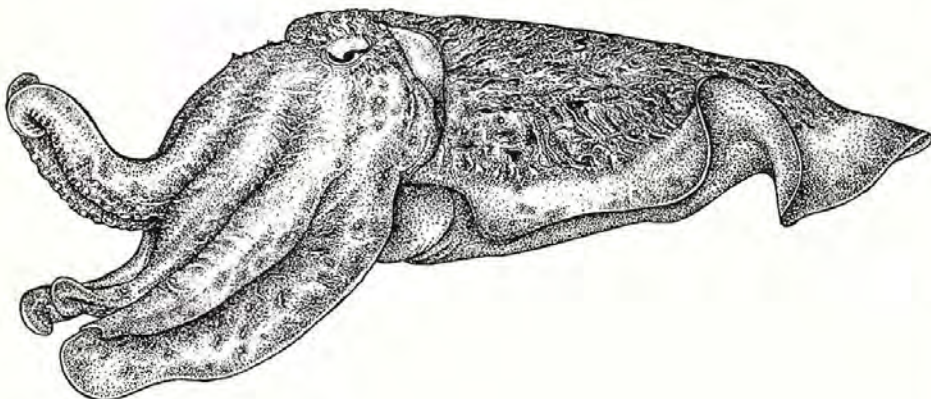
*Sepia apama* (bottom) adult swimming in midwater at Montague Island and showing particularly broad arms and mantle. Photos by R. Kuiter.





*Sepia mestus* resting on the bottom of Port Hacking with its lower body stretched into two keels which help support it in a resting position on the sand. The pigmentation under the eye in this species is yellowish-orange. Photo by R. Kuitert.

*Sepia whitleyana* with its two front arms curled up in a warning gesture. Drawing by C. Watson-Russell.



*Sepia whitleyana* Iredale, 1926

A fairly large, broad animal with long, slender arms and tentacles. The colours of the living animal and the other three deep-water species have not been described. The preserved animal has small white wavy lines on the mantle and white spots prominent on the arms against a purplish pink background. It is less common than the preceding two species. Size: 30 cm.

Habitat: This cuttlefish is trawled offshore north of Sydney and Newcastle in 70 to 90 m

from mud bottoms and sometimes appears in Sydney fish markets.

Range: Known from Queensland and northern New South Wales as far south as Port Macquarie, but was recently trawled as far south as Ulladulla, New South Wales.

Cuttlebone: Elongate with dorsal surface coarsely granulate. Ventral surface has a characteristic posterior part of the inner cone raised, forming a small calcareous ledge.

*Sepia cultrata* Hoyle, 1885

The species at present is known only from a few specimens.

Habitat: The type specimen was trawled off Twofold Bay, New South Wales, in deep water.

Range: Recorded from southern Queensland, New South Wales, Victoria and Western Australia.

Cuttlebone: Dorsal surface is salmon coloured with a distinct narrow median rib and two faint lateral ribs. Elongate in shape with a characteristic triangular pointed anterior end.

Note: While the cuttlebone has been commonly collected in some localities, the animal still appears difficult to collect.

# VENOMOUS AUSTRALIANS

by Paul Webber



Paul Webber explaining a death adder's anatomy to school children during the exhibition of venomous Australian animals held in the Long Gallery at The Australian Museum. Photo by John Fields.

Paul Webber, who previously worked in the Herpetology Departments at both the British Museum of Natural History and The Australian Museum, has established a company with John Edwards called 'Venomous Australian Wildlife'. Formed to promote an awareness among the public of our venomous animals, the company has a permanent exhibition at the top of Australia Square, in Sydney, and holds travelling exhibitions visiting shopping centres and schools throughout the state.

Stings, bites and scratches are an integral part of any camping, fishing or bush walking holiday and are common complaints around the house and garden and, indeed, are generally accepted as an overall part of an Australian summer. One of our more dubious claims to fame is that the Australian continent and its surrounding waters are home to perhaps the greatest variety, and numbers, of venomous animals to be found anywhere in the world. Of these, the majority are relatively innocuous, causing no more than minor irritation, but at the other extreme a number rank among the most venomous in the world.

For the purpose of brevity, many venomous animals will not be considered here—the majority of ants, mosquitoes, sandflies, scorpions, centipedes, etc—but those that can inflict painful or serious bite or sting are worthy of attention particularly where young children are concerned.

A common question asked is: "How quickly can a particular species kill you?" To this, of course, there is no answer due to a number of variables: How heavy is the person? How fit are they? Where were they bitten? Also, and this may be critical, what is the physiological condition of the patient—their individual degree of allergic reaction to the particular venom? Then there are a number of variables with respect to the particular animal. Did it inject with one spine, or fang, or more? How much (if any) venom was injected? And, in some cases, was the animal male or female?

Generally, there is little awareness of our venomous fauna—people are unable to identify accurately what has bitten them, and personal observations of school children suggest that perhaps a maximum of only 0.05 per cent are aware of the currently correct first aid.

One point that should be stressed is that if someone is bitten, but is given the appropriate first aid and taken to hospital for observation and/or treatment, their chances of total recovery are splendid. This does not mean that simple rules to avoid being bitten should be ignored, as probably the most important and immediate reaction, which is nearly always overlooked, is that the 'bitee' is in quite considerable pain and sometimes shock.

The monotremes, ranked as among the world's most unusual animals, are not only distinguished by being egg-laying mammals, but also by the males possessing a venomous spur on each hind leg. The spur of the

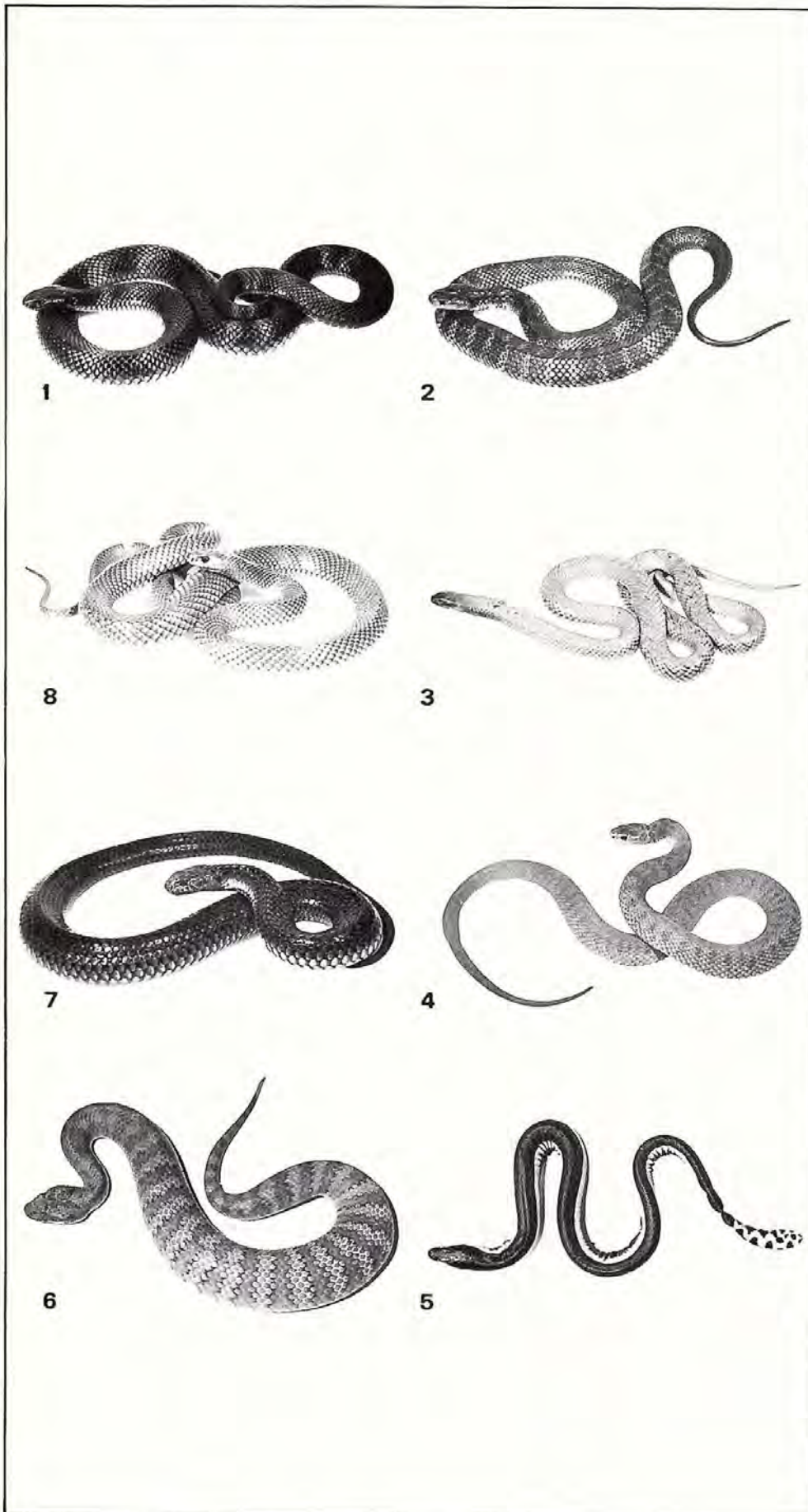
echidna, being vestigial, is extremely unlikely to cause any damage to a predator. The heavy covering of spines offers more than sufficient protection to this animal. The male platypus, however, has well-developed spurs and venom glands. The functional significance of these is not known, although the glands do swell during the breeding season. When these animals were trapped for their fur years ago, several cases occurred where trappers were jabbed with these spurs and venom injected.

An acquaintance who had just recently been 'spurred' informed me that the pain was "more of a dull ache than a sharp searing sensation", but was accompanied by almost immediate swelling around the puncture which extended up the arm after about 30 minutes, followed by nausea and dizziness. He made his way to hospital where antibiotics were administered amid general hilarity by the doctors and staff. Vertigo, nausea and diarrhoea continued for a further fortnight. Eventually a second opinion was sought with the result that the first medication was held to be totally inappropriate. A further two weeks elapsed before the patient was back on his feet again. One can perhaps understand the amusement engendered by such an encounter with this little 'Aussie favourite', but it took the recipient a long while to see matters in quite the same light.

The most widely feared, and yet generally least understood animals in Australia are the snakes. They may be loosely divided into the following categories: 1. Non-venomous; 2. Venomous with only sufficient strength or quantity to overcome prey, or cause minor irritation to humans; 3. Venomous with sufficient quantity or strength of venom to cause suffering (rarely death) in an adult; and 4. Venomous causing severe injury or death to an adult without appropriate treatment.

In the group which can cause severe injury or death, probably only a dozen or so species should be considered. These, however, are common, and four may be found within 20 km of the GPO, Sydney; red-bellied black snake, eastern brown snake, common death adder and eastern tiger snake. It is presently recognised that Australia has the 'top six' potentially most dangerous snakes in the world, but really this is only of academic interest—it is rather like the distinction between being run over by a truck or a car; the results can be identical.

So, what are the statistics on snake bites in Australia? The Commonwealth Serum



Laboratories estimate up to 3,000 people a year are bitten by snakes, with about 10 per cent requiring hospitalisation and administration of antivenom. In the last decade, 1978 was probably the worst year when 10 people died.

Although about 2,700 people in Australia each year are therefore bitten by harmless snakes or snakes of low potency, questions arise as to how, or why they were bitten and what subsequent action was taken. It is recognised that about 95 per cent of snake bites occur in the extremities and lower limbs. These may be conveniently divided into two categories: legs below the knee, and arms below the elbow. In the former instance, the snake has either been trodden on, or an unwary foot has descended in close proximity. The solution is simple—look where you are walking and when out bush walking, wear long trousers and a good pair of boots covering the ankle. Fortunately, most Australian snakes have relatively short fangs, usually no more than 3 or 4 mm in length, and it is extremely unlikely that their fangs will pierce a good leather boot. Similarly, there is a good chance that if trodden on, and the snake lashes around, it will grasp loose trousers rather than one's leg.

In the case of bites on the arms below the elbow, use a certain degree of caution in protecting hands when moving timber, bark, rubbish, etc. and even more important, do not attempt to pick up a snake, however small—deaths have occurred from the bites of juvenile snakes. It is quite fallacious to consider that it is safe to pick up a snake by the tail. Similarly, do not emulate television heroes and bury your hand in a hollow log to find out what is there. There are sufficient number of people around who do this and end up in hospital, often repeatedly. Don't be one of them!

Sea snakes pose little threat to the beachgoer—they can swim fast and put this to admirable effect in avoiding humans frolicking in the surf. To divers, a slightly different problem becomes apparent. Sea snakes are curious and will often approach divers, 'smelling' them with their tongues before leaving. Admittedly a worrying experience, but unless the snake is hit or grabbed, it is unlikely to prove injurious to either party.

The biggest 'bogey' of the Sydney region in particular, is the funnel web spider. It attracts more horror and publicity than Alfred Hitchcock's masterpieces, and, unfortunately, most alarmist reports carry about as much scientific fact as his 'Tales of the Macabre'. Even so, the funnel web is probably one of the world's most dangerous spiders and should on no account, either figuratively or literally, be brushed aside. It would be a relief, however,

In a clockwise direction from top left, 1. a red-bellied black snake, *Pseudechis porphyriacus*; 2. tiger snake, *Notechis scutatus*; 3. western brown snake, *Pseudonaja nuchalis*; 4. rough-scaled snake, *Tropidechis carinatus*; 5. yellow-bellied sea snake, *Pelamis platurus*; 6. death adder, *Acanthophis antarcticus*; 7. copperhead, *Austrelaps superbus*; and 8. an eastern brown snake, *Pseudonaja textilis*.

to lay to rest some of the more bizarre claims to fame of this spider, but unfortunately folk tradition has a strong hold, and with a peculiar distortion, most people prefer to believe marvellously sensationalised journalese. Funnel web spiders DO NOT jump, chase you across the floor, leap at you out of trees, get annihilated by spraying or kill you within seconds. The male, not the female, is the most dangerous. Spraying may kill some funnel web spiders, but it also severely decimates beneficial insects, lizards, frogs and small birds.

If you live in a renowned funnel web spider area, simple steps can be taken to prevent bites: when wandering to bathroom or kitchen at night, turn on the light; don't allow children

under the house; when working in the garden, rolling logs, rocks, sheets of tin, etc, use your brain first—pull up such items towards yourself, thus keeping the rock or whatever between yourself and any 'troglodite beastie'; don't gather up leaves, etc, with your hands—use a rake and wear gloves; shake out and check old gardening clothes left in the shed before putting them on; and educate your children—impress them with a sense of responsibility, not blind fear and panic.

The other spider worth mentioning is the redback. About 300 people are hospitalised every year due to bites from this animal. Of these, 55 per cent (about one person every two days) are bitten on the feet, as they have not shaken out a pair of shoes or boots they

have left outside; 22 per cent (one a week) are bitten on extremely delicate parts of their anatomy. Slim Dusty in his song "Red-back on the Toilet Seat" sums up the situation. No one can ever be in so much of a hurry that they cannot check out their boots or a toilet seat before use!

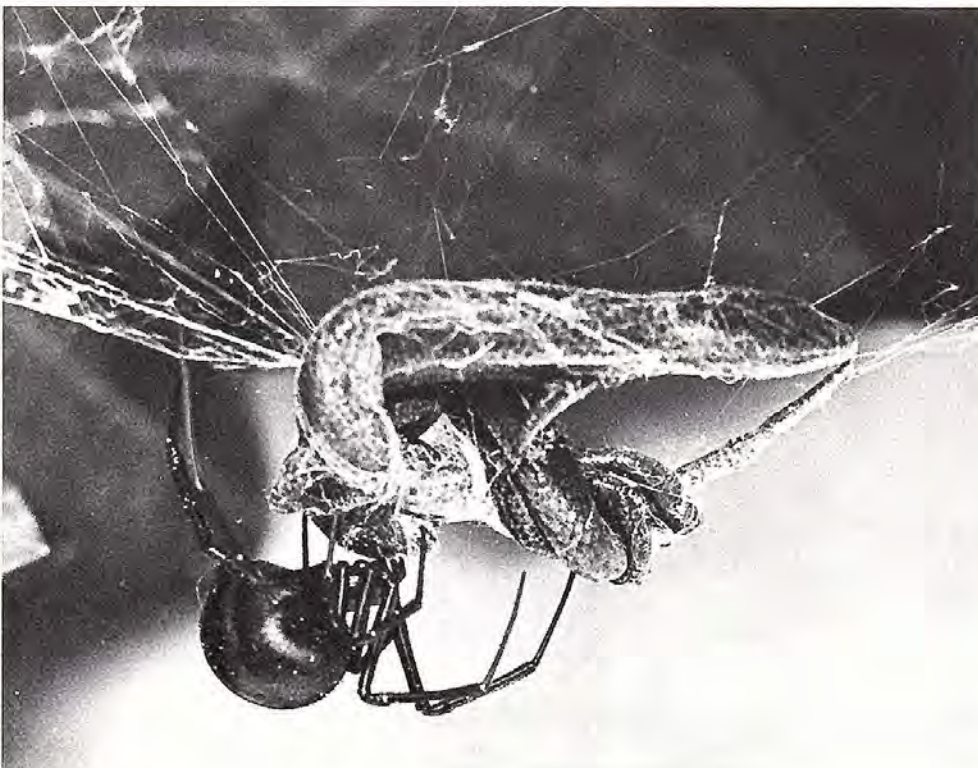
Escaping to the beach away from these previously mentioned animals one finds merely substitute organisms. The delight of most children living near beaches is to 'poke around in rockpools'. Still prone to this activity, I can vouch for the delight when encountering an unusual animal or observing the private life of some small organism. How many can remember back to childhood when we were enthralled by finding a shell in a rockpool which,



Above, web of a female funnelweb from northern NSW.

Top left, female Sydney funnel web, *Atrax robustus*, restricted to the central coast and mountains. Photos by Mike Gray.

Left, female red-back spider, *Latrodectus hasseltii*, feeding on a skink. Photo by N. Roberts.



when placed to our ear, gave out the sound of the sea? How many of us have watched kids retrieve drink cans from the sea, shake out sand, ooze and other detritous and peer wondering through the ring-pull hole? Twelve thousand blue-ringed octopuses have been collected for venom research from these and similar hiding holes.

Blue-ringed octopuses are common. They can be lethal. With tentacles stretched they measure maybe 10 cm across and house a body about the size of the end joint of one's thumb. In justice to the octopus, it is an inoffensive, secretive and elusive animal to capture. It is not blue, but goading the animal, by poking it or trying to put a fish hook through it, is rewarded by pulsating blue to purple bands and rings. The message is obvious.

As well as blue-ringed octopuses, one should consider the other hazards of rock-pools—sea urchins, oyster shells, to say nothing of myriads of small fish with spines which can inflict extremely painful injuries. Add, of course, the idiot human impact—broken glass, rusty wire, bits of tin, etc. The solution? Wear a pair of sandals when wading; they are equally effective for sea urchins or glass! Of course, in more tropical waters where stonefish occur, even sandals will not give protection from one or more of their 13 spines. Sandals will, however, substantially limit the depth to which the spines penetrate.

Often the immediate reaction to injury is panic, as exemplified by an acquaintance who successfully speared a stingray. Proudly returning to shore with the dead(?) impaled stingray, he placed his foot at the back of the ray to disengage the spear. The larger of the two spines penetrated his tibia whereupon he lit out for his car at the top of the cliff. He regained consciousness in hospital and was released, on crutches, a week later.

The only way to avoid a sting by the blue bottle, or Portuguese man-o-war, is not to swim when they are around. With tentacles sometimes up to 7 m in length and with the potential to deliver excruciating pain, discretion is most certainly the better part of valour. Another small animal closely linked with the blue bottle, of which people are largely unaware, is a small slug-like marine mollusc, *Glaucus*, which eats the jellyfish and is able to absorb the stinging cells, or nematocysts, and relocate them in its own epidermis, providing an admirable defence for itself. Because these nematocysts are often present at far greater density in *Glaucus* than the jellyfish, the concentrated 'sting power' is thus similarly increased.

Further north the box jellyfish, or sea wasp, has justly earned an awesome reputation. At present 42 people have died from its sting. Practically transparent, it is exceptionally difficult to see, and possessing tentacles of between 3-5 m armed with powerful nematocysts, it presents a formidable threat. Research by scientists at Townsville has led to the development of a 'stinger suit' which will protect bathers from the serious consequences of a chance encounter of the worst kind. This suit, as well as pantyhose (admit-



tedly rather shattering to sensitive male egos), can, and does, offer protection. However, the simple expedient of following warning signs placed by local councils will save injury or possibly lives.

In summary, enjoy the bush or beach, encourage interest, enthusiasm and most of all responsibility among young people. Avoid at all costs the irrationality of panic—we are NOT instinctively frightened of these animals, but rather this feeling is a result of inculcation throughout our life. Use common sense—that remarkably scarce commodity—and employ the maxim STOP, THINK, ACT.

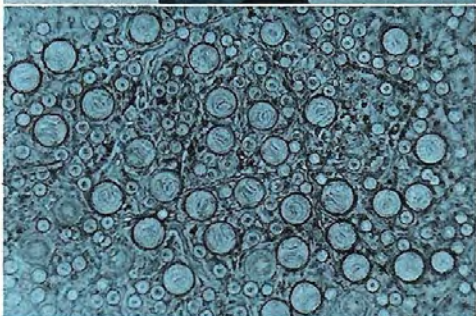
First aid for venomous bites and stings has recently been subject to some major changes. The following principles have been established largely by work carried out by the Commonwealth Serum Laboratories in Melbourne with support from James Cook University and Townsville Hospital, Queensland.

General First Aid Principles: Tourniquets should NOT be used for any form of venomous bites or stings. They only have temporary efficiency, having to be released after 20 minutes. Poor knowledge of the correct material to be used and method employed has often resulted in loss of limbs through necrosis and later gangrene. Use a constrictive bandage, ideally a crepe or elastic bandage usually used for sprains. If not available, use clothing—rip up a shirt, trousers, etc. Do not use a belt, as evenly applied pressure is necessary to restrict flow in superficial blood vessels and the lymphatic system. Never give drugs of any kind. Alcohol is disastrous, dilating blood vessels, speeding pulse, etc, and it may combine to form a bond with the venom. Always keep the patient as calm as possible—obviously not easy when they are in pain. Send someone for an ambulance, or notify the hospital that you will be arriving, so cutting down on what might be

The sea urchin, *Toxopneustes pileolus*, has short, thick, white-tipped spines poking through the array of flower-like pedicellariae. Known to inhabit Sydney Harbour this species is more common in Queensland. No known deaths have been attributed to a sting from this flower urchin, however, several deaths have been recorded in Japan. Stings from the pedicellariae result in immediate and intense pain, faintness, numbness, generalised paralysis, aphonia, respiratory distress and death. Photo by K. Gillett taken in Sydney Harbour.

crucial delays. Remember that with prompt first aid and hospitalisation, the chance of death or permanent damage (except perhaps scar tissue) is remote. Be prepared to keep the patient breathing if there is any difficulty whatsoever. Many venoms affect the muscles controlling the lungs. And lastly, DON'T PANIC! Someone's life may depend upon you keeping a cool head.

Snake Bite: Sit the person down. Apply a broad constrictive bandage immediately over the bite, and wind it over the area at the same pressure you would use for a sprained wrist or ankle. Continue up the arm or leg with the bandage and immobilise the limb with a splint—even a broom handle is suitable. Bring transport to the person and convey him to the



Top, a number of common Portuguese-man-o'-war, or bluebottle, *Physalia* sp., washed up on Long Reef Beach, Sydney. The nematocysts (stinging cells) of beach specimens such as this are frequently still viable and can inflict a sickening sting. Photo by Anthony Healy.

Centre, bluebottle stinging tentacles containing nematocysts. Photo by Anthony Healy.

Below, individual coiled up and discharged nematocysts as seen through a microscope. The venom from these nematocysts is basically a neurotoxin. Photo by Keith Gillett.

Top right, sea anemone, *Anthothoe* sp., which is one of few species noxious to humans. Photo by Keith Gillett.

A blue-ringed octopus, *Hapalochlaena maculosa*, right, injects venom by making two skin punctures. Although the victim may be completely unaware of being bitten, symptoms are virtually immediate—weakness, numbness of the head and neck and difficulty in respiration. The venom is largely neurotoxic, so that death usually occurs from respiratory failure. Photo by Keith Gillett.





hospital lying down. DO NOT cut, suck, wash or rub the wound, and leave it to the doctor to remove the bandage.

Spider Bite: Funnel web—Exactly the same as for snake bite. Redback—Do nothing to the wound, but convey the person to hospital.

Blue-ringed Octopus Bite: Same as for snake bite. Stand by to give mouth-to-mouth resuscitation if breathing becomes laboured or ceases. Convey to hospital.

Jelly-fish Sting: Do not try to remove tentacles. Apply household vinegar. Be on the alert to give immediate mouth-to-mouth resuscitation. Convey to hospital. It has recently been demonstrated that application of methylated spirits causes a violent discharge of the nematocysts, akin to dropping a lighted match into a box of fireworks—so do not apply alcohol.

Other marine animal venomous bites and stings: Immerse the affected area in hot (50 degree Celsius) water. Convey person to hospital.

Antivenoms Available from Commonwealth Serum Laboratories:

Name	Coverage
Black Snake	All black snakes and king brown snakes
Brown Snake	All brown snakes of genus <i>Pseudonaja</i>

Death Adder	Specific
Tiger Snake	Tiger, black, rough scaled, copperhead snakes
Taipan	Specific
Sea Snake	All unidentified sea snakes
Polyvalent	All unknown Australian and New Guinean snakes
Sea Wasp	Specific
Stone Fish	Specific
Tick	Specific
Redback Spider	Specific
Funnel Web Spider	Specific

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The sea wasp, *Chironex fleckeri*, can probably be regarded as the most potentially dangerous of all Australian marine stingers. Common during the summer months in northern waters, the sea wasp prefers the cloudy waters of the mainland coasts where the sediment is stirred up by prevailing winds. It has not been found in the clear waters of the offshore islands and coral reefs. Several factors affect the degree of envenomation including the sexual maturity of the species, the extent of the wound, the quantity of venom injected, and the nutritional status of the animal and the victim. Fatalities have been due to massive stinging which has caused respiratory distress, muscular spasm, a rapid weak pulse, prostration followed by respiratory failure and death, which may occur within 30 seconds to minutes. Photo by Keith Gillett.



# X-RAYS IN FOCUS

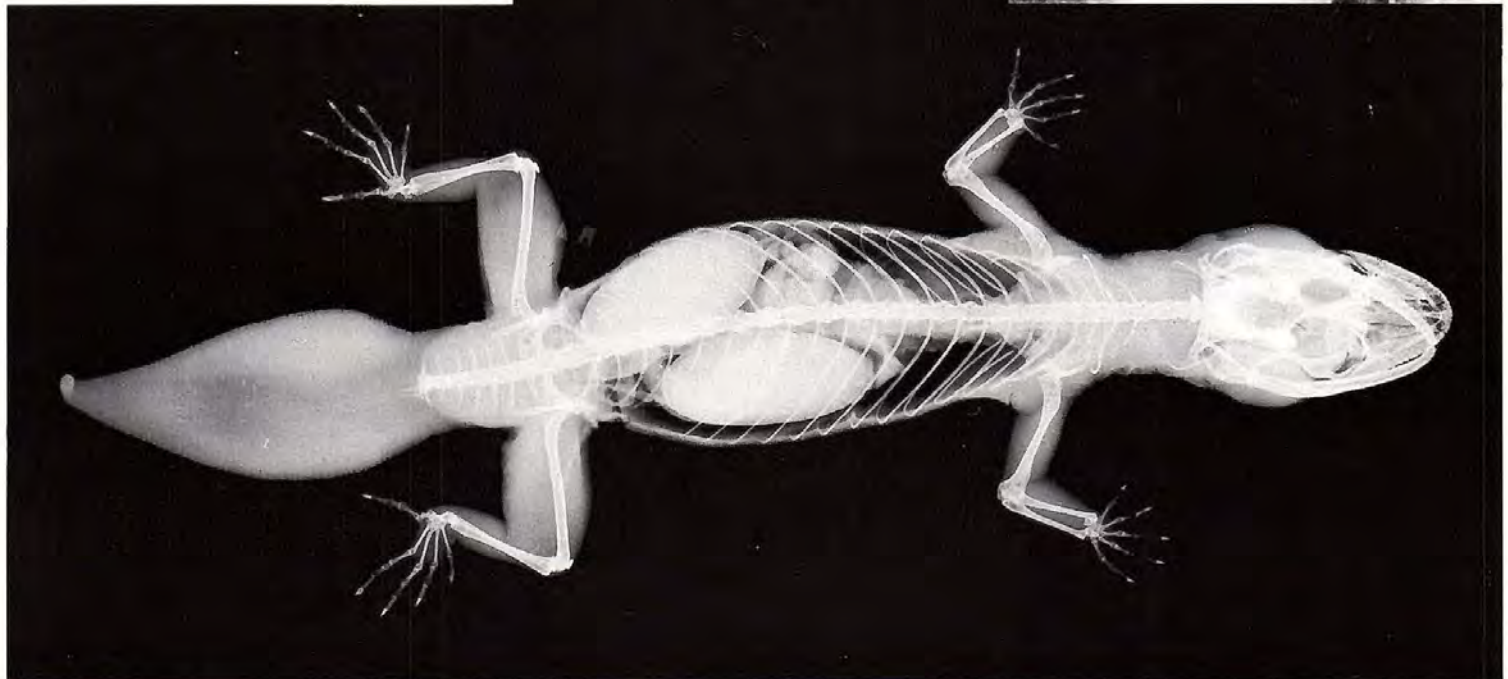
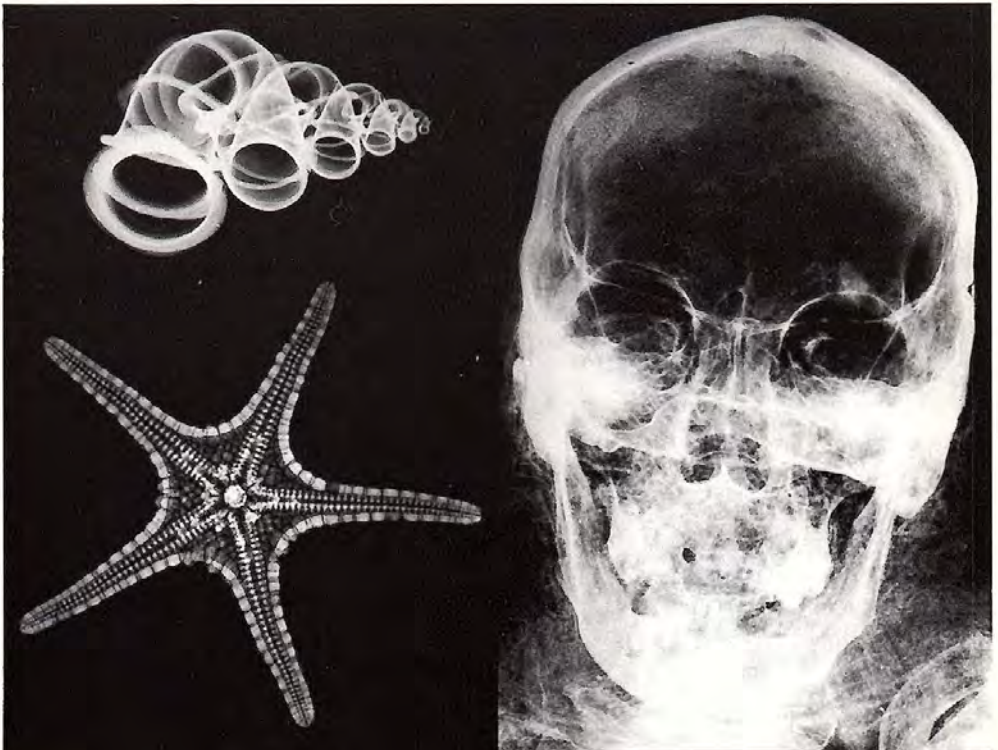
X-rays, a well known and widely used diagnostic tool in medicine and industry, form an important part of the photography section in The Australian Museum. Primarily used for determining skeletal characters and detecting abnormalities, x-rays can also show Museum scientists food content of the stomach and the state of the reproductive organs. The Museum's x-ray machine is a portable industrial unit made in West Germany specifically for small plant or scientific use. The Eresco, as the machine is known, operates in the 20-150kV range at 5 amps. The work of the x-ray unit in the Museum's photography section requires high information content and therefore fine grain x-ray film is used, giving the best resolution.

Right, a wentletrap *Epitonium scalare*, one of the most beautiful of shells. Occurring in the China Seas, it is sometimes washed up on the northern Queensland coast. The shell has eight rounded, smooth white whorls crossed by ribs. Rare during the 1770s, wentletraps from the China Seas fetched high prices (£40 per shell was a common figure) which led the Chinese to copy them in rice paste and sell them as the real thing.

Bottom right, an un-named sea star of the genus *Calliaster* which is common on the north west shelf. The x-ray shows the very prominent plates around the margin of the animal and the three spines on its arm tips. The white spot in its mouth is a protozoan which the sea star has just picked up.

Far right, one of The Australian Museum's two Egyptian mummies, showing the skull with many teeth missing and extensive dental caries. Probably a middle-aged man, the mummy is complete except that the lungs, heart and other internal organs have been removed, the thoracic cavities filled with opaque packs (probably pitch) and the orbital cavities packed with artificial filling. There is no sign in the x-ray to indicate cause of death.

Below, a marbled velvet gecko, *Oedura marmorata*, a rock and tree-dwelling lizard inhabiting most of the northern part of Australia. The specimen shown here is a female with two eggs and a nearly completely regenerated tail.

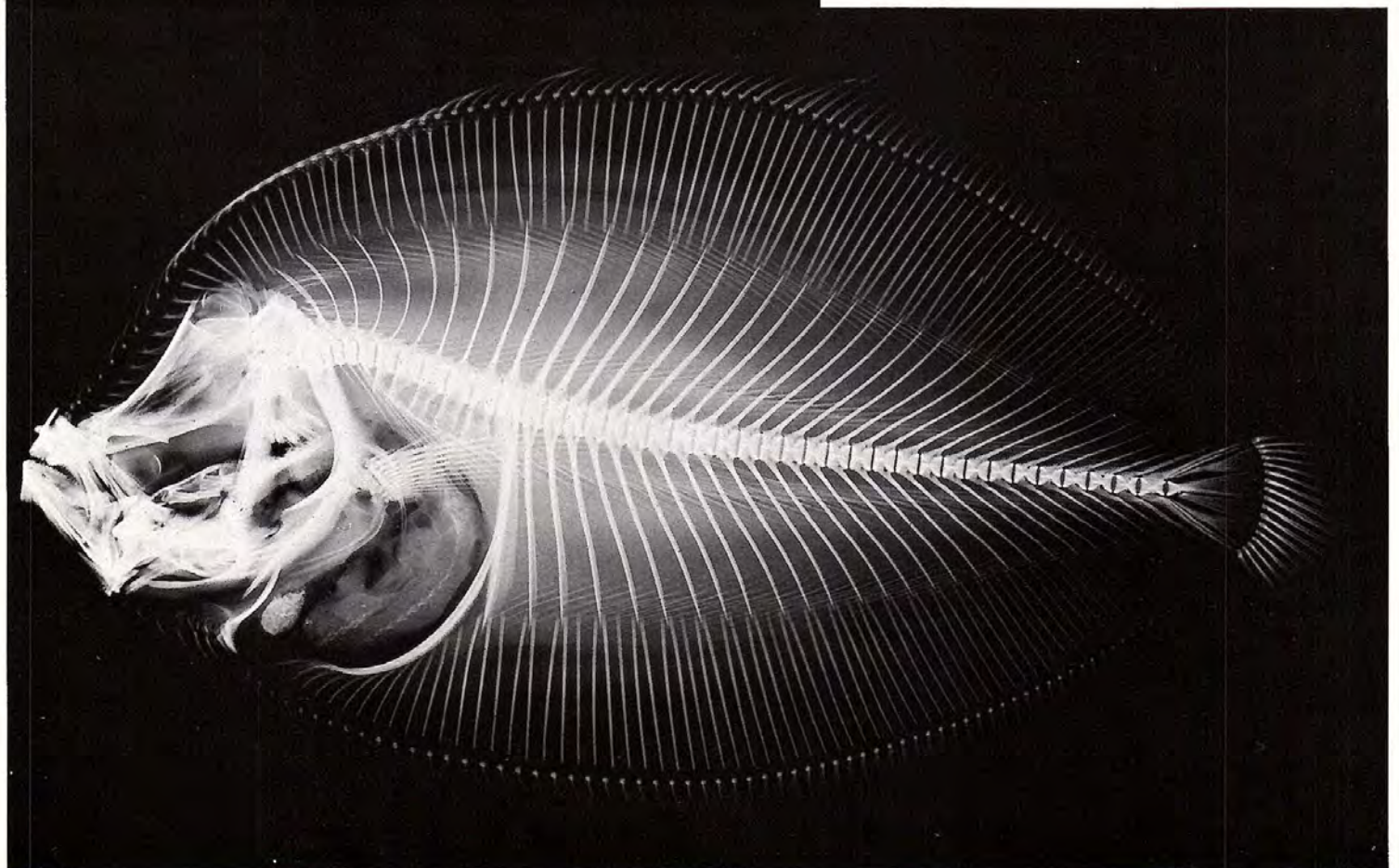




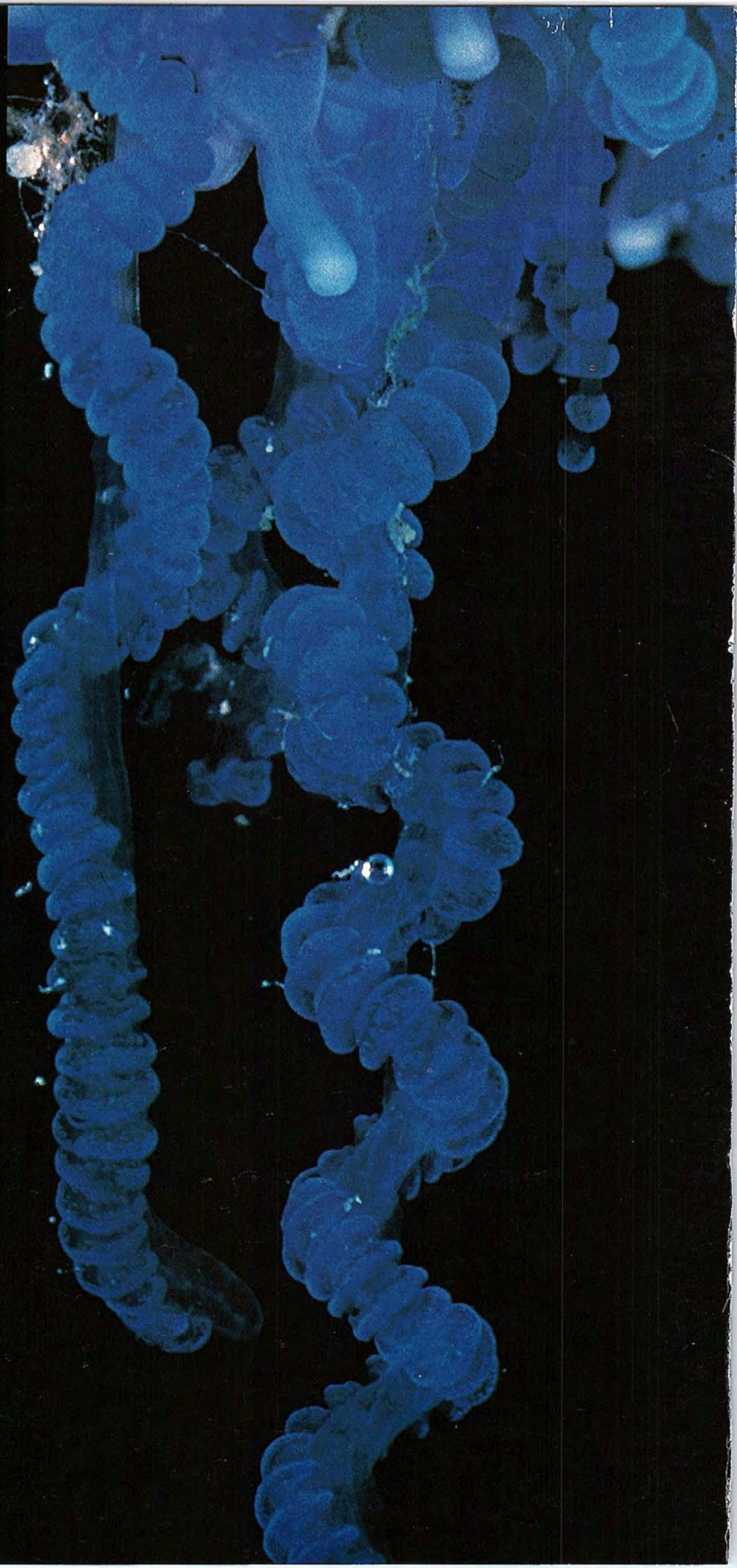
Left, an eastern water dragon, *Physignathus lesueurii*, an eastern Australian lizard common near rivers and creeks. Like most other climbing lizards it has extremely long toes and sharp claws. In contrast to many other lizards, dragons lack fracture planes in the tail vertebrae and hence do not readily lose the tail.

Below, a left-handed flounder of the genus *Bothus* from the New Hebrides. It is interesting to note that unlike many other fish the digestive tract and the area of the vital organs are restricted to a small area of the fish. Although not visible from the x-ray the fish is asymmetrical having both eyes on the one side of the head.

The sea snake, *Hydrophis elegans* (right), is found in the waters of northern Australia and southern New Guinea. This specimen shows a recent diet of eel, which is clearly visible. A particular adaptation of sea-snakes is the deep, flat tail which is supported internally by elongate dorsal and ventral projections from the tail vertebrae (inner part of the coil).







The underside of a blue-bottle or Portuguese-man-o'-war, *Physalia* sp., showing part of the long trailing tentacles, well armed with stinging capsules or nematocysts which cause intense and general irritation and urticarial rash when contact is made. Blue-bottles are widely distributed and are probably the best known of all venomous marine animals. Photo by Keith Gillett.