



50 c

AUSTRALIAN  
NATURAL HISTORY

MARCH 1970

Vol. 16 No. 9

PUBLISHED BY THE AUSTRALIAN MUSEUM, SYDNEY

REGISTERED AT THE GENERAL POST OFFICE, SYDNEY, FOR TRANSMISSION BY POST AS A PERIODICAL

# AUSTRALIAN NATURAL HISTORY

*Published Quarterly by the Australian Museum, College Street, Sydney*

Editor: F. H. TALBOT, Ph.D., F.L.S.

Annual subscription, \$2.20 posted

Assistant Editor: P. F. COLLIS

Single copy, 50c (55c posted)

---

VOL. 16, NO. 9

MARCH 15, 1970

---

## CONTENTS

	PAGE
CAN WE APPRECIATE ABORIGINAL MUSIC— <i>Catherine J. Ellis</i> .. .. .	289
MUSEUM'S MUSICAL INSTRUMENTS ON PAPUA AND NEW GUINEA STAMPS— <i>J. P. White</i> ..	294
FARMING THE SEA— <i>J. M. Thomson</i> .. .. .	295
THE CABBAGE WHITE BUTTERFLY— <i>J. V. Peters</i> .. .. .	300
AUSTRALIAN CRABS— <i>D. J. G. Griffin</i> .. .. .	304
COLLECTING REPTILES AND AMPHIBIANS IN NEW GUINEA— <i>Fred Parker</i> .. .. .	309
THE PRODUCTION OF HORIZONTAL HIGH-TIDAL SHORE PLATFORMS— <i>Norman K. Sanders</i> .. .. .	315
BOOK REVIEWS.. .. .	293, 308, 314, 319
MEET OUR CONTRIBUTORS .. .. .	320

---

● **FRONT COVER:** The Eastern Brown Snake (*Demansia textilis*) attains a length of up to 7 feet, and is one of our deadliest snakes. It is found in a wide variety of habitats in eastern and southeastern Australia, generally preferring open, drier country to the wetter sclerophyl forests. It is a fast-moving, timid snake which will normally avoid contact with humans but which may become very aggressive if provoked, adopting the attitude shown in the photo. The sensitive tongue, which is an important sense organ in snakes, is always active when a snake is alarmed and may be extended, quivering, for long periods. The Eastern Brown Snake is usually some shade of grey or brown above, though occasional specimens are almost black. The belly is usually cream with irregular orange spots and blotches. **BACK COVER:** A radiograph of a Butterfly Fish (*Chaetodon howensis*), trawled in 70 fathoms off Wollongong, New South Wales. X-rays are used in the study of fish to examine the bones of the skull, vertebrae, and caudal skeleton in particular; vertebral counts can be made and counts of unpaired fins verified. Occasionally a fish in the stomach contents will show up in an X-ray. [Photos: C. V. Turner]

---



# Can We Appreciate Aboriginal Music?

By CATHERINE J. ELLIS

Lecturer, Department of Music, University of Adelaide, South Australia

EMPATHY with a singer and his song is the only means by which we may learn to appreciate the music of a tribal people. The listener who takes the trouble to achieve this experience will find it a rewarding one. It may seem a strange possibility that a study of music can make clear for us the changes that are occurring in the society of which that music is an expression. Music is a very personal experience, but also one which is shared by society. Through song the noblest aspirations or the greatest fears may find individual expression, and may, at the same time, be shared by all. The history that music recounts is not a collection of coldly-observed facts, but a portrayal of the emotional struggles of those involved in events of consequence to them. It does not, however, become available to us until we have learned how to appreciate the music through which this history is recorded.

Despite the subjective account it supplies, the importance of artistic expression, particularly in song, must not be overlooked in the understanding of any people. It is possible, by listening carefully and sympathetically to the songs performed by any particular group of people, to achieve an intimate understanding of the thoughts of these people. Not only do the musical forms in use indicate areas of thought not necessarily manifest in any other activity of the group, but the texts of the songs can prove most enlightening. One of the reasons for this is pointed out by Merriam (1964): "... in song the individual or the group can apparently express deep-seated feelings not permissibly verbalized in other contexts", and again: "... one of the outstanding features [of song texts] is the fact that they provide a vehicle for the expression of ideas and emotions not revealed in ordinary discourse".

## Europeanized songs

There are many Europeanized songs in the current repertoire of detribalized part-Aborigine performers which highlight social



Europeanization in music: Douglas Carter, of Murray Bridge, South Australia

problems. They range from the pathetic utterances of a despondent Aborigine:

Every nation has a flag, except the old black coon.  
I wish I was a white man, instead of an old black coon

to the cynical comments:

White fella put the fences across the country,  
Jacky sits and laughs all day.  
He don't care what become of the country,  
But Jacky like to take it that way.

These Europeanized songs are conveying inside thoughts on the pressing problems that confront the detribalized Aborigine. The music of these songs has nothing about it which is new to us. The songs themselves, however, cannot be appreciated unless time and trouble are taken to be a sympathetic listener, and to share with the singer his feelings and thoughts.



Men at Oonadatta, South Australia, singing their section of a history song

This is equally so with the fully tribal music of the Australian Aborigines. The difficulty here is greater for us: we face an unfamiliar musical system which conveys unfamiliar concepts. Those musical intervals which do not coincide with any used in our own musical system will initially be regarded by us as "out of tune". This problem may bother the more musical a great deal: before they can understand the tonal language in use in a musical system, they find it very difficult to understand what is taking place in the musical communications arising from the system. In the case of the tribal music from Central and South Australia (the area to which this discussion will be restricted) the element of the music most familiar to the non-Aboriginal is rhythm.

Not many people have the opportunity of hearing or seeing an Aboriginal performance in its natural setting. Of those who do have this opportunity, few understand what is taking place. The performers themselves find it difficult to convey anything at all of the significance of the occasion, particularly as they must use a foreign language, English,

to do so. When we are confronted with Aboriginal music, which often uses musical forms quite alien to our ears, we cannot initially appreciate the beauty of sound which is obviously experienced by the participants; if we also lack an understanding of the significance of the performance, then it is necessary to say that we cannot appreciate the music at all.

#### History songs

Tribal music conveys at least two quite different types of history. One is spoken about by the performers, and forms the basis of the religious beliefs. The other is less obvious, and can be found only after careful scientific evaluation of the distribution of musical forms used in different areas. Of the latter it need only be said here that in South Australia at least two distinct musical cultures have been found, one in the south-east of the State, the other strongest in the northwest. For detailed discussion of this, see Catherine J. Ellis' "Aboriginal Songs of South Australia", *Miscellanea Musicologica*, Vol. I (Adelaide, 1966), pp. 137-190, or the same author's "Folk Song Migration in



Aboriginal South Australia", *Journal of the International Folk Music Council*, Vol. XIX (1967), pp. 11-16. The first type of history contains those songs performers themselves call "history songs".

History songs recount events in the lives of the totemic ancestors, in their journeys, their meetings with other totemic ancestors, their good fortunes or their misfortunes at various places. There are different forms of any one history; it may be told as an explanation of the life of the ancestor, or it may be sung in a series comprising many short verses, each of which tells about a particular event or place associated with the ancestor: or the performance may be a full ceremonial one which includes portrayal of relevant events in the performance of dances accompanied by the singing of the appropriate verses. The song associated with any one totemic "line" will have the one melodic form throughout. This means, in the case of very long "lines" of song, where the ancestor is reputed to have crossed thousands of miles of territory, that the characteristic melodic form will be found in areas with differing languages and musical techniques. Because of the latter differences, an outside

observer may well fail to recognize extreme sections of the one song-line as conforming to the same musical pattern, but that they do conform has been repeatedly stressed by performers and shown by a number of detailed analyses. The concept differs from our experience of melodic sameness; it consists of repetitions of sections of melody for a set proportion of the time the total verse takes to perform. For example, the melodically unifying element of a particular bandicoot song-line from the north of South Australia consists of a division of each verse into five segments, the exact notes of which are not clearly defined, but rather the particular range which must be covered, and whether it is covered in ascending or descending progressions, are clearly defined. Each verse lasts for approximately 30 seconds, and this total duration is divided between the segments so that the proportions remain in the ratio of 4:1:2:1:2. (The exact duration of each segment is actually controlled by the structure of the rhythm, which changes continually from verse to verse. Nevertheless, the proportional duration suffices as a non-technical explanation of the process.)



Preparatory dancing while other women are away being painted for a main dance, the designs of which are secret. The singers providing the accompaniment are facing the dancer.



Cooper Pedy (South Australia) people talking to research team members. Contact with European conditions leads to changes in musical form.

### **Totemic line**

Because this technique allows flexibility in those areas of musical expression which tend to change from one tribe to another, the basic information can be kept intact even though the total history may be retained, section by section, in many different tribal areas. This means that, even when a visitor from afar is unable to understand the language that the locals are using in a song, he can determine, from the musical structure, to which totemic line the song belongs. And, because his own totemic song has been a very strong conditioning agent in the total processes of his education to adult status in the community, the recognition of his own song in another area will have very deep significance. The history songs link the time long past with the present: the singer is part of a continuum: he is reliving events of another era, and is yet part of them.

In the total ceremonial setting, only a short section of the history is performed, under the strict control of the most knowledgeable elder of the area. In this situation we find special musical forms for songs used to accompany body painting, others again for preliminary dancing while the painters are away preparing for the main dances, and

yet others for the dances themselves. These changes in form concern the rhythm of the verses, or the forms of vocal ornamentation, or again, whether or not the verse will be accompanied by some form of rhythmic beating. They in no way alter the established melodic procedure. In such a setting the various facets that comprise the whole are unintelligible to the performers if separated out: the painted designs on the bodies of the dancers are meaningless without the correct accompanying song; the melodic form is meaningless without the words; the rhythm is meaningless without the dance; the act is meaningless without the knowledge of the site at which the original events took place; the site is not fully represented without the correct melodic progressions. In fact, in the total ceremonial form all facets are very tightly integrated. The performance itself, as well as being a re-enactment of events, can be an expression of kinship ties, of ties to territory, or of group coherence.

Whether we wish to understand the music of the tribal people, or the songs of those seeking a place within the white community, it is certain that we can gain no real appreciation only by listening; this applies particularly to recordings, which inevitably



dissociate music from its environment. Our appreciation will become a vital process when we come to an understanding of the significance each song has for its singer.

[The photos in this article are by R. B. Buckley.]

Acknowledgments: The information on which this article is based has been collected and analysed as a result of grants from the University of Adelaide, the Australian Institute of Aboriginal Studies, and the Australian Research Grants Committee. The photographs were taken during group fieldwork among Andagarinja women on a grant from the Australian Institute of Aboriginal Studies, the total scope of which is described in *Group Project on Andagarinja Women* (two volumes) compiled by the researchers, Buckley, Ellis, Hercus, Penny, and White. Copies are held in the Universities of Adelaide and Monash, and the Australian Institute of Aboriginal Studies.

## REFERENCES

- Discs with additional information:  
Jones, Trevor, *The Art of the Didjeridu* (Wattle Ethnic Series). One 12-inch LP disc.  
Moyle, Alice M., *Songs from the Northern Territory* (Australian Institute of Aboriginal Studies). Five 12-inch LP discs and companion booklet.
- Tapes:  
Moyle, Alice M., *A Handlist of Field Collections of Recorded Music in Australia and Torres Strait* (Occasional Papers in Aboriginal Studies, No. 6, Australian Institute of Aboriginal Studies, Canberra, 1966).
- Published material on Aboriginal music:  
Ellis, Catherine J., *Aboriginal Music Making: A Study of Central Australian Music* (Adelaide, 1964).  
Strehlow, T.G.H., "Aboriginal Australia: Languages and Literature", *Hemisphere*, Vol. 6, No. 8, (Sydney, August, 1962) pp. 2-7.

---

# BOOK REVIEW

**KANGAROOS**, by H. J. Frith and J. H. Calaby. F. W. Cheshire, Melbourne. Price \$12: 209 pages.

At a time when the exploitation of kangaroo populations is being hotly debated with more emotion than knowledge, it is gratifying to find a publication in which an objective and informed assessment of the situation is presented. Both authors are members of the Division of Wildlife Research of CSIRO and have had considerable experience in studies of many aspects of the biology of kangaroos.

The book, which is well produced, deals successively with the history of discovery and systematics of the kangaroo-like macropods as a whole, and then proceeds to a detailed discussion of the distribution, behaviour, ecology, reproduction, population dynamics, and economics of the larger kangaroos, with particular emphasis on the Red Kangaroo.

The fine photographs by Fderic Slater, with which the book is well illustrated, do much to enhance its general appearance. The line drawings by Frank Knight, which are distributed throughout the text, are also pleasant and help greatly to indicate the diversity of appearance of macropods in general and to illustrate important aspects of the biology of these animals. On the other hand, the coloured plates of the large kangaroos leave much to be desired. The animals are presented in rigid postures and are ill proportioned and lacking in detail.

A well balanced attitude to the conservation of kangaroos is given by the authors, who maintain that there should be stricter control of harvesting and utilization of stocks by the "application of correct game management principles". In this way, over-abundance which would interfere with pastoral

interests and extermination of the species would both be obviated. Since the degree of competition between kangaroos and domestic stock may be less than has formerly been suggested, it should be possible for properties to run both sheep and kangaroos simultaneously. The latter could then be culled on a controlled basis so that a reasonable population level could be maintained. The meat and skins so produced would provide a considerable financial return to the grazier, without involving the destruction and waste which are characteristic of the present uncontrolled kangaroo meat industry.

Although the Red Kangaroo was described by Desmarest in 1822, it is only during the present decade that the major features of its life-history and ecology have been determined, mainly by biologists of CSIRO.

The results of these investigations are contained in the book under review and, in consequence, this is a most valuable compilation of our present knowledge of the biology of the large macropods.

This fine and attractive book, which is unfortunately very expensive, is strongly recommended not only to professional biologists but also to all members of the community who are interested in and have a feeling for the continued survival of the Australian fauna. It is to be fervently hoped that the recommendations of the authors regarding the strict control of kangaroo harvesting on game-management principles will be implemented immediately by the responsible authorities. The greatest compliment that could be paid to the authors would be the realization that their unbiased and objective treatment of the subject had been responsible for the survival of kangaroos in Australia.—  
*B. J. Marlow, Australian Museum.*

# Museum's Musical Instruments on Papua and New Guinea Stamps

Four stamps featuring musical instruments from the Australian Museum collections were issued by the Territory of Papua and New Guinea on 29th October, 1969.

The 5-cent denomination features a seed pod rattle (*tareko*) from the Gulf of Papua. Bunches of seed pods are attached to a band of pandanus fibre painted with a typical design of the area. These rattles are commonly used in dances.

The slit gong (*garamut*) shown on the 10-cent stamp is on display in the Museum's Gallery of Melanesian Art. The gong is from the Admiralty Islands and stands 3 feet high. A carved head projects from one end, and panels carved in traditional style decorate the sides. *Garamuts* are played by beating on the side with a stick and may be used in dances or for sending messages. This example was collected in the 1880's by a daughter-in-law of "Queen Emma" Farrell, an historic Territory personality.

Pan-pipes (*iviliko*), which are displayed on the 25-cent stamp, occur in almost every area of the

Territory. Normally they are made of grass or bamboo stems of varying lengths bound together so that one end is level. They are played by blowing across the top of the level end. Although pan-pipes are used occasionally in ceremonial activities, they are most commonly played casually for enjoyment.

The 30-cent stamp shows an hourglass drum (*kundu*) from the Sepik River district. A great deal of artistic care is often lavished on these drums. To make them a log is hollowed out by fire and a piece of reptile or marsupial skin stretched over one end. The pitch of the drum is regulated by applying small lumps of wax to the membrane. This example, also on display in the Museum's Melanesian Gallery, features a curvilinear motif on the lower part of the body and handles on each side representing a crocodile and a bird, possibly a hornbill.

The stamps were designed by Mr G. Hamori, of Sydney, on the basis of photos taken in the Australian Museum.—*J. P. White, Australian Museum.*







Wire-bottomed trays raise oysters above the mud, where predators are abundant. The trays also permit bulk-handling of the live oysters. [Photo by courtesy of "The Telegraph", Brisbane.]

## *FARMING THE SEA*

By J. M. THOMSON

Professor of Zoology, University of Queensland, Brisbane

We live in a hungry world, though for us, living in Australia, it is difficult to realize the abject misery that perpetual hunger brings. The United Nations, through its instrumentality the Food and Agricultural Organization (FAO), is attempting to ameliorate the situation. Perhaps too much attention is being given to increasing conventional crops and not enough to exploiting new sources of food production. Certainly this is true in Australia, whose contribution to the world's food larder has scarcely produced any novelties, unless it is kangaroo-tail soup, which seldom appears on the shelves of the starving in Asia, Africa, or South America.

Popular articles about the future food supplies of the world frequently talk about "the inexhaustible sea". The last 20 years

of research have indicated that the sea is by no means inexhaustible and that, under present conditions of exploitation, the take of marine food products can increase only to something between two and four times the present total. The greater part of the fishing industry is only a hunting activity. When Man the Hunter metamorphosed on land into Man the Farmer, the population that a given area of land could support increased. Is there any hope, then, in turning to aquaculture?

In the present state of knowledge there is little hope of controlling the production cycle of the open sea. But by closing off portions of coastal waters, the aquaculturist can control and influence the conditions under which fish crops can be raised. There has been some sea farming for many years.

The Romans used to impound various sea fish, particularly the Red Mullet or Surmullet (also known as Goatfish), which had, to the Roman epicure, the reputation that barramundi has for his Australian counterpart. The Romans were also oyster farmers; unlike the Surmullet farming, the oyster farming survived and today flourishes in France, Holland, the United States, Japan, and Australia, as well as on a smaller scale elsewhere. Australian oyster farmers (at least in New South Wales) can hold their own with anyone in the world for technical achievements and enterprise.

### Centuries-old fish farming

Some brackish-water (estuarine) fish farming has been going on in the tropical and subtropical Indo-Pacific and in the Mediterranean for several centuries. The number of species involved has been few and the methods have been traditional. In the great Po River delta-Venetian Lagoon area in Italy the prime produce is eels, which fetch a high price on the European market. Mullet are also abundant in these fish farms. They are placed there to provide food for the more valuable eels, but the surplus mullet that reach marketable size are sold also.

Up to 15 years ago eels were the most important fish farmed in Japan; mullet are farmed there in separate ponds for their own sake. In an arc around southeast Asia, from the Philippines and Hong Kong to India, various sea fish have been farmed in the last 100 years or more.

Mullet farming is perhaps the most widespread of brackish water aquacultural practices. Other species farmed in local areas include the fish marketed in Australia as the Barramundi (really the Giant Perch, *Lates calcarifer*, known in India as the *behkṭi*). Others are the Milkfish (*Chanos chanos*), the Pearl Spot (*Etroplus suratensis*), the Ox-eye Herring or Tarpon (*Megalops cyprinoides*) and the Ten Pounder (*Elops machinata*). Besides these scaled fish, prawns have been farmed in some localities.

The culture practices in the farming of these brackish water fish have not, until recently, embraced the whole life-cycle of the fish. Recent work in Japan has changed this picture. Traditional practice was to let the young larval or post-larval fish or prawns enter the farm

ponds with the tide by opening sluice gates at times when either traditional knowledge or sampling suggested they should be about in quantity. This is obviously an undependable means of "planting" a fish farm and in some places, particularly in the Aegean Sea and in southern India, fishing for small fish with fine-mesh nets and other devices has augmented the self-delivery system.

### Experimental work

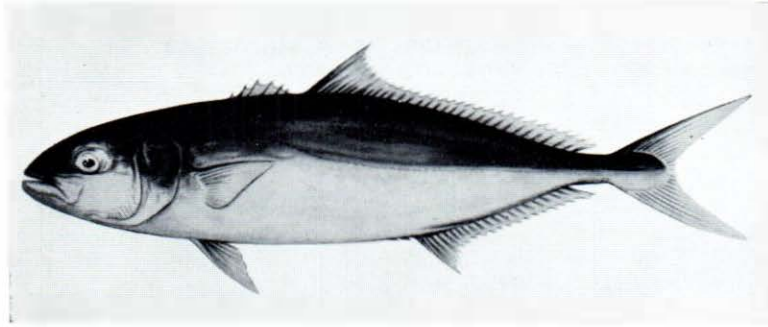
In the beginning natural ponds and backwaters that could be shut off easily by constructing sluice-gates and short walls provided the necessary ponds. Later artificial ponds were dug out of estuarine mudflats, as in the extensive tambaks of Indonesia. A great deal of experimental work on brackish water fish farming has gone on over the past 20 years, but, except in Japan, little of this work has got beyond the experimental stage. The rearing of larval sea fishes such as plaice has been achieved in hatcheries both in England and Norway, but this is not aimed at farming in ponds; instead, it is for the liberation of the young fish into the sea to increase the stocks, a procedure akin to releases from trout hatcheries.

That farming on a catch-and-grow basis can succeed outside the areas where it is already practised has been demonstrated in both Australia and the U.S.A. But in both countries the farming has yet to be proved economic. The great advances establishing fish farming on a scientific basis have been achieved in Japan. By 1966 the produce of fish farms provided 6 per cent of the fish production of Japan. This percentage may sound small, but when the world-wide fishing activities of the Japanese are considered it is quite a large amount. In fact, in 1966, Japanese fish farms produced 440,000 tons of fish, valued at \$250 million.

The traditional eel and mullet farms of Japan continue, and there have been exciting developments. For instance, there are 1,300 *hamachi* farms. Perhaps "farm" is too grandiose a title, for many of the rearing areas are simply netting enclosures hung from rafts. The *hamachi* is a species of Yellowtail Kingfish, very similar to the species that is caught off eastern Australia. The *hamachi* are bred in captivity. With typical ingenuity, the Japanese *hamachi*



The Yellowtail Kingfish  
(*Regificola grandis*).  
[From T. C. Roughley's  
*Fish and Fisheries of  
Australia.*]



breeders have a current of water running through the pond where the parents are placed for spawning, so that the eggs are wafted straight to another pond on being shed and do not remain behind to provide instant caviar for their own parents. Thirty-eight thousand tons of *hamachi* are sold every year. Besides being a good spawner in captivity, this Yellowtail Kingfish species is popular with farmers because it grows fast. In 1 year it reaches 16 inches, and in 2 years 25 inches. It matures in 1 year.

#### **Prawn-breeding in Japan**

Perhaps the most exciting development—exciting both because an invertebrate is involved and because the product fetches such a good price—is the establishment of prawn breeding in Japan. Prawns grow rapidly, reaching marketable size in less than a year. The old farming methods were uncertain because they depended entirely on the entry of prawn larvae to the ponds. Dr Motosaka Fujinaga studied the life-cycle of *Penaeus japonicus* and experimented with the rearing of larval prawns for more than 20 years before he reached the stage of commercial rearing and farming.

The great difficulty in prawn rearing is the variation in food requirements at different growth stages. However, years of patient research revealed the necessary secrets and Dr Fujinaga's enterprise is now well established. The pond-reared stock produce fewer eggs than do their wild "cousins", indicating perhaps that there is something lacking in their diet, but the growth rate of the cultivated prawns seems normal. About 400,000 larvae per female are produced. During the early larval stages they feed on a variety of microscopic foods and, during this stage, they are held indoors in tiled

tanks. But in the post-larval stages the prawns are liberated into outdoor tanks and fed on crushed clam meat. The final catch in Dr Fujinaga's farm numbers some 10,000 prawns from the 400,000 eggs per female originally produced.

Another "fishery" product that is farmed in Japan is a kind of seaweed, known as *nori*. The cultivation of this red alga extends back to at least the 17th century. Seaweed is not on the normal diet of Australians; even in Japan only small amounts are eaten fresh, as the popular use of *nori* is in a sun-dried form which is used to flavour soups and sauces. The traditional way to catch *nori* was by planting out bundles of brush, on which the spores settled. This method is now largely replaced by the use of a heavy-gauge netting hung horizontally at what is believed to be the optimum height for *nori* settlement.

Kelp is also farmed in Japan, at least to the extent that newly-cleaned stones of the right size are set out by the seaweeders at the right time of year for the spores to catch.

#### **Australian experiments**

Here in Australia a few desultory experiments in brackish water fish farming have been carried out. Mullet have been the fish widely used, though whiting were also successfully kept in a pond at Woy Woy, New South Wales, some years ago. In Western Australia a number of farm dams have been successfully stocked with mullet, and this same species was reared for some years in an enclosed piece of the mudflat at Oyster Point, N.S.W., where the Georges River nears its discharge point into Botany Bay.

But the only type of saltwater farming that forms an established industry in Australia

is oyster farming. Even this is confined to a few hundred miles of the coastline of New South Wales. Suitable country in Queensland is only slightly exploited. The industry is threatened from time to time by the encroachments of civilisation. Future dock areas may destroy some of the prime oyster farms. Estuarine pollution is potentially dangerous, menacing the health of oyster eaters. But the industry has weathered many crises: when mud-worm threatened, cultivation was raised above the bottom; when the favoured stands of black mangrove were cut out, the oystermen turned to fibrocement slates and tarred, sawn timber for clutch material. Pollution has been surmounted by quarantining the oysters in irradiated water before marketing. There is no danger in eating oysters from polluted estuaries if they are treated in this way first. European oysters have been treated in less sophisticated ways for many years to fit them for market.

We have a number of species of fish and invertebrates suitable for farming. Mullet and barramundi are already farmed elsewhere; the kingfish is farmed in Japan. The most likely prawn for farming, if breeding is to be attempted, is the Greasy-back or Greentail Prawn (*Metapenaeus mastersii*), which will breed in coastal lakes. Most of the other species require some depth of water at sea for spawning, though the School Prawn (*Metapenaeus macleayi*) spawns fairly well inshore.

### Tests with molluscs

With experience and increasing knowledge, other species will undoubtedly be added to the list of farmable fish. Dr Imai in Japan is experimenting with various clams, abalones, and scallops. In western Europe mussels are farmed by techniques similar to those used for oysters. Undoubtedly Australian mussels would be amenable to similar farming. There are probably no insuperable difficulties in farming sand crabs. In America a similar species has been reared in ponds on an experimental scale. The mud crab might be more troublesome, owing to its burrowing habits. One day crayfish rearing may also be an everyday affair in the life of the sea farmer.

Various blue mackerel and herring species have been reared in laboratory aquaria. The basic techniques are known; they need refinement, and they need examination to ascertain the likely economics of aquaculture.

The most advanced aquaculture is perhaps where agriculture was 200 years ago. Certain practices are carried out. But often no one knows why they work, and no one knows what to do or even what has happened when things go wrong. There is much work to be done before aquaculture becomes truly scientific. We need pond trials of the effects of fertilizers, comparable to plot-trials in agriculture. Some native farmers prefer organic manures in the ponds, others swear by inorganic fertilizers. Almost no work has been done to examine what really happens

Stick cultivation of oysters, as carried out in New South Wales.  
[Photo: Author.]





to pond production when various fertilizer combinations are tried. In parts of the Philippines the regular practice is to let the pond drain to dry the bottom in the sun every 2 years, and the bottom is harrowed. Whether this is better than adding fertilizer, or better than digging a few inches of the old soil out, as is done elsewhere, has never been studied. There are a host of such cultivation techniques that require objective assessment.

#### **Possible diseases**

Almost nothing is known of the diseases to which brackish water fish may be liable or of the means of treatment. Various parasites have been identified from fish by zoologists. But in few cases has the incidence of parasites per fish or percentage of fish infected been ascertained. Nor is much known about what level of infestation is debilitating or fatal to the fish.

Nothing is known of optimum stocking rates. Present indigenous practices are very wasteful; less than 1 per cent of the fry placed in the ponds reach maturity in most cases. There are indications that water at least 4 feet deep is desirable in the tropics for the fish to escape the direct heat of the sun, but the heat budget of fish ponds and its effects on fish directly and indirectly are unknown. There are suggestions from observations made elsewhere that muddy areas with a clay substrate provide the richest ponds. Whether this is really true and what it might mean in quantitative terms are unknown.

There will be social problems involved in brackish water farming. The suitable areas will be competed for by real estate developers and others. The value of fish farming will have to be established and asserted. Many ponds will be open to thieving and may require costly fencing for protection, thus adding to the establishment costs. The whole economics of fish farming require careful consideration. The cost of pond formation and of its maintenance, costs of fertilizers, food and wages for employees, the rate of growth of the fish to marketable size, survival rates of the fish—all these and many other factors will make or break the

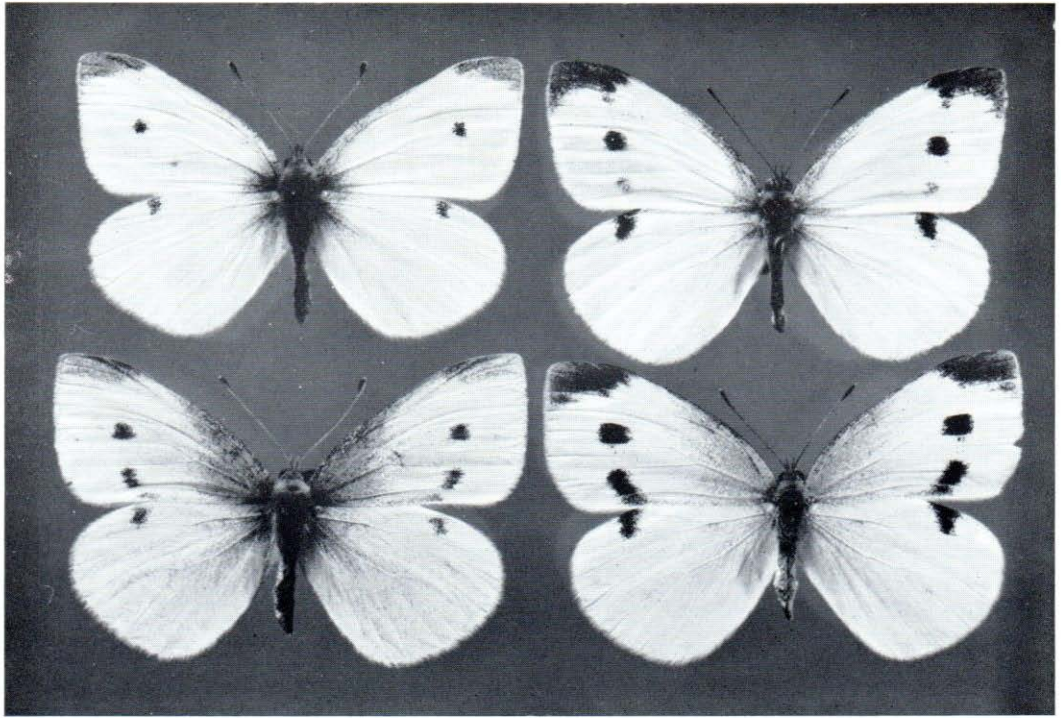
system. Above all, there is the worth of the product. Prawns fetch a luxury price, so they are probably high in desirability. But the capital expenditure on spawning and growing ponds will be high. Fish such as mullet are proven pond fish, but their prices are fairly low. On the other hand, the beauty of pond farming is that the shrewd farmer can market his fish when the natural catch is scarce because of bad weather or other causes, thus gaining high prices.

I believe we in Australia will come to fish farming over the next 25 years. We should be gaining the basic technical knowledge now instead of waiting for a crash programme when the matter becomes urgent. One matter we can attend to now. Undoubtedly our fish farming will start along the shores of estuaries. And all our estuaries are becoming increasingly polluted. It is probably true that increasing pollution, and hence lack of fish resources in estuaries, helped force Japan into fish farming. But if we allow a similar fate for our estuaries it will complicate our farming problems by making it difficult to obtain unpolluted water for the farms. Most pollutants are harmful because, as they decay, oxygen is taken from the water and so no life can survive in it; others, such as industrial wastes, are poisons. We have become aware of the dangers from insecticides and fungicides which are widely used in both agriculture and home gardening. Run-off from farms and gardens finds its way to the rivers and takes with it the soluble pesticides, some of which are long-lasting.

Fish farming is already rewarding many people. It holds challenge, and the pioneers may find it slow to provide ample rewards. But it must come as one of the few ways in which the world may exploit essentially new methods of producing food to maintain our ever-increasing population.

#### **FURTHER READING**

- Iverson, E. S., 1968: *Farming the Edge of the Sea*. Fishing News (Books) Ltd, London.
- Pillai, T. G., 1962: *Fish Farming Methods in the Philippines, Indonesia, and Hong Kong*. FAO Fisheries Biology Technical Paper No. 18.
- Jones, J. R. E., 1964: *Fish and River Pollution*. Butterworths, London.



The two butterflies on the left are a male (above) and female of the spring form of the Cabbage White Butterfly. The two on the right are a male (above) and female of the summer form. They are white with black markings, and are slightly smaller than shown in the photo, having a wing-span of about 2 inches.

## *The Cabbage White Butterfly*

By J. V. PETERS

Entomology Department, Australian Museum

**T**HE appearance of the Cabbage White Butterfly (*Pieris rapae*) in Australia was an unfortunate occurrence, as its larvae cause considerable damage to such vegetable crops as cabbages and cauliflowers.

Originally, this butterfly was distributed throughout Europe, northern Asia, and Africa, and first appeared in North America about 1860. The first specimens were collected there in Quebec, Canada, but it has been suggested that the butterfly may have been present in the vicinity of Quebec as early as 1859. In 1865 it first appeared in the United States, at Maine, and by 1868 it had reached New York. By 1880 it had spread to the States bordering the Gulf of

Mexico, and in 1883 to California.

From the United States it spread to Mexico and Hawaii, reaching the latter islands by 1898. In 1930 the butterfly was first observed in New Zealand, at Napier, Hawke's Bay, and by 1935-36 its invasion of New Zealand was complete. It is thought that the species then reached Australia from New Zealand.

Although *P. rapae* is known to migrate in Europe, its spread to the North American continent, Hawaii, New Zealand, and Australia was, no doubt, through the agency of man. Cabbages and cauliflowers for use on board ship bring larvae and pupae, and when the resulting butterflies emerge some fly ashore when the ship is in port.





This map shows the spread of the Cabbage White Butterfly in Australia and New Zealand

Reports of the butterfly's establishment and subsequent spread in Australia (see map) are scattered through the publications of the Departments of Agriculture of the various States and are more detailed in some instances than in others.

The first specimens reported in Australia were two captured in March, 1939, in the grounds of the University of Melbourne and at Canterbury, Victoria. During the first week of October, 1939, the butterfly was first seen on the eastern side of Port Phillip Bay, and by April, 1940, was seen as far away as Orbost in eastern Victoria and Nhill in western Victoria.

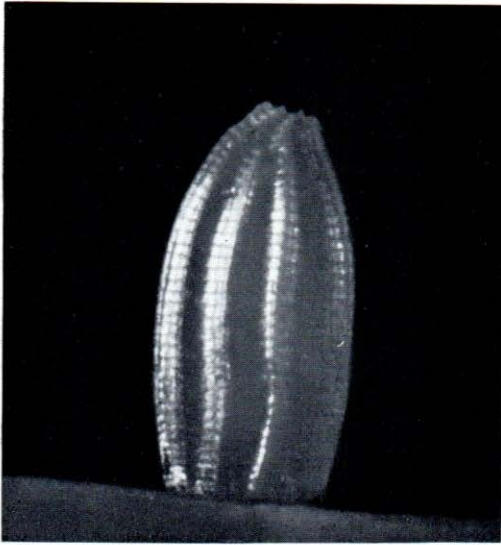
On 1st January, 1940, the first specimens were captured in Tasmania, at Ulverston on the northwest coast, and the butterfly reached Hobart by October of the same year. By 1942 it had spread all over the island.

In May, 1940, the butterfly was first recorded in New South Wales—at Albury, on the N.S.W.-Victorian border—and on 23rd January, 1941, the first specimens were captured in Sydney. Specimens in the Australian Museum collection indicate that the butterfly had reached the following

places by the dates shown in parentheses: Canberra, A.C.T. (16th July, 1941), Cootamundra (6th April, 1941), Wagga (22nd April, 1942), and Gosford (31st December, 1942). It was recorded in Queensland before October, 1943.

The westward movement of the butterfly was just as phenomenal as its spread northwards. By 1940 it was recorded in the southeast of South Australia, at Murray Bridge, and had reached Lobethal in the Adelaide Hills by 1942: in the same year it was recorded in Western Australia. By January, 1943, the butterfly had been seen at Mundaring and Perth in southwestern Western Australia.

The establishment and spread of this butterfly over the whole of North America and New Zealand were remarkable, and it is not surprising that within 4 years it was distributed from southern Queensland south to Tasmania and west to Western Australia. It has been shown that, apart from the prerequisite of food supply, temperature range appears to be a very important factor affecting distribution. Large areas of Australia are no doubt beyond its range because



The egg of the Cabbage White Butterfly. Its natural size is about one-sixteenth of an inch high

of extremes of heat and the arid nature of much of the country. However, where conditions were suitable the rapid spread of the butterfly was aided by the following three factors:

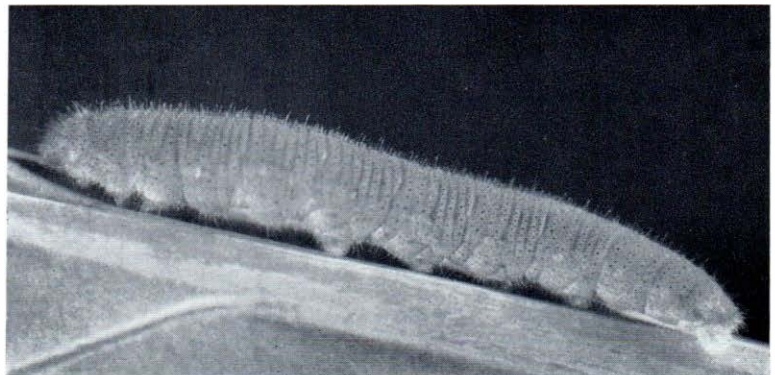
●Firstly, the larval food plants—of the families Cruciferae (cabbages, cauliflowers, turnips, radish, etc.), Tropaeolaceae (nasturtium), and Resedaceae (mignonette)—were already well established as vegetables or weeds.

●Secondly, the natural enemies of the butterfly did not occur in Australia. Three of them have since been introduced and liberated at many places, and it is reported that they rapidly became established and have a marked beneficial effect. These

natural enemies are parasitic wasps; one is a chalcid, *Pteromalus puparum*, while the other two are braconids, *Apanteles glomeratus* and *Apanteles rubecula*. *Pteromalus puparum* is a pupal parasite and only attacks the pupal stage of the host. The grubs feed and pupate within the pupa of the butterfly. *Apanteles glomeratus* and *A. rubecula* are larval parasites. *A. glomeratus* lays up to 100 eggs in each young butterfly larva, the grubs feeding within the host until it has spun the silken pad for the attachment of the pupa. The butterfly larva then dies, for at this time the grubs eat their way out of its body. They then pupate, and the mass of yellow cocoons which they spin surrounds the dead larva. *A. rubecula*, however, lays only a single egg in each larva, and the wasp grub emerges and pupates when its host is only half grown.

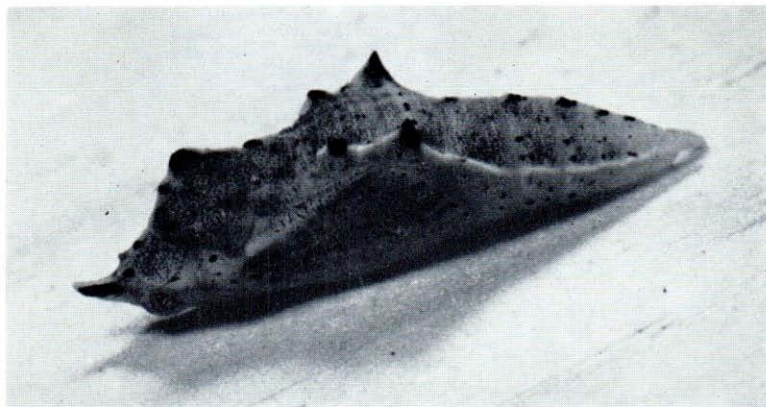
●Thirdly, the climate throughout the butterfly's range in Australia appears to be ideal for the development of eggs, larvae, and pupae. In the regions of the Northern Hemisphere where winters are long, *P. rapae* usually has two broods, sometimes three. The two broods are quite distinct and are known as spring and summer forms. However, in Sydney, where winters are short and mild, the butterfly has at least eight broods. As a result it is on the wing throughout the year, although during June and July specimens are only seen on the warmer days. It has been recorded that breeding is continuous throughout the summer in Tasmania and the broods, of which there are four or five each year, overlap each other. In the coastal areas of northern New South Wales and southern Queensland breeding is probably continuous throughout the year.

A caterpillar of the Cabbage White Butterfly, ●on a cabbage leaf. These caterpillars are about three-quarters of an inch long and pale green in colour





A pupa of the Cabbage White Butterfly



Due to this large number of broods in Sydney there is no distinct seasonal variation. Instead, a gradual increase in the size and intensity of the markings occurs from spring through to late summer. The butterflies that emerge in spring have small, light markings; during early summer these markings become larger and darker until mid and late summer, when the markings reach their maximum size and intensity of colour.

Although the early stages of the life-history are well known, it is interesting to compare the lengths of each stage of metamorphosis in Sydney with the recorded lengths for each stage in Europe (British Isles). The average length of each stage, for the months of February and March, in Sydney are: egg, 4-5 days; larva, 13 days; and pupa, 9 days. For the British Isles they are: egg, 5 days; larva, 20 days; and pupa, 21 days. These differences are accounted for by the different climates and day-lengths of each area.

A research worker in the U.S. has suggested that seasonal variation in the markings of the adult butterflies may be due to factors such as length of day, rate of development, and temperature during the larval stage, and length of time spent in the pupal stage. Although these factors may play a role in nature, it is not known to what extent each may determine variation, as experiments with larvae and pupae have not been conclusive.

Experiments have been conducted on the protective adaptations in the larvae of *P. rapae*. They are cryptically coloured, for they are green and match the leaves on which they feed. When the larvae are placed on in-

appropriate backgrounds they are heavily eliminated by insectivorous birds. Larvae resembling their backgrounds are successful in escaping predation, although movement destroys their background's protective value. It has been noticed that it is the moving insect which first attracts the attention of the predator.

The colour of the pupae also provides some protection from birds, as the pupae are thought to be affected by their environment. It is said that those found on a green background are more often green than dark-coloured, and those found on a dark background, such as fences, walls, and trees, are more often dark in colour than green.

The story of the spread of the Cabbage White in Australia parallels that of other introduced animals—animals introduced into a suitable environment and one without effective predators and competitors. The Cabbage White is here to stay; it is now a part of the Australian ecosystem.

[The photos in this article are by C. V. Turner. The map is by the author.]

#### FURTHER READING

- Evans, J. W. (1940): "The Cabbage Butterfly". *Tasmanian Journal of Agriculture*, 11 (4), 202-204.
- Ford, E. B. (1945): *Butterflies*. Collins, London.
- Kolyer, J. M. (1969): "Effects of Environmental Factors on the Markings of *Pieris rapae* (Pieridae)". *Journal of the Lepidopterists' Society*, 23 (2): 77-94.
- Muggeridge, J. (1942): "The White Butterfly (*Pieris rapae* L.)". *New Zealand Journal of Science (Tech. A.)* 24 (3), 107-129.
- Pescott, R. T. M. (1940): "Those White Butterflies." *Wild Life*, Melbourne 2 (11), 12-13, 22-23, 46.



*Hypothalassia armata* (left), a quarter natural size, and *Ranina ranina*, a third natural size



## AUSTRALIAN CRABS

By D. J. G. GRIFFIN

Curator of Crustaceans and Coelenterates, Australian Museum

THE true crabs, or Brachyura, form one of the three major groups of Reptant or walking Decapod (ten-legged) Crustacea, the others being the crayfish and lobsters (Macrura) and the half crabs and hermit crabs (Anomura). There are about 1,200 species of Decapod Crustacea in Australia, and the Brachyura include more than half of these, about 670 species, grouped into 23 families.

Crabs (the name Brachyura means short-tailed) have the short, flattened abdomen folded under the body, which is enclosed in a generally heavily calcified carapace. The eyes are on stalks and usually can be retracted into hollow orbits. The two pairs of antennae are located anteriorly. The mouth is surrounded by six pairs of appendages, including three pairs, the maxillipeds, which are modified thoracic appendages. Only the first pair of legs are provided with nippers. The remaining four pairs may be variously modified for digging or swimming, etc. The abdominal appendages are modified for reproduction in the male (only two

pairs are present), but in the female are very hairy and hold the developing eggs. Male crabs usually have longer nipper limbs and a narrower abdomen than the females. Like all arthropods, crabs grow by a series of moults. The moult cycle, the development of secondary sexual characteristics, colour change, and a number of other processes are controlled by hormones usually secreted by the central nervous system. The life-cycle includes a number of larval stages, zoeae, which are free-floating and form part of the temporary plankton. Finally, crabs breathe by means of gills attached in series to the base of each thoracic appendage and to the adjacent wall of the gill cavity and protected by the overhanging sides of the carapace.

### Five major groups of crabs

There are five major groups of crabs: the Oxystomata (pebble crabs, box crabs, etc.), in which the outer maxillipeds are triangular in shape (in other crabs the mouthparts close to form a rectangle); the



Dromiacea (sponge crabs), in which the last pair of legs are reduced, provided with two claws at the tip, and folded up over the back: the Oxyrhyncha (spider crabs or masking crabs), which have a somewhat triangular carapace with a narrow front sometimes produced into spines; the Cancroid crabs, which have a round or transversely oval carapace; and the Grapsoid crabs, which have a square or rectangular carapace. These two groups, Cancroids and Grapsoids, include between them the bulk of crab species and comprise a large number of families such as the Portunidae (swimming crabs); Xanthidae (reef crabs), Grapsidae and Ocypodidae (ghost crabs, fiddler crabs, etc.). These different groups are found in different parts of the seas and oceans. For instance, whilst nearly all have intertidal and offshore representatives, xanthids, grapsids and ocypodids are almost confined to intertidal areas, and sponge crabs and spider crabs are largely offshore, rather solitary animals.

In common with the general pattern found in other animals and plants, there are many more species in tropical areas than in temperate regions. Most crabs in Australia are marine, only two families have truly freshwater representatives, and three include semi-terrestrial or terrestrial species.

#### Australia's largest crab

The largest crab in Australia is the giant Tasmanian crab *Pseudocarcinus gigas*, an offshore xanthid found in the Bass Strait area. This animal grows up to 18 inches across the carapace, with one chela larger than the other, and up to 17 inches long from base to tip of fingers; large ones may weigh up to 30 pounds. Another large xanthid found off southern Australia and also in Japan, *Hypothalassia armata*, is rather smaller, about 5½ inches across the carapace. This animal has long spines around the sides of the carapace and covering the upper surfaces of the nippers and legs. Spider crabs of the genus *Leptomithrax* also attain a very large size. One southern species, *L. gaimardii*, reaches a carapace length of 6 inches and almost 2 feet across the legs. These crabs moult in May in shallow water and sometimes come ashore in very large numbers around Tasmania, Victoria, and South Australia in autumn. The animals washed up are large, and their bodies are

often heavily encrusted with worm tubes, small oysters, lace corals, and other organisms.

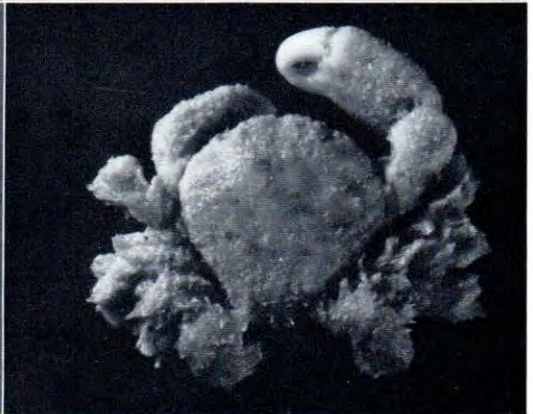
Spider crabs commonly have various organisms attached to the carapace, and some intertidal species appear to have a garden of seaweeds growing on their backs. In fact, the seaweed is plucked from the sides of rocks and placed on the back by the very mobile chelipeds; there it attaches to special curled hairs which occur in clumps over the carapace. The common little Seaweed Crab (*Naxia tumida*) may be completely covered by seaweed.

Among other large crabs are a number of swimming crabs, including the two commercially exploited species, the Blue Swimmer (*Portunus pelagicus*) up to 7 inches across the carapace, and the Mud Crab (*Scylla serrata*), up to 8 inches wide. These two swimming crabs are extremely widely distributed throughout the Indian and Pacific Oceans, and the Blue Swimmer is the only Australian Decapod which occurs right around the whole Australian coastline.

The sponge crabs, as already mentioned, have very short last legs provided with two hooks at the end. These animals continually wear a sponge cap which sometimes is so large that it covers the whole animal. The hooked, upturned legs are used to move the sponge into position and help to hold it in place. The crab actually cuts out the piece of sponge and trims it to the required shape. Not a great deal is known about Australian sponge crabs. One of the species which is not uncommon intertidally is *Petalomera lateralis*. A related species, *Cryptodromia octodentata*, is unusual in that the larval stages are passed within the egg and the young hatch as small crabs.

#### The Oxystomata

The Oxystomata include two main groups, the Leucosiidae or pebble crabs and the Calappidae or box crabs. The leucosiids generally have rounded bodies and long chelipeds, and the family includes some extremely abundant offshore species, such as the Nut Crab (*Phlyxia intermedia*), which occurs in very large numbers on soft sediments around southern Australia. A related species, the Smooth Pebble Crab (*Philyra laevis*) is common in estuaries and can be



Top (from left): *Carpilius maculatus*, one-third natural size; *Eriphia sebana*, half natural size.  
Centre (from left): *Trapezia cymodoce*, x 1.25; *Cymo andreossyi*, twice natural size. Below (from left): *Leucosia anatum*, x 1.25; *Parathelphusa transversa*, two-thirds natural size.



seen moving about at low tide searching for food by pushing its hands down into the soft mud. The late H. M. Hale wrote of the courtship behaviour of this crab: "A male selects a female and moves around her in a clumsy sort of dance; after a time the female, as if fascinated, folds her legs and remains quiescent. The male then seizes his consort with one or other of his large chelipeds, and bears her off at arm's length, the female remaining all the time quite motionless". This species burrows very rapidly by tilting its front upwards and moving its legs quickly. In tropical regions the common leucosiids are species of *Leucosia*, often brightly coloured and having a peculiar channel in the side of the carapace just above the point of attachment of the chelipeds. This channel and the base of the chelipeds are often surrounded by prominent tubercles. Several species vary quite widely in coloration. One, *Leucosia anatum*, which occurs in Western Australia and throughout much of the Indo-Pacific area, is found in four different forms or "morphs". One is generally stone-grey to brown above with a horseshoe pattern of white spots on the back, and the tubercles on the chelipeds are orange. In others there are red circles, large white spots, and small red spots on the carapace. Not surprisingly, this species has been described under eight different specific names.

Calappids or box crabs have large flattened chelae which fold in front of the "face" in a particular way, each being provided with a complex series of grooves and bumps. They are commonly dredged in the sandy lagoons of reefs. One species common on the Great Barrier Reef is *Calappa hepatica*.

The family Raninidae is sometimes considered to be closely related to the Oxystomes. This family includes the Spanner Crab (*Ranina ranina*), a strange looking animal with large spinous flanges around the front of the carapace. The tips of the legs are flattened and used for burrowing.

### Parasitic crabs

There are several groups of crabs which live as commensals or parasites. Probably the best known are the Pinnotheridae or Pea Crabs, which are found in the mantle cavity of bivalved molluscs such as oysters, mussels, and scallops and also in some other animals, including holothurians or sea cucumbers.

The most common species around southern Australia is *Pinnotheres pisum*, which occurs in mussels (genus *Mytilus*). In these crabs the female grows to a greater size than the male and the carapace never hardens. The males are much less commonly found than the females.

### Abundant intertidal crabs

The xanthids are by far the most diverse and most common tropical reef crabs. More than 160 species occur in Australia, and most of these are widely distributed throughout the Indo-Pacific. The Red-Eyed Crab (*Eriphia sebana*) is frequently seen scuttling along the beach rock and reef crest of coral islands. This is a scavenger and hides under rocks and sometimes in crevices. The Shawl Crab (*Atergatis floridus*), so named because of the lace-like pattern on its back, is common in shallow water just off the reef crest. Another species, *Carpilius maculatus*, sometimes called the Blood-spotted Crab (not to be confused with the swimmer, *Portunus sanguinolentus*) or Spotted Pebble Crab, is also commonly found in shallow reef areas. Species of *Phymodius*, *Actaea*, and *Liomera* are often found hiding under rocks and among corals. *Chlorodiella* species are found in huge numbers in clumps of seaweed, whilst small xanthids such as *Cymo andreossyi* and *Trapezia cymodoce* are found in large numbers amongst branching corals such as *Pocillopora* and *Acropora*.

In southern parts of Australia the most abundant intertidal crabs are grapsids. The Steelback (*Leptograpsus variegatus*) is typical of rocky coasts exposed to pounding surf. The body and legs are flattened so that it is able to shelter in narrow crevices, and the terminal two segments of each walking leg are provided with stout spines which enable it to grip rock so effectively that a strong wave can wash over it without dislodging it. The Steelback forages around the sides of rock stacks and boulders and feeds mainly on encrusting algae, which it scrapes off with the spooned fingers of its chelae. Species similar in shape and habits, belonging to the genus *Grapsus*, are very common in tropical areas (see *Australian Natural History*, Vol. 15, No. 2, June 1965, p. 37). Species of *Cyclograpsus* and *Paragrapsus* are common on more sheltered coasts in southern Australia.

The fiddler crabs (*Uca*), ghost crabs (*Ocypode*), and sentinel crabs (*Macrophthalmus*), of the family Ocypodidae, are the most abundant crabs on estuarine flats and river banks in tropical Australia. All live in burrows and have a fairly complex array of social behaviour patterns (see *Australian Natural History*, Vol. 15, No. 3, September 1965, p. 87). Some fiddler crabs and ghost crabs appear to communicate by making noises, rubbing a ridged area on some part of the cheliped against a smooth area on the base of the cheliped or the underside of the carapace, or by tapping or drumming on the ground with their chelae or walking legs. However, there is no evidence that these crabs can detect air-borne sounds. Only recently it has been discovered that nerves in the legs of one species of *Ocypode* and a species of *Uca* respond to short tones transmitted through the ground.

#### Freshwater crabs

The only truly freshwater crabs in Australia are the six species of *Parathelphusa* (family Potamidae) and the little flat-backed crab *Halicarcinus lacustris*, although one of the southern Australian grapsids, *Leptograpsodes octodentatus*, sometimes lives in hyposaline pools or near freshwater seepages (see *Australian Natural History*, Vol. 14, No. 3, September 1962, p. 71). There are six species of *Parathelphusa* in Australia and five of them are found only in the Cape York Peninsula area of Queensland. The sixth species, *P. transversa*, occurs in the Northern Territory, Queensland (not Cape York Peninsula), and New South Wales. These crabs are found in creeks, swamps, springs, river pools and farm dams and drains, where they burrow into the mud banks. During droughts the burrow mouth is sealed by a plug of earth, thus preventing evaporation. The larval stages are passed within the eggs, which hatch as young crabs.

*Halicarcinus lacustris* (family Hymenosomatidae) is one of the spider crab group. It is a small animal, black or dark brown in colour, occurring beneath stones in lakes and streams in New Zealand, Norfolk and Lord Howe Islands, and southeastern Australia.

Crabs are of widespread interest to many. About 60 per cent of the species known from Australia have been described since the

beginning of this century. Yet a lot of work remains to be done in the fields of both taxonomy and biology.

[The photos in this article are by C. V. Turner.]

#### FURTHER READING

- Crustaceans*, by Waldo Schmitt. University of Michigan Press, U.S.A., 1965.
- The Crustaceans of South Australia*, by Herbert M. Hale. Government Printer, Adelaide, 1927.
- Pacific Crustacea*, by S. W. Tinker. Charles E. Tuttle, Tokyo, 1965.
- Articles by Melbourne Ward in *The Victorian Naturalist*, Vol. 46, No. 4, 1929, p. 75; *The Australian Zoologist*, Vol. 5, Part 3, 1928, p. 241, and Vol. 13, Part 2, 1965, p. 127; and Proceedings of the Royal Zoological Society of N.S.W., 1967, p. 59.
- "Crabs of the Sydney Foreshores", by F. A. McNeill, in *Australian Natural History*, Vol. 14, No. 2, June, 1962.

## BOOK REVIEW

**AUSTRALIAN WILDFLOWERS IN COLOUR; photographs by Douglass Baglin, text by Barbara Mullins; published by A. H. and A. W. Reed, Sydney, 1969; 112 pages. 109 colour plates. Price \$3.95.**

Among the diversity of illustrated books on Australian flowers now available, this relatively small volume is notable for its widely representative selection of plants and for the excellent illustrations which accompany the brief, informative text.

Examples of thirty-two families are treated, including those generally most familiar in temperate Australia as well as some of the most handsome flowers of northern and inland Australia.

For each family the distribution and size are indicated, with mention of well-known or economically important members. Notes follow on the particular species illustrated, giving an outline of their distribution and other points of interest. Mistakes are few, but the following were noted: Lecythidaceae (page 66) and *Trichinium* (p. 82) are misspelled, and the plant illustrated as "*Careya* species" (p. 66) is *Planchonia careya*.

A book of this size cannot be comprehensive, and is therefore only to a limited extent useful for identification, particularly as the emphasis on the flowers in the photographs, while leading to most attractive illustrations, is sometimes at the expense of other features useful in recognition. Some indication of the scale of the photographs would have been helpful.

This attractive publication will have wide appeal and is good value.—Barbara G. Briggs, *Royal Botanic Gardens, Sydney*.





The author (centre) and two native carriers ferrying cargo across the flooded Pio River on a raft during a reptile-collecting expedition.

## **COLLECTING REPTILES AND AMPHIBIANS IN NEW GUINEA**

By **FRED PARKER**

Assistant District Officer, Daru, Western District, New Guinea

**E**ARLY in 1960 I arrived in New Guinea and was posted to Bougainville Island, in the northern part of the Solomon Islands. Initially, I was kept busy learning the varied aspects of a general administrative position with the Government. It was when it came to the practical side—road building and patrolling over the large rugged island covered in dense rainforest that I took notice of the many striking species of reptiles to be found along the narrow tracks between villages, from sea-level to over 8,000 feet, through lowland swamps and along razor-back ridges. In patches of sunlight in the dark gloomy forest there were small scurrying gold-striped skinks with iridescent blue tails, thin grey tree-snakes swiftly darting into the undergrowth, large noisy black goannas with yellow spots, and large green and brown

prehensile-tailed skinks with habits very much like those of the Australian blue-tongue *spæzi* and which ate only leaves and fruit high in the trees. At night, in the village rest houses of woven sago palm leaves, brown tree-snakes would chase and catch rats in the rafters and fat sluggish ground pythons would crawl under boxes and into beds.

Having had an amateur interest in reptiles while still in Australia, I tried to put names to the many species I saw, and came up against the great barrier in New Guinea taxonomy—many of the papers describing its reptiles and amphibians are scattered through old and obscure journals in German, Italian, Dutch, French, and other languages. Most collections have been made by workers during short visits to various places, and

many of these collectors were not primarily interested in herpetology. Thus, each of the scattered papers dealt with only a few species and rarely was there any information recorded about the living animals. By writing to many Museums I obtained copies of these papers, and when Dr Ernest Williams, of the Museum of Comparative Zoology, Harvard, wrote to suggest publishing observations on the life-history and behaviour of Bougainville animals, collecting quickly expanded to fill all my spare time. After 4 years I moved to the central highlands of New Guinea, where there were different species of reptiles, different people, and different habitats—montane grasslands and stunted moss forest as well as normal rainforest. I found that native collectors were bringing in the bulk of my collections, as far as numbers went, but that most observations on the habits and habitat of the living animals resulted from my own trips by day and night.

#### The native people as collectors

I found native collectors a mixed blessing. In New Guinea, as in many tropical countries,

the native people are often willing collectors of animals and plants. But the degree of willingness depends on many things—the knowledge the people have of the specimens wanted, the kind and magnitude of the rewards offered, whether the reasons for the collecting have been adequately explained, understood, and accepted, and any fear or dislike the people may have of all or some of the things wanted. So a collector in any biological field should not come to New Guinea expecting to make a comprehensive “armchair” collection by enlisting the aid of native collectors.

#### Villagers' knowledge of wanted specimens

Surprisingly enough, the village people do not always know all the species of reptiles and amphibians to be found in the countryside in which they live, hunt, and garden. As a rule, the animals which are best known are those which are hunted for food, those which are dangerous, and those which are strikingly noticeable in behaviour or appearance. On Bougainville the habits of the two species of large river frogs, *Discodelles guppyi* and *D. bufoniformis*, are well known



*Corucia zebrata*, a large aboreal skink found only in the Solomon Islands, is strikingly similar in appearance and behaviour to the Australian Blue-tongues.



This froglet, *Platymantis parkeri*, is less than half an inch long when fully grown, and is found in leaf litter on the forest floor on Bougainville Island. It is dark red-brown with yellowish markings and white bands on the lips.



to the natives because the legs of these frogs are a popular item in the diet. Similarly, the prehensile-tailed skink, *Corucia zebra*, also an item of food, the estuarine crocodile, *Crocodylus porosus*, occasionally a man-eater, the striking forest dragon, *Goniocephalus godeffroyi*, and the ficus gecko, *Cyrtodactylus louisianensis*, are well known to the people: all of them have names in the native languages, and are most commonly collected by the people. In the central highlands, where protein is at a premium, the many tree frogs normally collected by the women for food are well known and easily collected, whereas the many species of burrowing and leaf-dwelling Microhylid frogs, none of which are eaten, are not as well known, more rarely collected and do not have distinctive names in the local languages. In most of the areas in which I have collected, the small cryptic lizards, frogs, and snakes, which are of much importance in taxonomy, are little known by the native people, and groups of species are lumped together under single names according to habitat, size, or colour. In many cases of very small cryptic species, I have collected all specimens myself—native people have not brought any in at all. Often a group of collectors have become most enthusiastic when I have been able to describe in detail some small species of which they knew little or nothing.

Children are often the most enthusiastic collectors in a village, but, generally speaking,

limit their activities to the more common species and lose interest when one limits purchases to only the more unusual and uncommon kinds. Adults supply the larger and rarer species.

Another feature becoming more common in many parts of New Guinea is a widespread lack of knowledge about wildlife on the part of the younger generation in the more sophisticated areas. Older children have grown up in Government and mission schools, away from the influence of their parents, who would normally teach them bush lore, and in one or two generations this knowledge may be lost.

#### Rewards

Some knowledge of the people in an area is a necessity if one is to ask them to collect specimens. In the more developed groups money is the acceptable payment for animals brought in. In more backward areas, if there are no stores in which money can be put to use it is not accepted. The amount to be paid for a given animal also requires careful consideration. Higher prices should not be paid only for large animals if they are difficult to catch, but also for species which are obviously rare and those which are valued for food or other reasons. In many parts of Bougainville I have found the people afraid of all snakes, even though none of the land snakes there are dangerous, and have offered higher prices for them to ensure



representation of the species. In parts of New Guinea large native collections may contain no goannas (*Varanus* species) or green tree-pythons (*Chondropython viridis*). This is because goanna skins are used to cover the wooden hour-glass drums (kundus) and green tree-pythons are a valued food, especially in the highlands. Incentives have to be tailored to fit these groups.

When I took time off for a trip from Karimui, in the central highlands, to Baimuru, in the Gulf of Papua, through villages which have not had a lot of contact by the Administration, I packed quantities of razor blades, matches, twist tobacco, axes, knives, and lengths of coloured calico. Despite flooded rivers, timid natives, who faded into the forest leaving deserted villages, and the loss of many carriers who were afraid to cross tribal boundaries for fear of sorcery, I arrived on the coast with specimens representing over 100 species of reptiles and amphibians. Many of these have proved to be undescribed. Had I taken money I would have had very few specimens brought in by the people.

#### Importance of explanations

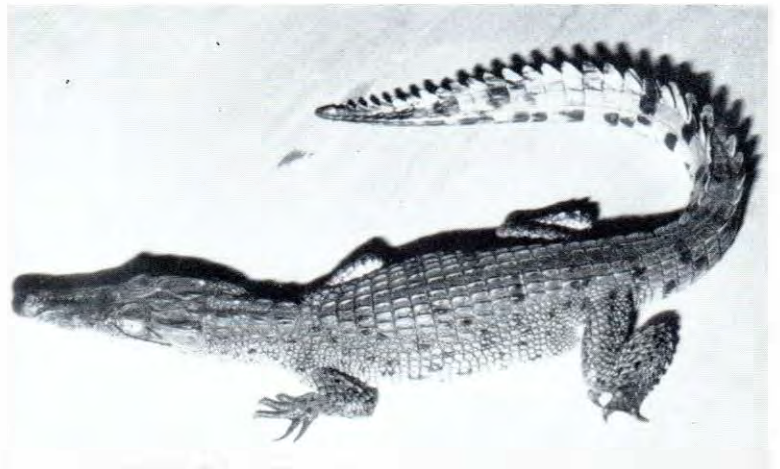
Often village people extend, at the best, a cool welcome to a visiting patrol officer, since he has both police and judicial powers. Many times I found that an interest in wildlife led to discussions with the men, and using local names and detailed descriptions of the habits of various snakes and lizards I managed to "break the ice" and the

atmosphere warmed noticeably. Many times I have been asked why various white men, myself included, insist on collecting everything from rocks and artefacts to animals and plants. A rambling reply describing museums, universities, and taxonomy, and why different species inhabit different areas and habitats, could make the people much more interested in collecting and could overcome any misgivings the villagers had about collecting. In areas where sorcery is common and much feared, an interest by a stranger in snakes or particular kinds of frogs could be interpreted to mean that he intended to use them in sorcery. Again, in some areas people felt reptile collecting might be a commercial venture and wanted to know whether this was the case and, if so, how the animals were marketed. Once, near Kieta, on Bougainville, the rumour spread that all the snakes brought in to me were being sent to Japan to be cooked and put into tins of fish. This led to some very fast talking—I made my explanations to irate storekeepers with large stocks of unsaleable tinned fish. Thus, the amount of assistance the village people will give collectors often depends on a truthful explanation of the reasons for scientific collecting and the degree to which it is accepted and understood.

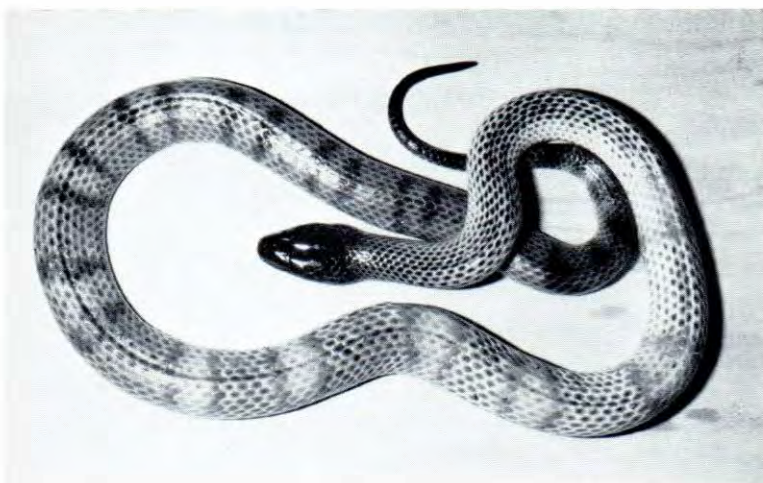
#### Fear an important factor

Apart from a common fear of snakes, both harmless and dangerous, many native groups have totems—forbidden animals which members of particular clans or lineages cannot touch or kill. The long list

The New Guinea freshwater crocodile, *Crocodylus novaeguineae*. This young specimen is about 3 feet long. The species grows to about 11 feet and is harmless to man.



The large nocturnal venomous snake *Micropechis ikaheka*, found under logs and rubbish in the New Guinea lowlands.



of totems includes many larger birds, some marsupials, and such reptiles as turtles, crocodiles, and pythons. Where some reptiles are endowed with mystical powers or are the subject of a particular belief there may be a reluctance or refusal on the part of the villagers to collect them. This applies often to snakes, which are incorporated in cults and ceremonies, and, in some areas, are believed to be the agents of sorcerers. Any of these factors can leave gaps in reptile collections.

#### Valuable collections

These limitations do not prevent large collections made by the native people from being extremely valuable. On a quick visit to a place, by far the best results are to be had by purchasing animals from villagers. It is by such means that most collections have been made in New Guinea to date. But there is room for improvement on this type of collecting. For instance, when an unusual specimen turns up amongst common species brought in by native collectors I discuss the animal's habitat in detail with the collector if time permits, and also attempt to go to the actual site. Questions about even the common species can result in unexpected information. There can be other surprises which must be guarded against. Often a man away working or visiting will pick up an animal that interests him and take it home as a pet. Parrots, hornbills, possums, tree kangaroos, pythons, and goannas are so transported for considerable distances—for

instance from the coast to the highlands. Careful questioning ensures that specimens bought in a particular area do in fact belong there.

By learning where the villagers find the animals they bring in I have also learned to look for places where villagers do not seek the smaller frogs and lizards. As a result, many interesting cryptic species have found their way into my collections. Some small species I have collected only myself, none having appeared in large collections brought in to me. Near Kainantu, in the highlands, a low croak in the extensive swamps in the open grasslands led to a find of a new small green frog, *Hyla contrastens*, which the natives had not collected. It was named and described only in 1968. In the mountains near Goroka while Dr Richard Zweifel, of New York, was with me collecting on patrol, we spent one night picking minute brown frogs off the leaves of clumps of pitpit or wild sugar cane. The frog's call was like that of a small insect, and the native people had assured us that frogs did not live in these exposed clumps on the open ridges. This is a species of *Cophixalus*, yet to be described and named.

#### Results of collecting

Nine years of collecting in various parts of New Guinea, by many hundreds of native collectors and myself, have added considerably to the known herpetofauna of New Guinea. From Bougainville four new species of lizards, eight of frogs and one



blind snake either have been described or soon will be. And many years ago it was said that almost certainly the fauna of the island was then well known. From New Guinea, the specimens collected have still to be fully studied and compared with the scattered descriptions in the literature. At least four new lizards and six frogs have turned up so far. Many observations on the habits, habitat, and breeding behaviour have yet to be assembled into order for publishing—a difficult task when new collections are coming in all the time.

The end is nowhere in sight. Many collectors of reptiles and amphibians (and any other forms of life you care to mention) could spend their lifetime studying the

different forms in the various habitats of New Guinea and there would still be extensive gaps in knowledge. An understanding of the full fauna of New Guinea is necessary before the origins of Australia's wildlife can be known.

[The photos in this article are by the author.]

#### FURTHER READING

- Nelly de Rooij: *The Reptiles of the Indo-Australian Archipelago* (2 volumes), Leiden, Holland, 1915.  
P. N. van Kampen: *The Amphibia of the Indo-Australian Archipelago*, Leiden, Holland, 1923.  
Arthur Loveridge: *Reptiles of the Pacific World*, New York, 1945.  
Michael J. Tyler: "Papuan Hyliid Frogs of the Genus *Hyla*," in *Zoologische Verhandelingen*, Leiden, Holland, 1968.

---

## BOOK REVIEW

**ELEMENTS OF ENTOMOLOGY**, by Harold Oldroyd, Weidenfeld and Nicolson, London, 1968; 312 pages, 70 text figures, 50 black and white plates, Price, \$6.65.

This is a book consisting of a brief introduction, twenty-three relatively short chapters, an appendix, a bibliography and an index. In the introduction it is stated that the purpose of the book is to bridge the gap between school and university or between courses of general biology and courses of zoology or specialist entomology. It is stressed that the book is not a teaching manual but a book for background reading in addition to recommended text books. The book, therefore, is decidedly aimed at the serious student. The facts presented are essentially the same as those which are to be found in many modern texts on entomology, and they are presented in popular terms wherever possible.

Chapters 1 to 7 are arranged very much as in many other recent texts. The first chapter is a general introductory one giving the fundamental anatomy of the insect. The second relates to immature insects, and chapters 3 to 7 deal with the various orders and other groups of insects in a systematic fashion. For each of these the salient features of their biology are indicated. Chapters 8 to 10 deal essentially with certain restricted aspects of insect biology such as vision, sound and hearing, flight and adaptation to terrestrial and aquatic environments. Chapters 13 and 14 are devoted to feeding, and 15 to 17 are devoted to the social insects. Chapter 18 is a general chapter on behaviour, and the remaining chapters deal with the various economic aspects of entomology. Each of these chapters forms a general introduction to its subject for the intelligent lay reader. For the serious student it would perhaps be preferable to proceed directly to more technical texts.

This is a good introductory book on insects. The layout, with clear chapter headings and clear headings to sections, makes it an easy book to go

back to. The illustrations vary in their quality from poor to excellent: for example, plate 48 (of a mosquito) is poor, plates 49 and 50 are not convincing, whereas plate 25 is very fine.

It is inevitable that, when one author attempts to cover so wide a field as that of insects and their biology, as is attempted here, there would be errors of fact and certain inaccuracies. These, however, are comparatively few in this book and whilst they may irritate specialists they are of little consequence to the general reader and do not detract from the value of the book from his point of view. Perhaps some of these could have been eliminated by reference to a specialist.

The most important chapters are chapter 8 and those which follow. The material of the first seven chapters is inevitably repetition of material to be found in many other elementary general texts. It is some years since the subject matter in the later chapters of this book has been presented in popular vein, and since the earlier publications there has been considerable advance in knowledge in the many spheres of insect biology which are covered. More widespread appreciation of the value of insects as experimental animals, the tremendous improvement in techniques and the greater number of research workers in entomology have all contributed to great advances in insect physiology and insect behaviour studies. The essence of much recent work which has not previously been reported in popular literature is condensed in this volume; sometimes this could have been more accurately done, but it is mostly well done.

This book is recommended to the layman who wishes to obtain modern general information on insects and their biology. If it leads to more detailed reading in any of the briefly covered sections, the few inadequate sections will be obvious; if not, at least the general picture will have been well presented.—C. N. Smithers, *Australian Museum*.



A horizontal high-tidal shore platform, Eaglehawk Neck, Tasmania. [Photo: Author]

## *The Production of Horizontal High-tidal Shore Platforms*

By NORMAN K. SANDERS

Assistant Professor of Geography, University of California, U.S.A.

**H**ORIZONTAL platforms at the approximate level of high tide occur on many of the world's shores, but some of the best examples can be found on the southeastern Australian coast. From northern New South Wales to Tasmania, shore platforms give distinctive character to the coastal scenery and are great attractions for fishermen and scientists alike. For the fisherman, the rewards are immediate and satisfying. The scientist must be content with less tangible and sometimes inconclusive results.

Geologists and geomorphologists have been trying to explain the formation of shore

platforms for over a century. One complicating factor is the number of different platform types possible. Horizontal, high-tidal platforms are the most spectacular, but forms such as horizontal supratidal, horizontal subtidal, and sloping intertidal also occur.

Theories of horizontal high-tidal platform formation have become polarized into two basic areas: (1) Shore platforms at present exposed at high tide were cut by wave-propelled rock abrasion when relative sea-level was higher; (2) shore platforms have been formed by some agency or combination

of agencies with sea-level near the present height. If shore platforms were produced by wave abrasion at a higher sea-level, then they would be good indicators of sea-level change, and they have in fact been cited as evidence by many researchers.

Earlier workers tended to neglect three major avenues of investigation which are important in defining the processes involved in shore platform development. These are: precise mapping of the platform surfaces, laboratory work including wave tank experiments, and underwater study. In addition, the influence of biological factors, climate, wave characteristics, and tidal regime were often overlooked. It was in these neglected areas that I concentrated my research, supported by a Fulbright Grant and a University of Tasmania Scholarship.

### **Mapping**

The mapping phase of the study was concentrated in the Eaglehawk Neck area of the Forestier Peninsula, 30 air miles southeast of Hobart. Detailed surveys of the platforms were accomplished with a Wild TO theodolite. The data was plotted to obtain maps with scales of 1 inch to 10 feet and contour intervals of 6 inches, with elevations tied to a sea-level datum through the use of a portable tide gauge developed for the project.

As the maps were compiled, they began to show some interesting similarities. One of the most striking was the bevelling of the sloping sedimentary rock surfaces to produce a horizontal area near the elevation of mean higher high water. In some instances the rock was not bevelled, but was deeply pitted. The pits extended downward to the approximate level of mean higher high water and then stopped. This would seem to indicate that the bevelling process was at present active and that some mechanisms should be apparent. Abrasion by wave-propelled rocks has often been mentioned as a platform-producing force. In this instance, however, the pits were narrow and deep and contained no tool stones. Another alternative was sub-aerial weathering—the gradual breakdown of rocks by chemical, mechanical, and organic forces. Weathering seemed a more plausible explanation, but why should the process develop a horizontal surface which is at the same elevation on a number of different platforms? Obviously, further study was needed.

Underwater investigation was being carried on at the same time as the mapping of the exposed platforms. The sub-surface survey showed that a number of distinct platforms existed offshore, producing a stepped profile which was eventually obscured by sand at a depth of about 40 feet. This stepped profile might have supported the theory of underwater formation of shore platforms by rock abrasion except that any rocks present were wedged firmly in cracks and matted with organisms. The platform surfaces themselves were also completely covered with algae and other forms. These observations matched those made elsewhere in Tasmania and the Pacific Basin and indicate that submarine rock abrasion, while locally important in Britain, may be of less consequence elsewhere in the world.

### **Bevelling repeated**

When the Eaglehawk Neck survey was completed, platforms in other parts of the State were measured. The bevelling found in the sandstones of Eaglehawk Neck occurred in other sedimentary rocks on the Tasmanian coast. More significantly, the Tertiary basalts along Bass Strait were also bevelled into horizontal platforms at the level of mean higher high water, even though the tide range between mean higher high water and mean lower low water was over 9 feet (compared to a range of 2.6 feet at Eaglehawk Neck). One platform at Don Heads, near Devonport, showed extreme horizontality: surface elevation varied only 0.28 feet over the 10,000-square-foot area. The arched and plunging nature of the olivine basalts in which the platform is cut rule out the possibility of stripping by wave action to a horizontal joint plane. Again, the evidence pointed toward some sub-aerial weathering process which was limited in its downward action.

A process has been mentioned periodically in the literature which could account for the horizontality noted on the shore platforms studied, but details of how the process actually worked were scanty. The mechanism was called "Water Layer Weathering", proposed by C. K. Wentworth in 1938. He believed that alternate wetting and drying of rocks in the coastal zone encouraged breakdown through surface tension phenomena, colloidal and dilation behaviours, and recrystallization of salts. This action



would be inhibited by permanent wetness—the saturation level in the rock. Of all the water-layer weathering processes, salt crystallization offers the most possibilities for rapid removal of material to a base level. The brine enters minute cracks in the rock and evaporates. Crystals then grow in the concentrated solution left behind, exerting pressure on the walls of the crack. Eventually the pressure may cause the rock particle to flake off and the process begins again on the newly exposed surface.

For salt crystallization to bevel coastal rocks into horizontal shore platforms, three conditions must be met: (1) Rocks must have characteristics allowing entry of sea-water for salt crystallization, and, when the process reaches its final stages, to permit sufficient water-flow to prevent crystallization at a certain level; (2) the rocks must contain a horizontal water table; (3) the process must be rapid enough to act before other mechanisms with lower base levels can degrade the surface.

### Laboratory tests

To determine if the Tasmanian rocks were permeable enough to meet the requirements for salt crystallization weathering, laboratory tests were conducted. Samples included Permian sandstone and Tertiary basalts, both of which often support horizontal platforms, and Devonian granite and Jurassic dolerite, which usually have sloping surfaces. One of the tests consisted of measurements of the sample rocks cut into 1-inch cubes and immersed in saltwater for 70 hours. The basalt, host of the extremely horizontal platform at Don Heads, absorbed the most water—5.11 per cent by weight. The Eaglehawk Neck sandstones absorbed 3.01 per cent water by weight, while the dolerite and granite took on 0.34 per cent and 0.26 per cent, respectively. The test showed that basalt and sandstone could take on appreciable quantities of water which might favour the action of salt crystallization.

The existence of a horizontal water table in the rock is more difficult to measure.



A platform in the process of being bevelled. Eaglehawk Neck, Tasmania. The white patches on the platform surface are salt crystals. The very small white objects are the grazing periwinkle *Melarapha unjasciata*. The survey rod is calibrated in tenths of feet. [Photo: Author.]

My crude experiments consisted of drilling holes in platform surfaces and weighing oven-dried samples taken from within the platform itself. Results of the weighing experiments indicated that the rock was saturated, but horizontality of the water table was impossible to determine.

### Speed of crystallization

Like the characteristics of rock saturation, the rapidity of salt crystallization is not easy to prove. However, an old bridge abutment at St Helens, Tasmania, shows evidence for very rapid rock disintegration in the peritidal environment. The rock, a Triassic sandstone, has been in place for about 100 years. It is deeply pitted, with some of the holes measuring 9 inches deep and 15 inches in diameter. This massive breakdown of material has occurred in blocks artificially disturbed by quarrying and transportation, but gives an indication of the attainable rate.

Salt crystallization alone may be a powerful platform-producing force, but when joined by biological action the process could be speeded-up considerably. A part of the activity is mechanical, some is chemical and a large proportion contains elements of both. The mechanical factors include scraping, boring, plucking, and wedging, while chemical action is largely in the form of solution. Worms, pholads, chitons, limpets, and sea urchins have long been recognized as agents of erosion. Other members of the biotic community which aid in the breakdown of rock are algae, lichen, and periwinkles. The organisms may remove rock directly, as in the case of the periwinkles which graze on the surface, or may create small openings in the rock which will favour increased water circulation and subsequent salt crystallization.

Hydraulic activity is yet another process which is important to shore platform formation. The theory of storm wave production of shore platforms still has its adherents, and wave-splash obviously has some effect on the level of saturation in the rock. In an attempt to experimentally examine the effects of storm waves on sea cliffs, I created waves in a tank to erode specially cast plaster-sand blocks. The results showed that the waves did indeed erode a notch in the cliff, but that the notch

was so low on the cliff that any horizontal platform produced would be below mean sea-level. A platform shape subjected to wave attack became degraded into a sloping form, indicating that, in some cases, wave action may be destroying horizontal platforms.

### Summary

In summary, shore platforms are developed in response to a number of interacting passive and active factors. Passive factors are inherent in the rock itself and active factors produce the platform morphology. Active factors include weathering, the activity of organisms, hydraulic processes, and environmental considerations. These considerations are climate, tidal regime and wave characteristics, all of which have influence over platform development.

Rock characteristics exert a major control over the type of platform present (if any) and the rate at which the platform will form. Most favourable for platform development are permeable, well-jointed rocks; least favourable are massive formations with no water absorption potential. Given a suitable rock type, we can attempt to reconstruct the process leading to the development of the horizontal, high-tidal platforms common on the Australian coast. First of all, it is necessary to bring a rock surface into contact with the sea. This can come about either through movement of the land mass or a change in sea-level. When the sea contacts the rock surface the most obvious immediate result is hydraulic action by waves. Though the waves may appear overwhelmingly powerful, their erosive action is fairly slow except in areas where weathering has already acted along joint and bedding planes. Thus, waves may roughly plane an area down to the level of saturation in the rock—the level, roughly at mean higher high water, at which sub-aerial weathering can no longer act. To this extent, storm waves may play a part in platform development. When the surface has reached this level, the forces of water layer weathering can speedily act to produce horizontality.

A revised definition of water layer weathering could be: "A complex interaction of chemical, mechanical, biological, and biochemical processes which produce horizontality through facilitating the rapid

activity of salt crystallization to a level where wetting and drying cycles are inhibited by water saturation within the bedrock." Such horizontality is only temporary, because many of the processes can act below the saturation base level.

While the platform surface is undergoing bevelling, the rock at higher levels is being eroded back by normal sub-aerial weathering processes. The net result is the typical sea cliff with a platform at its base. Often the platforms are quite wide, making it difficult to see how so much material could be removed in the time since sea-level reached its present height. It is possible that these situations represent evidence of former high sea-levels in the geological past. The ancient platforms may have been renewed by modern forces.

Can shore platforms be used as indicators of past sea-levels? Only in broad terms. The present horizontal high-tidal platforms are very much in equilibrium with contemporary climate, tidal regime, and wave characteristics. Horizontal subtidal platforms and horizontal supertidal platforms indicate other higher and lower sea-levels, but degrading forces are acting upon them and determination of the exact previous level would be difficult.

Even though shore platforms may not be very useful for precisely measuring past sea-levels, they are still valuable areas to study for insight into weathering mechanisms and coastal erosion processes. In addition, shore platforms offer productive hunting grounds for zoologists and fishermen. Without the action of sub-aerial weathering to a saturation base level much of the rocky coastline now fringed by platforms would be inaccessible vertical cliffs, and an important source of information and enjoyment would not exist.

#### FURTHER READING

- Sanders, N. K. (1967): "Construction of a Simple Portable Tide Gauge", *Australian Journal of Science*, Vol. 20, No. 8, pp. 282-283.
- Sanders, N. K. (1968): "Wave Tank Studies into the Erosion of Rocky Coasts," *Papers and Proceedings of the Royal Society of Tasmania*, Vol. 102, pp. 11-16.
- Wentworth, C. K. (1938): "Marine Benchforming Processes: Water Level Weathering," *Journal of Geomorphology* 1, pp. 6-32 (Part 1).

## BOOK REVIEW

RECENT FORAMINIFERIDA OF THE CENTRAL COAST OF NEW SOUTH WALES, by Alberto D. Albani. *Australian Marine Sciences Association Handbook No. 1* (1968). Price, \$1 (students and members of AMSA), \$2 (non-members).

This attractive little handbook (37 pages) is an excellent introduction to recent foraminifers of N.S.W., suitable for non-specialists and interested amateurs with access to a low-power microscope.

The handbook covers all of the common species, which are illustrated by 160 good-quality photographs or sketches. The accompanying descriptions are concise and informative, and three tabular keys should enable even a beginner to identify specimens to family and genus after a little practice. Other sections cover the ecology of foraminifers, and the best methods of collection, preparation, and study.

This handbook should certainly be included in every school library, since it describes organisms readily available in local beach deposits: these are easily sorted by children, providing a fascinating introduction to these attractive micro-organisms. The handbook, which also contains a useful bibliography for further reading and an up-to-date geological time scale, is available from the Honorary Secretary of AMSA, c/o Hydrographic Office, R.A.N., Garden Is., N.S.W. 2000.—A. Ritchie, *Australian Museum*.

---

#### BOOK ON MARINE MOLLUSCS

The National Museum of Victoria, Melbourne, announces that the price of the book *Marine Molluscs of Victoria*, by Macpherson and Gabriel, has been reduced from \$7 to \$3.50. The book, which contains 475 pages and 486 illustrations, is published by the National Museum of Victoria and Melbourne University Press.

---

#### PRIVET HAWK-MOTH CATERPILLAR

L. Courtney-Haines writes to the editor that the last paragraph of his article "Privet Hawk-Moth Caterpillar", on page 96 of the September, 1962, issue of *Australian Natural History* (Vol. 14) seems to indicate that it is the female Privet Hawk-Moth (*Psilogramma menephron menephron*) that produces a squeaky, rasping sound. The paragraph in question, Mr Courtney-Haines states, should read as follows: "The moths are both crepuscular and nocturnal and are attracted to various garden flowers, among which petunias and honeysuckle are greatly favoured. The females, somewhat larger than males, may have a wing-span of 4 inches or more. The males when alarmed are capable of producing an audible squeaky sound, which is quite startling and is no doubt some protection against enemies."



# MEET OUR CONTRIBUTORS . . .

CATHERINE J. ELLIS, Mus.Bac. (Melb.), Ph.D. (Glas.), was educated in Victoria, completing a performer's Bachelor of Music in Melbourne in 1956. She maintained contact with professional music while spending the following two years as assistant to T. G. H. Strehlow at the University of Adelaide, South Australia, transcribing and analysing recordings from Strehlow's own collection of Aranda songs. From 1959 to 1961, a grant from Glasgow University enabled Dr Ellis to continue work on Aboriginal music in the music department of that institution, where much experience was gained in methods of research into musical materials. Research has since been continued in Australia through grants from the University of Adelaide, the Australian Institute of Aboriginal Studies, the Myer Foundation, and the Australian Research Grants Committee.

DESMOND GRIFFIN joined the staff of the Australian Museum in June, 1966, as Assistant Curator of Marine Invertebrates, and was appointed Curator of Crustacea in December, 1968. He graduated M.Sc. from Victoria University of Wellington, New Zealand, in 1962, and obtained his Ph.D. from the University of Tasmania in 1966. His main interests are in the taxonomy of spider crabs and the ecology and behaviour of shore crabs. He is spending from January to September, 1970, as a Visiting Research Associate at the Smithsonian Institution, Washington, U.S.A.

FRED PARKER completed his secondary education in Victoria, and, when not at school, spent all his spare time collecting and identifying reptiles and tending animals at the Healesville Sanctuary. He joined the New Guinea Public Service in 1960 as a Cadet Patrol Officer. He spent 4 years at various stations on Bougainville Island, a further 4 years at Goroka and Kundiawa in the Central Highlands, and is now in charge of local government in the Western District of Papua.

JOHN V. PETERS was born in England and educated there and in Northern Ireland. He came to Australia in 1961 to take up a teaching position with the New South Wales Department of Education, and was seconded to the Australian Museum in January, 1968, to rehouse and reorganize the butterfly collections. Mr Peters is particularly interested in the distribution of the butterflies of Australia and the South Pacific, and has carried out fieldwork in Australia and New Caledonia. He has also published notes on the butterflies of Norfolk Island and Lord Howe Island.

NORMAN K. SANDERS is Assistant Professor of Geography at the University of California at Santa Barbara. In 1964 he received a Fulbright Fellowship to study the Tasmanian coast—a study continued on a University of Tasmania Research Scholarship. He obtained his B.Sc. from the University of Alaska in 1958, his M.A. from the University of California, Los Angeles, in 1964, and his Ph.D. from the University of Tasmania in 1968. Dr Sanders is studying various aspects of environmental pollution and human impact on coastal landforms. In addition, he is a member of a team constructing a microwave radiometric remote-sensing device to detect oil pollution from aircraft.

J. M. THOMSON, D.Sc., is Professor of Zoology at the University of Queensland, and was a first-class honours student of the University of Western Australia. His experience in marine biology is wide, as he has worked in every State of the Commonwealth as a member of the CSIRO, in which organization he reached the status of Principal Research Officer. He was a scientific adviser to two Australian delegations and two United Nations meetings on conservation and the law of the sea. His major research interest at present is the effect of man on the estuaries and inshore fauna and flora.

# THE AUSTRALIAN MUSEUM



**PRESIDENT OF TRUSTEES:** W. H. MAZE, M.Sc.

**CROWN TRUSTEE:** EMERITUS PROFESSOR A. P. ELKIN, C.M.G., M.A., Ph.D.

## **OFFICIAL TRUSTEES:**

THE HON. THE CHIEF JUSTICE, THE HON. THE PRESIDENT OF THE LEGISLATIVE COUNCIL, THE HON. THE CHIEF SECRETARY, THE HON. THE ATTORNEY-GENERAL, THE HON. THE TREASURER, THE HON. THE MINISTER FOR PUBLIC WORKS, THE HON. THE MINISTER FOR EDUCATION, THE AUDITOR-GENERAL, THE PRESIDENT OF THE NEW SOUTH WALES MEDICAL BOARD, THE SURVEYOR-GENERAL AND CHIEF SURVEYOR, THE CROWN SOLICITOR.

## **ELECTIVE TRUSTEES:**

SIR FRANK McDOWELL; R. J. NOBLE, C.B.E., M.Sc., Ph.D.; G. A. JOHNSON, M.B.E.; S. HAVILAND, C.B.E.; PROFESSOR L. C. BIRCH, D.Sc., F.A.A.; PROFESSOR D. P. MELLOR, D.Sc., F.R.A.C.I.; R. C. RICHARD; PROFESSOR H. N. BARBER, F.R.S., F.A.A.; K. L. SUTHERLAND, D.Sc., F.A.A.; PROFESSOR A. H. VOISEY, D.Sc.; PROFESSOR G. H. SATCHELL, Ph.D.

## **DIRECTOR:**

F. H. TALBOT, Ph.D., F.L.S.

## **DEPUTY DIRECTOR:**

C. N. SMITHERS, M.Sc.

## **SCIENTIFIC STAFF:**

R. O. CHALMERS, A.S.T.C., Curator of Minerals and Rocks.  
S. S. CLARK, M.Sc., Assistant Curator, Department of Environmental Studies.  
H. G. COGGER, M.Sc., Ph.D., Curator of Reptiles and Amphibians.  
H. J. DE S. DISNEY, M.A., Curator of Birds.  
M. R. GRAY, M.Sc., Assistant Curator (Arachnology).  
D. J. G. GRIFFIN, M.Sc., Ph.D., Curator of Crustaceans and Coelenterates.  
D. K. McALPINE, M.Sc., Ph.D., Assistant Curator of Insects and Arachnids.  
B. J. MARLOW, B.Sc., Curator of Mammals.  
D. R. MOORE, M.A., Dip.Anthrop., Curator of Anthropology.  
J. R. PAXTON, M.Sc., Ph.D., Curator of Fishes.  
W. F. PONDER, M.Sc., Ph.D., Curator of Molluscs.  
ELIZABETH C. POPE, M.Sc., Curator of Worms and Echinoderms.  
H. F. RECHER, Ph.D., Curator, Department of Environmental Studies.  
A. RITCHIE, Ph.D., Curator of Fossils.  
C. N. SMITHERS, M.Sc., Curator of Insects and Arachnids.  
J. P. WHITE, M.A., Ph.D., Assistant Curator of Anthropology.  
Vacant: Assistant Curatorship of Crustaceans and Coelenterates.

## **EDUCATION OFFICER:**

PATRICIA M. McDONALD, B.Sc., M.Ed.



