

# AUSTRALIAN NATURAL HISTORY

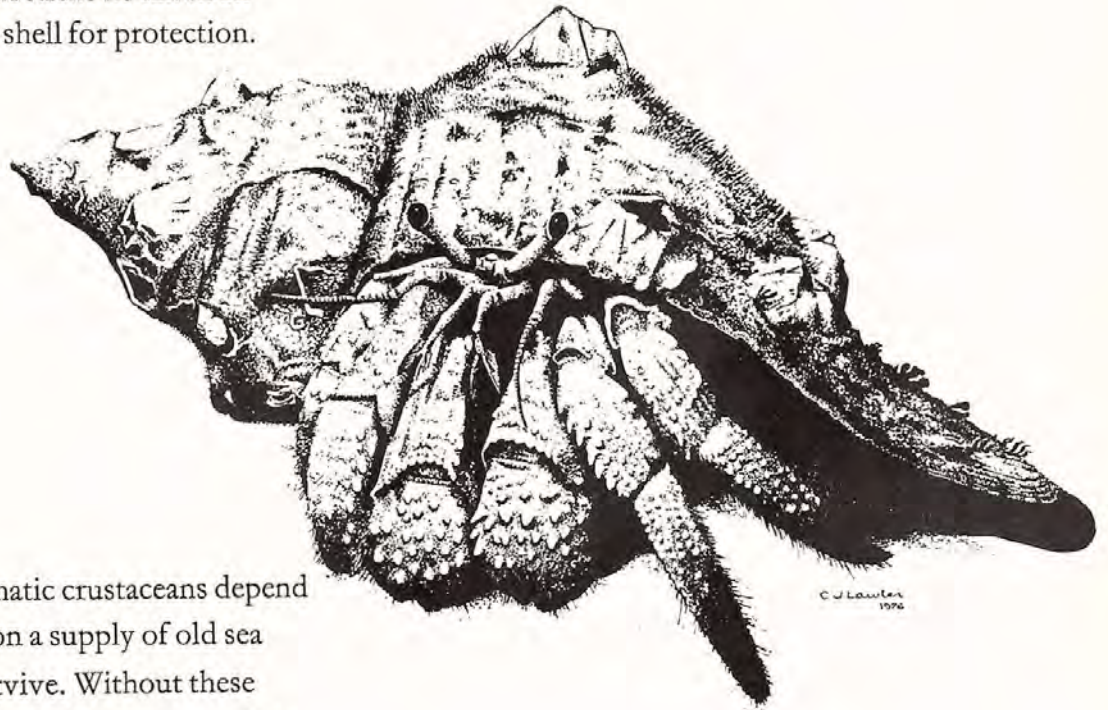
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MARCH 1976 VOLUME 18 NO. 9 \$1\*

Hermit-crabs aren't really hermits. In fact most of them are quite gregarious. Neither are they crabs. They have much more in common with lobsters or crayfish and could be regarded as a soft-bellied cousin which sticks its tail in an old mollusc shell for protection.

## The Southern Red Hermit-Crab



These enigmatic crustaceans depend entirely upon a supply of old sea shells to survive. Without these dead mollusc shells to protect their soft abdomens, would the hermit-crabs turn to discarded tin cans or bottles as a substitute?

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# AUSTRALIAN NATURAL HISTORY

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COVER: A modern Balinese shadow puppet of Hanoman, the white monkey—hero of the *Ramayana*. Its *wayang* (shadow) appears on the back cover. (Photos: Gregory Millen/The Australian Museum)

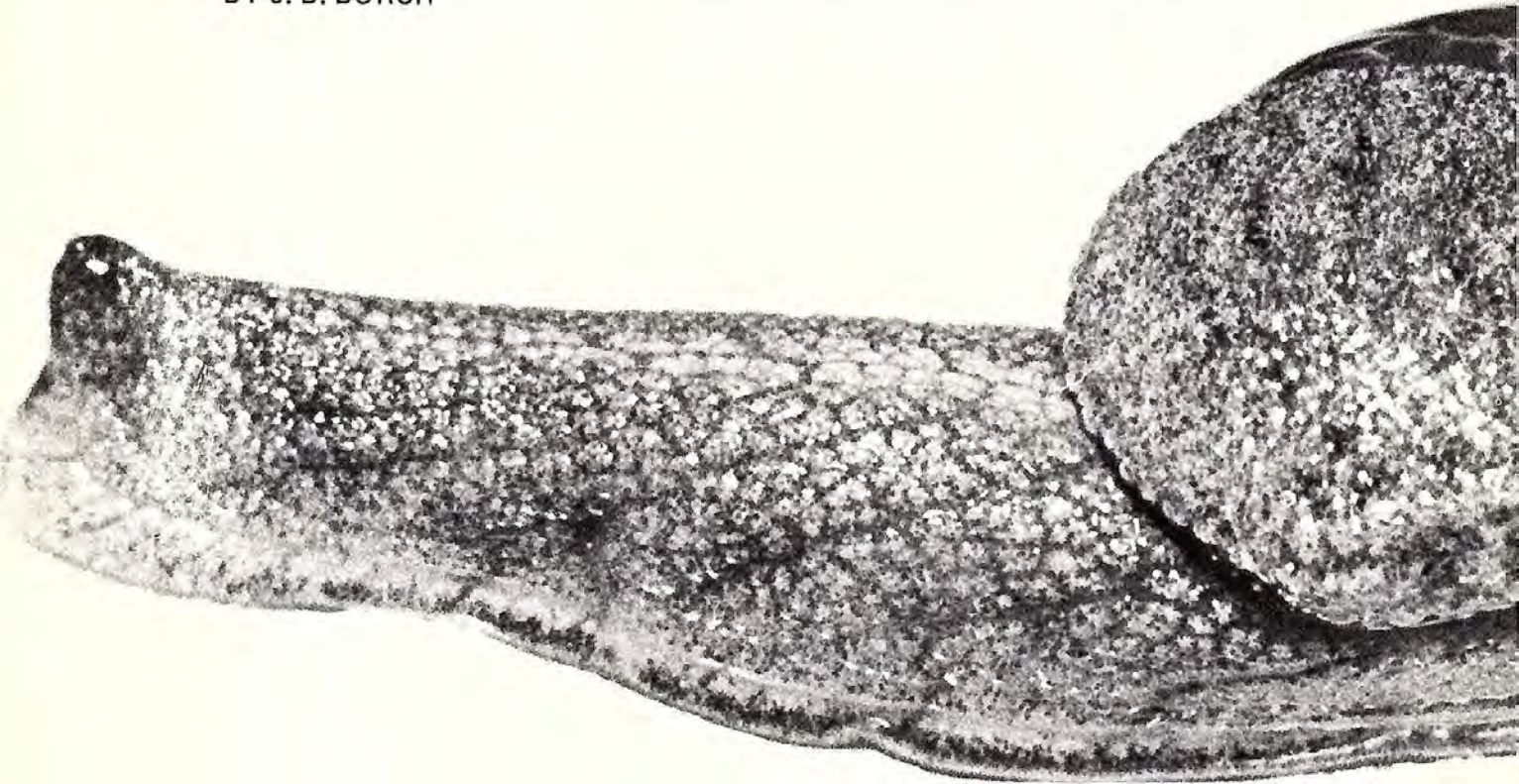
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# SNAILS WITHOUT SHELLS

BY J. B. BURCH



The largest group of molluscs, the gastropods or snails, are soft-bodied invertebrate animals with their internal organs enclosed in a hard, usually spiralled shell, composed mainly of calcium carbonate. Not all snails have this protective covering. These naked molluscs are called slugs, snails without external shells. Their shells have been lost through a long evolutionary process which continually reduced the relative size and thickness of the shell. The fact that slugs do not have external shells does not necessarily imply that they do not have internal shells. Most slugs have a small bit of remnant shell buried within their mantle (the hump or triangular patch on their dorsal surface). In one slug (*Testacella*) the small remnant shell is not imbedded in the mantle but actually is still external. Slugs are well-known but unfortunately those best known to Australians are the introduced pests from Europe, the common garden slugs, such as the spotted Leopard Slug (*Limax maximus*). Australia's truly native slugs are found in the less urbanized areas, especially in bush country and rainforests. They are not only among the most colourful in the world, but are also among the most scientifically interesting; however, little is known about the biology of most of

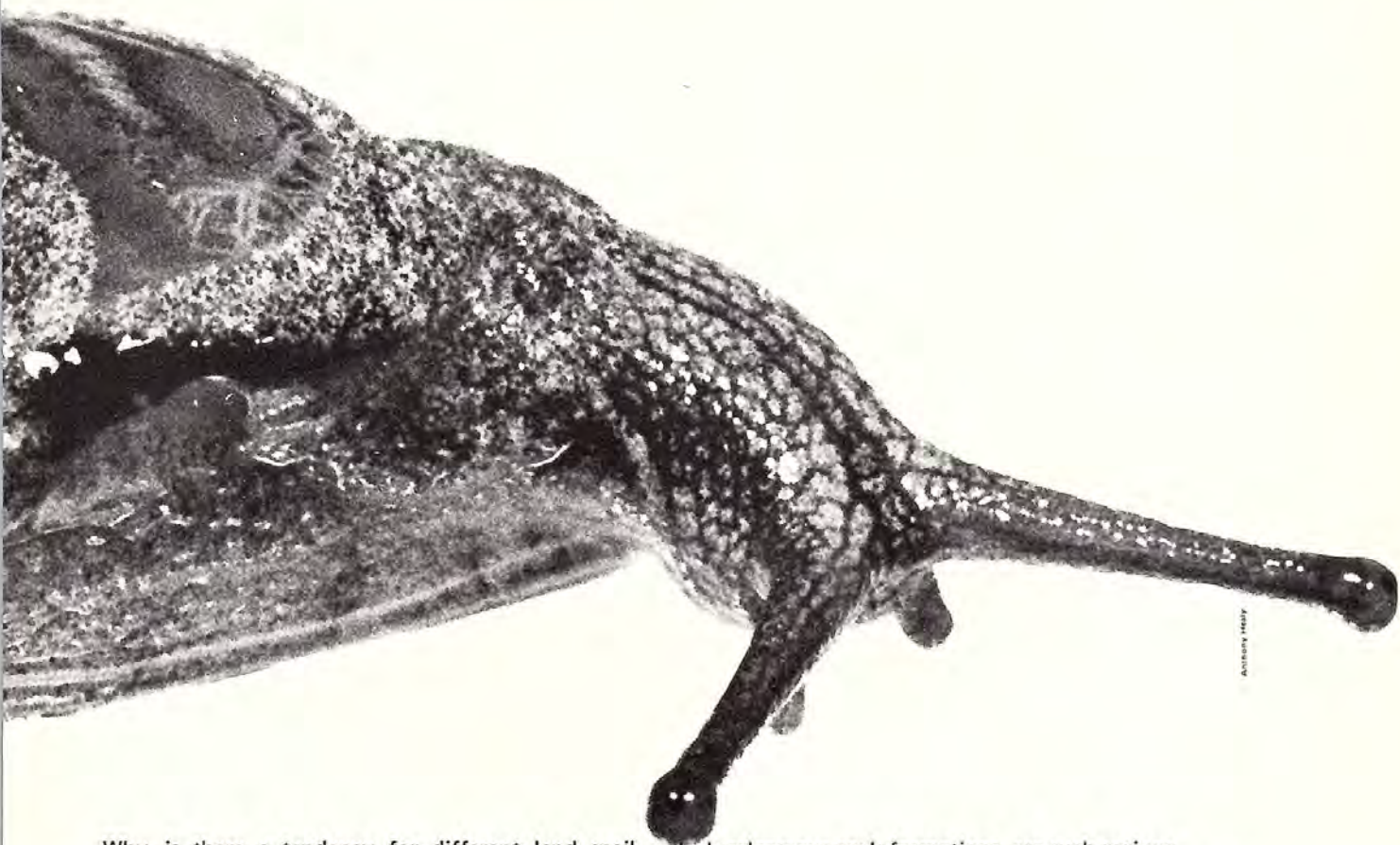
the native species.

The ancestors of slugs were snails with large well-developed shells. A snail's shell is its means of protection from periods of unfavourable climate, especially drought, and from predators from which the shell not only provides stiff mechanical resistance, but also cryptic coloration by which to escape notice. Slugs no longer have this means of protection and so small cracks and crevices that would otherwise be inaccessible now provide a refuge from enemies and a cool, moist and dark environment during the day and during hot, dry periods. Although still quite 'sluggish' in movement, the reduction and loss of shell in semi-slugs and slugs has probably allowed somewhat greater speed, at least in some of the slug and slug-like groups.

A protective device exhibited by slugs may be a mucus noxious to their potential predators. Some slugs are known to be distasteful to predators which normally eat shelled snails. The bright colors of animals with disagreeable flavors often serve as a warning of their bad taste to potential enemies. A predator will rarely make a second meal of a gastronomically foul species. The bright colours of some slugs provide such a warning.

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ANTHONY HEALY

Why is there a tendency for different land snail groups to evolve slug-like and slug forms? The answer probably lies in the snails' response to their environment. Snails have four basic needs: moisture, food, calcium and shelter. Calcium is needed for the construction of their shell and the shell in turn helps to conserve body moisture, although they still need moist shelters during the drier daytime periods. The importance of moisture to land molluscs cannot be over-emphasised. In their evolutionary history, snails with a rather constant supply of moisture but little calcium could still survive quite well, assuming food was available and predation not too severe. Under such favourable moisture conditions, the protective value of the shell for preserving water would be diminished. In fact, the bulky, heavy shell, which also requires a considerable amount of metabolic energy to construct, might prove to be a disadvantage. Therefore, under such circumstances, small mutations reducing the shell would be selected for rather than against. As might be expected, slug and semi-slug species are abundant in regions with high rainfall and reduced availability of calcium. Australia's eastern humid subtropical and tropical forests, which generally

lack calcareous rock formations, are such regions.

The land slugs of the world belong to eleven families. The semi-slugs, i.e., those in the process of evolving into a slug condition but still possessing a functional external shell, occur in two of these same families, plus eight additional families which do not contain true slugs, but to which some of the true slug families are closely related. Thus, slugs do not form a natural group among themselves, most of the slug families each having closer relatives among one of the shelled groups than to another slug group. 'Slug' refers to a body type (a shell-less snail), and not to an overall taxonomic group.

The slugs of Australia may be grouped into seven families, of which three, the Limacidae (including the Milacinae), Arionidae and Testacellidae, have been introduced from Europe. The two species in Australia of the fourth introduced family, the Veronicellidae, probably came from Africa and from South America or the West Indies. The three native slug families are the Rathouisiidae, Cystopeltidae and Athoracophoridae. Another family, the Helicarionidae, although not full slugs, are semi-slugs—well on their way to becoming slugs. These semi-slugs are more common in Australia

*Helicarion*, a semi-slug, in which the mantle flaps nearly conceal the reduced shell. This specimen was found in Chichester State Forest by W.F. Ponder and P.H. Colman.

Museum. He is one of the world's leading authorities on freshwater and terrestrial molluscs.



Anthony Healy

The bright scarlet  
*Triboniophorus*  
from near Narrabri,  
New South Wales.  
Collected by  
R. Taliana.

than the native true slugs.

The Rathouisiidae have few species, two of which are rare and found in Queensland, and several others in New Guinea, the Philippines, western India, Indo-China and China. The Australian species, triangular in cross-section and often reaching 4cm or more in length, are carnivorous as can be determined by their radular teeth, but the type of animals on which they feed is not known. In fact, very little is known about the Australian rathouisiids. Their method of tentacle (eye stalk) retraction, is basically different from other land snails. While their eyes sit at the top of the upper and larger pair of tentacles, and the tentacles can be shortened by contraction, the eyes and stalks can neither be inverted nor withdrawn into the slug's haemocoel or body cavity. A bit more is known about the Cystopeltidae which is an exclusively Australian family of slugs. Four species are recognised, and these are distributed from southern New South Wales to Tasmania. They seem to be related to the common Australian semi-slugs, the Helicarionidae.

The Athoracophoridae are a most interesting relict group, restricted in distribution to eastern Australia, New Zealand, New Hebrides, New Caledonia, New Britain and the Admiralty Islands. Any close relatives seem to have vanished in antiquity, their only distant present-day relatives being the archaic Succineidae, world-wide in distribution. The athoracophorid's internal respiratory sac or 'lung', instead of being an entirely sac-like space, contains a system of branching tubes. This impressed the early investigators, reminding them of the tracheal respiratory system of insects. Accordingly, these slugs were placed in a separate order, to which the name Tracheopulmonata was applied. Several other peculiar characteristics distinguish the athoracophorid slugs. For example, they have only two tentacles, one pair on the head, rather than two pair like other 'land pulmonates'. Further, other land pulmonates, when withdrawing the eyes at the tips of the upper and larger tentacles, do so by inverting the eyes into the hollow tentacle stalk, and by continued inversion the eyes are brought com-

pletely into the snail's haemocoel or body cavity. The athoracophorid slugs can also withdraw their eyes into their haemocoels, but they cannot invert their eyes in doing so.

The athoracophorid genus *Triboniophorus* is exclusively Australian. Its distribution ranges from Wollongong, New South Wales, to the Bellenden Ker Mountains, northern Queensland. The number of species is not known, but in the past only one has been recognized, *T. graeffei* Humbert, a grey slug with a narrow scarlet border around both the edge of its foot and the edge of its small triangular mantle on the dorsum. This coloured margin is bright orange rather than scarlet in some Queensland populations. Both colours occur in other populations, suggesting a genetic inheritance for scarlet/orange colour type. Some populations lack the colour borders altogether, but it is not known whether these represent only individual genetic variants, geographic races or distinct species. A solid pink variety has been named from northern Queensland, *T. graeffei* var. *rosea* Hedley, but this may

be a distinct species. A yellow form with a solid red mantle has been found in Dorrigo National Park, New South Wales, and another remarkable slug, brilliant scarlet all over, occurs in the region of Narrabri, New South Wales. Although these may be only extreme colour variations, it is quite possible that they too may be distinct species.

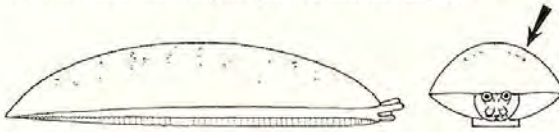
The introduced European slugs have been in Australia since the early settlement years. In fact, the first slugs described and named from Australia, thought then to be native, were introduced European slugs. These were *Limax megalodontes* and *Limax maurus* described from Port Jackson by Quoy and Gaimard in 1824. In the latter part of the 19th century, eight other 'new species' based on European slugs were named from Australia, their describers not recognizing them as foreign species.

Slugs have received less attention than other agricultural pests because their damage is unpredictable and localized and they are difficult to control. Nevertheless, that they are of economic importance is attested to by

*Triboniophorus graeffei*, showing the common colour pattern found throughout eastern Australia.

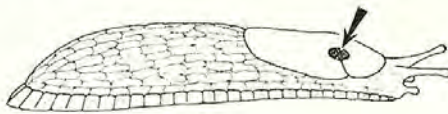


VERONICELLIDAE: *Angustipes*, *Eleutherocaulus*



Mantle rounded, dorsally covering entire animal

ARIONIDAE: *Arion*



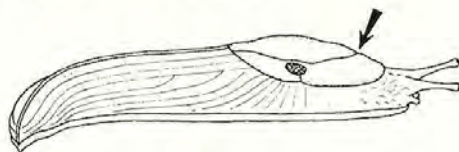
Mantle small, breathing pore anterior

LIMACIDAE: *Limax*, *Deroceras*, *Lehmannia*



Mantle small, without groove, breathing pore posterior

LIMACIDAE (Milacinae): *Milax*



Mantle small, with groove, breathing pore posterior

TESTACELLIDAE: *Testacella*



Rudimentary posterior external shell

RATHOUIIIDAE: *Prisma*



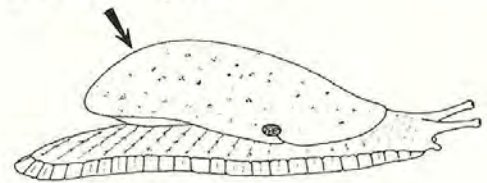
Mantle keeled, dorsally covering entire animal

ATHORACOPHORIDAE: *Triboniophorus*

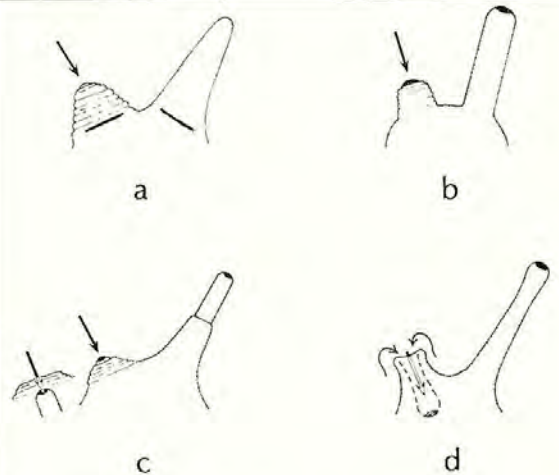


Mantle small, triangular; only two tentacles

CYSTOPELTIDAE: *Cystopelta*



Mantle covering a large dorsal visceral hump



Types of tentacle retraction in land pulmonates. a, Contraction, eyes at base of tentacles (carychiids). b, Contraction, eyes cannot be inverted or withdrawn into body cavity (rathouisiids and veronicellids). c, Basal half of tentacle contractile and hollow; anterior rod bearing the eye is not invertible, but can be invaginated into the body cavity (athoracophorids). d, Inversible, the distal eyes can be withdrawn into the body cavity by inversion of the tentacles (most land snails and slugs).



the many official leaflets and bulletins published by governmental agricultural agencies on slug control. Some of the introduced slugs are not without a few interesting habits. For example, a mating pair of Great Gray Slugs or Leopard Slugs (*Limax maximus*) go through a spectacular acrobatic aerial courtship, while hanging suspended in mid-air by a mucous string. Prior to their aerial suspension they follow each other around for 1-1½ hours, caressing each other with their tentacles. Following their mid-air mating, one slug crawls up the mucous string to the supporting branch above, while the other either consumes the string or drops to the ground. Unfortunately, little is known about the mating habits of native Australian land slugs.

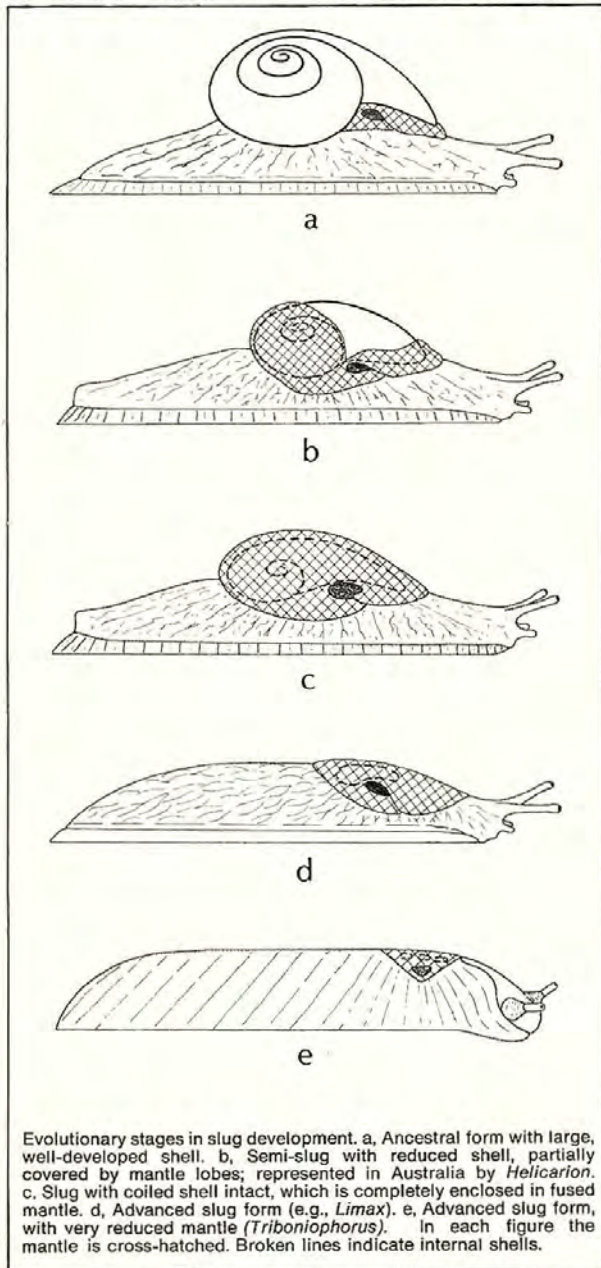
Native Australian slugs are not pests, and in fact will very seldom be found in urbanized areas or near agricultural crops. Their food consists of fungi or



Alfred D'Ombrain

decaying bits of wood and leaves rather than vegetables or succulent plants. But, in spite of their timid nature and innocuous habits, Australia's native slugs deserve much further study, as they may provide invaluable clues to the zoogeographic relationships and origins of Australia's ancient terrestrial mollusc fauna.

The mating of *Limax maximus*. The two entwined partners are suspended in mid-air by a mucous string.



Evolutionary stages in slug development. a, Ancestral form with large, well-developed shell. b, Semi-slug with reduced shell, partially covered by mantle lobes; represented in Australia by *Helicarion*. c, Slug with coiled shell intact, which is completely enclosed in fused mantle. d, Advanced slug form (e.g., *Limax*). e, Advanced slug form, with very reduced mantle (*Triboniophorus*). In each figure the mantle is cross-hatched. Broken lines indicate internal shells.

#### FURTHER READING

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# THE REDISCOVERY OF LUFU

BY PETER DWYER

There is a special excitement in rediscovery. Some plant or animal unseen for years, perhaps even presumed to be extinct is discovered anew. Anyone who has read Bernard Heuvelman's *On the Track of Unknown Animals* will have imagined the excitement for themselves. In 1972, I experienced this, but with an unexpected twist and an important lesson, when I rediscovered **lufu**.

In that year I was studying mammals in the Eastern Highlands District of New Guinea. I lived with Rofaifo people at Leu village on the eastern fall of an impressive limestone massif, Mt. Erimbari. As a companion to my biological studies I sought information from Rofaifo people concerning their system of naming and classifying animals. To what extent did the scientific taxonomy I had learned correspond to the Rofaifo folk taxonomy? Did we, for example, recognise the same entities as species? I also hoped to learn what differences occurred in our separate systems of recognising relationships between species and to discover the bases for such differences in classification.

Practical reasons for seeking this knowledge were forced upon me at the outset. If I were to obtain specimens of all mammal species in Rofaifo territory it was necessary to know what to ask for and how to ask for it. I was at first a naive Pidgin speaker and, of course, but a 'babe-in-arms' when it came to the Siane language—a dialect of which is spoken by the Rofaifo. The people of Leu village taught me Pidgin though I sometimes suspected I had acquired an aberrant tongue, something entirely of my own manufacture, and that the Rofaifo, who were skilled linguists, learned to understand this as well. My excursions into the Siane language were even less accomplished; I learned a multitude of names for things, mostly for animals, but pronunciation of these often remained a hazardous exercise.

With practice I gradually learned the route from the English through improving Pidgin to clumsy Siane;

from, for example, cassowary through **muruk** to **orona** or from dog through **dog** to **hula**. I found that cats, introduced into New Guinea by overenthusiastic Europeans and by now living as both domestic and feral animals in Rofaifo territory, were **hula busi**—that the Pidgin word for cat had simply been appended to the Siane word for dog, that cats were viewed by Rofaifo as members of the dog family and were named accordingly. The marsupial native cat with its rich brown fur spattered with white blotches and appropriately named in scientific taxonomy as *Satanellus albopunctatus*—a 'devil with white spots'—was another member of the dog family for Rofaifo. They named it **hula rano**; a name which, fascinatingly, was also given to hiccups. To my initial surprise, Rofaifo people spoke of two kinds of **hula rano**. I had thought there was just one species of native cat in New Guinea; it seemed briefly that there might be two.

First appearances proved false. As specimens came to hand, all were *Satanellus albopunctatus*, but the Rofaifo named\* larger individuals as **hula rano pau** and smaller ones as **hula rano ukulu**. They were insistent that these were separate kinds and would emphasize the smaller, more sharply defined white spots of **hula rano ukulu** and liken them to stars in the heavens—stars, in Siane, are named **ukulu**. I had discovered that what biologists recognised as a single species might be more than one to the Rofaifo. Amongst the larger mammals this was frequently the case. The ring-tailed possums *Pseudocheirus forbesi* and *P. cupreus* were each named as three kinds by Rofaifo, as subdivisions of **mi** and **heufa** respectively, while the handsome forest cuscus *Phalanger vestitus* was named as five kinds, each one a subcategory of the covering term **duana**. Usually the divisions were based on size differences—large, middle-sized and small—but for the cuscus, different colour patterns added to the complexity of the taxonomy. Rofaifo were adamant that these named kinds were separate, that they did not

\*The Rofaifo commonly refer to animals by their terminal names only. Folk taxonomies used by Europeans are similar; for example, we say 'terrier' rather than 'dog terrier' and 'merino' rather than 'sheep merino'. Here, for the sake of clarity, we retain the more inclusive Rofaifo name as well.

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Dressed up in a skirt of spun cuscus fur and a head piece of lorikeet plumes.

interbreed, and that the smaller kinds did not change with time into the larger. Sometimes, however, I did find one to one correspondence between scientific and Rofaifo species. This occurred with the ring-tailed possum *Pseudocheirus corinnae* which, unlike most other ring-tails, does not build a nest but spends the daylight hours clinging to some vine or limb. Rofaifo sometimes grouped several species under *one* name as they did with the remarkably different water rats, *Hydromys chrysogaster* and *Crossomys moncktoni*. Both were named as *homo* in Siane; a name without subcategories.

This apparent tangle of lumping some species and splitting others is not a haphazard affair. It proves quite intelligible from a Rofaifo point of view. The difficulty of course is trying to penetrate that point of view, to glimpse it at the very least, when you have not been born into that culture. The splitting of species on the basis of size emerged, in my interpretation, as a rationalization of traditional dietary prohibitions. Men, it seemed could not eat the young of any mammals; these had to be given to the aged and to women and children. The rule would guarantee some protein to non-hunting members of the community and was reinforced by a belief that the flesh of a male who broke the rule would become 'soft like that of a woman'. Yet such a prohibition poses problems of definition and of possible ambiguity. When is a young mammal not a young mammal? When is a particular capture, a delectable wallaby or a giant rat perhaps, fit for male consumption? Rofaifo resolved these difficulties through their taxonomy and they gave the benefit of the doubt to the men. With the exception of undeniably young individuals, those that were still suckling from their mothers, the status of larger individuals was resolved in Rofaifo thought by a

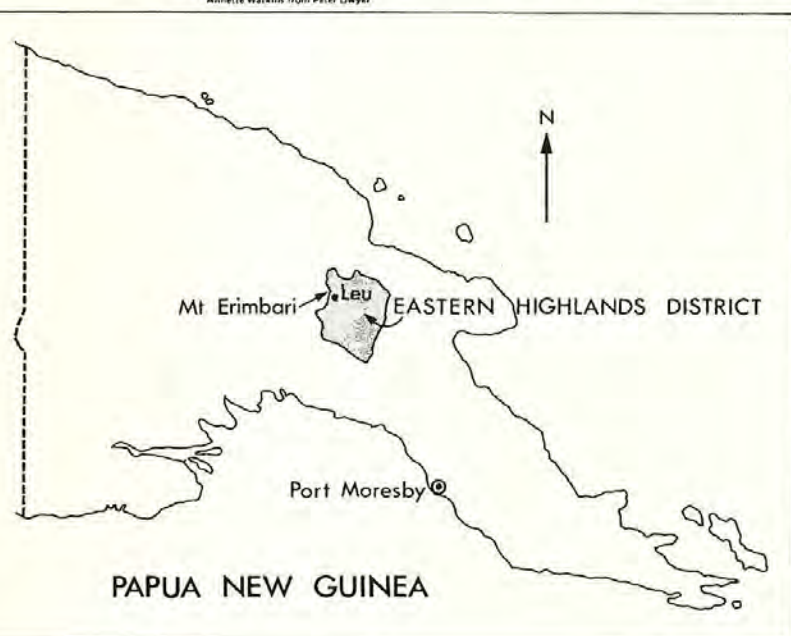
taxonomy that denied all possible ambiguity. If they were independent of their mothers, they were adult. They were simply the adults of a group of species that differed from each other in size such that size alone was sufficient to name them as adult members of one of those species and thereby to render them appropriate to the men's table.

How could Rofaifo people rationalize the fact that they never encountered half-grown specimens of *their* largest mammal species? I put this question to a man named Guringbao and learned that subtle morphological differences occurred between the species. For example, according to Guringbao, the smallest category of *duana* (i.e. the forest cuscus *Phalanger vestitus*) had tiny bristles on the terminal section of its tail while the largest category lacked these whether it was old or young. I suspect that those bristles wore off as the cuscus aged but occasionally wore off quite early in life. Differences in behaviour relating to sleeping and foraging places and to food preferences between different age classes of mammals were added to the distinctions drawn by Rofaifo. Their species were not based on single characteristics but were recognised in terms of an integrated complex of morphological, behavioural and ecological traits.

It is apparent now that there is a strong utilitarian flavour to Rofaifo taxonomy. Biological species of economic importance are likely to be split into several Rofaifo species. This applies whether the mammal in question is important as food or, as the cuscus, both as food and as fur used for decoration. Yet an interpretation of Rofaifo taxonomy as serving solely utilitarian functions would be a misrepresentation. The taxonomy is very sophisticated. It has a high degree of internal consistency. For example, the practice of splitting economically important species or, more often, the practice of grouping several as subcategories of a single covering term, is extended to many smaller mammals where economic considerations seem of little significance. It is as though the taxonomy is founded upon a number of rules, with rules relating to size especially important, that are applied across the full range of mammals regardless of their economic value to the Rofaifo. In this way, the taxonomy itself becomes a powerful mental construct for ordering the biological world. This is to say that although the taxonomy has emerged from careful and detailed observation of nature it is, in its developed form, a schema that forces Rofaifo people to observe nature in a particular way.

I have recognised other rules concerning abundance and habitat as important in patterning Rofaifo taxonomy. The failure to split the ring-tailed possum *P. corinnae*, into more than one Rofaifo species and the lumping of two biological species of water rats under one Rofaifo name illustrate these. Through the ten months I lived at Leu only two *P. corinnae* were

Annette Watkins from Peter Dwyer



obtained; these were the first seen in the area for a number of years. For this ring-tail, therefore, there would be little opportunity for Rofaifo people to establish distinctions of morphology by comparing several specimens of different size at the one time. A taxonomy that split a rare biological species into several folk species would fail for lack of practical reinforcement. Similarly I received only a few water rats and then only after I had placed a moderately high price on their heads. Early in my stay with Rofaifo an animal named as **homo** was described to me. No mammalogist could have failed to recognise that description. Its aquatic habits and its extraordinarily large feet, likened to those of a duck, left no doubt that it was the earless water rat *Crossomys moncktoni*. No other kind was hinted at. Six months after my arrival I was brought my first specimen of **homo**; it was the common water rat *Hydromys chrysogaster*, a beautiful animal but of far less bizarre appearance than *Crossomys*. Guringbao, who carried the specimen from Leu to where I was camped that night in rainforest 500 metres higher, explained that he had never before seen **homo**. He was about thirty years old. He explained also that when the older men had seen this specimen they said there were two kinds of **homo**, this one which was small and a larger one with feet like those of a duck. But there were no names to separate the two. **Homo** was applied to both though they were completely different in appearance. Here then, the shared aquatic habitat must account for both being classed as **homo** while their relative scarcity explains the failure to further subdivide the taxon. Only a few appreciated that more than one kind was included; this was esoteric knowledge.

The mammals discussed above are all moderately large and of distinctive appearance. I had relatively little difficulty translating from scientific nomenclature to Rofaifo nomenclature for these. When it came to smaller mammals, to the fourteen small rodents, the three marsupial mice and the pygmy possum with its black masked face, it seemed for a time that I might never begin to apply Rofaifo names. **Goravi**, **momonofomo**, **hunembetaia**, **hiongo**—the names seemed endless and impossible to grasp. They were not associated with any mammals I expected to find near Leu. I would imagine I had recorded all possible names or all subdivisions of a particular term and then, a month later, another would be mentioned in passing. I had been told of two kinds of **hiongo**, one large and named **hiongo anduaba**, the other small and named **hiongo lufi**. Both were said to be abundant; I would be able to trap many individuals. **Hiongo anduaba** cropped up regularly in conversations about small mammals. It was said that some **hiongo anduaba** transformed to **igana**, a ground-nesting cuscus (*Phalanger gymnotis*), and some people told me that two colour variants occurred, one red and another with



Photo: Clive

a white belly. Eventually a man named Siemon took several traps and set them one night at the base of coffee trees that grew near a creek. In the morning he presented me with two rats, each weighing around 100 grams, and identified them as **hiongo anduaba**. They were reddish-brown in colour, without a white belly, and had rather short tails. They proved to be the ground rat *Melomys levipes*. A few weeks later I was brought my first specimen of the very long-tailed, snow-white-bellied tree mouse, *Pogonomys mollipilosus*. It had been shot with bow and arrow at night while feeding on fruit in a tree. It was of the same size as *M. levipes* and was also named as **hiongo anduaba**. The specimen produced a flood of information. I was told and retold how some **hiongo anduaba** transformed into the much-prized ground-nesting cuscus, **igana**, and I heard over and over again how **hiongo anduaba** lived as groups of eight or ten or more individuals in long burrows dug into the ground. I was convinced that I

Rainforest below summit of Mt. Erimbari. Limestone sinkholes lie either side of the perched valley; the smoke is rising from a bush hut at the head of the valley.



Peter Green

A household garden safe from pigs with a backdrop of casuarinas.

had translated *hiongo anduaba* into the language of science and that the name embraced both the reddish ground-dwelling *M. levipes* and this handsome species of *Pogonomys*.

My conviction was short-lived. A second species of tree mouse *Pogonomys sylvestris*, was added to my mammal list—a smaller species, grey-bellied but of similar form and habits to *P. mollipilosus*. Then a new rat arrived, brought to me by two children who, though quite uncertain what to call it, wondered whether I might purchase it. It was intermediate in size between the two *Pogonomys* but of identical proportions with a long prehensile tail, and it was quite red—redder indeed than *M. levipes*. I presumed at first that it was a third *Pogonomys* but upon closer examination found it was a brush mouse, *Pogonomelomys sevia*, one of several species in the scientifically difficult New Guinea genus *Pogonomelomys*. I asked older men to name it and received two answers. It was *hiongo anduaba* to some men; it was the reddish form they had told me of earlier, but to others and especially to those old men whose expertise I had come to respect, it was a third kind of *hiongo*. It was *hiongo heriwe*, the 'wild pandanus man', named quite literally for its habit of nesting under dense mats of dead fronds at the apex of wild pandanus palms.

By now I was suspicious of Siemon's identification of *M. levipes* as *hiongo anduaba* even though other men had agreed to this. It did not gel with my growing feeling that Rofaifo taxonomy was founded upon

rational rules. *M. levipes* is a ground feeder and is not colonial whereas both species of *Pogonomys* are arboreal feeders that live colonially. To place these three species together in *hiongo* conflicted with Rofaifo rules relating to ecology. I could appreciate that the red *Pogonomelomys sevia* might be placed here; at least it was arboreal even though it was not colonial. More importantly, its comparative rarity in Rofaifo territory could well mean that morphology dominated the taxonomic decision and that ecological considerations played a minor part. But the ground-dwelling short-tailed *Melomys levipes* simply did not look or behave like any of the other species.

Late in my stay at Leu I was certain of Siemon's error. An old man named Olubien was an expert in these matters and I turned to him to solve many of my major problems. Olubien spoke no Pidgin and I could not communicate in Siane. If my question was important I had to bide my time, waiting to catch Olubien alone with a young boy or perhaps with a man I knew to be uninformed regarding mammals. In this context I could rely on the translations that took place when I asked Olubien questions and he replied. More informed translators often gave their own opinion of my question if they differed from Olubien. In fact, using this strategy I learned from Olubien the appearance and precise habitat of a remarkable mammal just one week before I left Leu. I had heard its Rofaifo name only three times from different people but could not obtain a description that made sense to my ears.

When I asked others about it they said there was no such animal and suggested I had fallen victim to a 'leg pull'. I waited three months to catch Olubien in appropriate circumstances for translation. He described it well—its minute size, its strange head, its colouring—and, most importantly, he sketched in words a contour across the slopes of Mt. Erimbari—a contour that marked an altitudinal change in ground vegetation—and told me to trap above that. I did as he said and caught the lucky thirteenth specimen known to science of the shrew mouse *Mayermys ellermani*, a diminutive relative of the water rats and the only rodent in the world with a single molar tooth in each jaw. It was Olubien also who confirmed my suspicion that the ground-dwelling *M. levipes* was not **hiongo**; he placed it firmly with some other terrestrial rainforest species in the quite separate taxon **yahunembe**. His analysis left no room for doubt.

**Hiongo lufi** has been left unidentified so far and the small tree mouse *Pogonomys sylvestris* remains unpositioned in Rofaifo taxonomy. I received many *P. sylvestris* and for several months kept a group of five caged in my house, feeding them on sweet potato, corn, banana, and other fruit. Always they were named as **hiongo** and if I asked which **hiongo** the reply came that they were "**hiongo hevora**". (**hevora** = small) or that they were "just **hiongo**". There was, however, no Rofaifo animal named **hiongo hevora**—this was not a formally recognised taxon.

Sometimes I felt excessively boring. "How many kinds of **hiongo** are there?" I would ask. There were two, **anduaba** and **lufi**, or if my informant was more knowledgeable, **heriwe** was added as a third. Then, pointing to my captives, I would ask for their name. "Just **hiongo**" or "small **hiongo**" was the invariable reply. "A third kind?" or "A fourth kind?" I would ask. "No we have told you all the kinds." It was quite

frustrating. Why would no one name them as **hiongo lufi**? Or, if they were not **lufi**, why did no one bring me a specimen of **lufi**? After all, everyone said that **lufi** was abundant. And why did they assign my wretched tree mice to a non-existent taxon?—"Just **hiongo**" indeed! Obviously my Pidgin was hopeless.

Sem solved it for me. Sem was a close friend and one of my Rofaifo brothers. He was neither particularly interested in the smaller mammals nor very knowledgeable about them. One night I was pursuing my inevitable topic, this time trying to convince Sem that my captives were **lufi**. Sem disagreed. I remember his words well. "I do not know much about small mammals but I do know **lufi**", and he continued with a magnificent description of a small mouse, with small eyes (Sem screwed up his eyes for emphasis), a black mark on its nose, living as groups in burrows and sleeping close together with their long tails intertwined (Sem twined his fingers). The description was lengthy. Meshed with the morphological details were comments on behaviour and on hunting techniques. Once a burrow opening was found other possible exits should be located and sealed, the ground above cleared of litter and, preferably, for a large catch the position of the nest chamber guessed at and twigs broken and placed above it. If the hunter was skilled and had located the nest chamber accurately then his patient digging along tortuous passages would be rewarded by the sudden exposure into light of as many **lufi** as there were broken twigs above the chamber. A swift death and a pleasant feast.

At last I knew, though Sem still insisted my animals were not small enough, and that their eyes were too big to be **lufi**. Yet I was right. I had rediscovered **lufi**. The only difficulties being that no one would agree that *Pogonomys sylvestris* was **lufi** and no one considered that **lufi** had ever been lost.



A family group outside the author's house show fledgling hawks that they reared to independence

A hat of possum fur and a rich display of bird feathers. The long black plumes come from a species of bird-of-paradise that is locally named lumbalumba. The man in the picture has the same name.

For months I had been surrounded by clues but had never guessed the nature of the riddle. It had started years before with the arrival of Europeans, with increased access to European goods and food stuffs and with the slow erosion of Rofaifo culture. Hunting declined in emphasis. Some practices declined more rapidly than others, for where many larger mammals remained highly valued for their fur, the return from smaller species was now hardly worth the effort. Traditional dietary prohibitions were relaxed so that men no longer refrained from eating juvenile mammals. With these changes, first-hand knowledge of animals in their natural habitat also declined. Rofaifo taxonomy, refined over generations and patterned unconsciously to represent the natural world as Rofaifo lived in it, was gradually being made redundant. If a man could eat young mammals with impunity then there was no necessity to question the status of a particular capture and, hence, no necessity to learn taxonomic details that solved ancient culinary problems. Most men below 45 years, significantly those who in their youth had worked as indentured labourers on the coast, employed a simplified taxonomy. They had little need to know the subcategories of *duana* or *mi* or *heufa* and there were few indeed, of this age class, who could list all those subcategories with ease. As the youngest man in town with the entire vocabulary (but no comprehension of it!) I soon became something of a phenomenon.

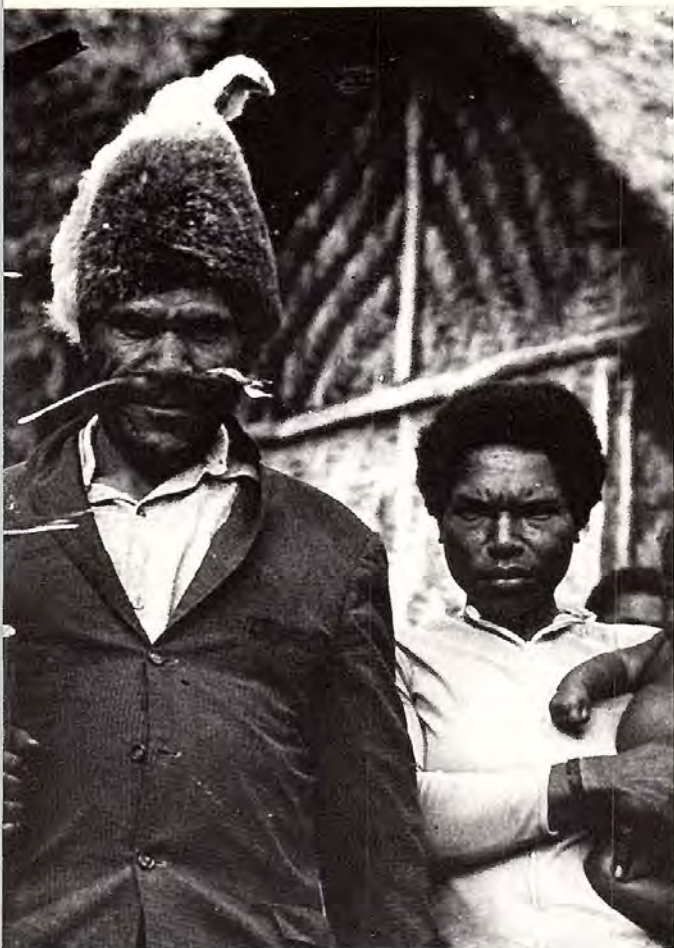
Mammals and birds provide decoration for Rofaifo. This youth uses a cuscus pelt, pig tusks and the wings of a bird-of-paradise to effect.

Peter Dwyer



When I arrived at Leu small mammals were for the most part ignored as food. Boys might collect and eat some species on a casual basis but men no longer practised traditional trapping and luring techniques. The precise identification of most kinds was of little interest. There is, however, a world of difference between recognising and naming a thing in the hand and retaining the idea of that thing in the mind. Would you recognise a unicorn if you saw one, or a bunyip, or a thylacine? Rofaifo people had not forgotten the names, for most of those names recurred in legends and fables, in past adventures, in the names of places and plants and people that were recounted endlessly around fires at night. They had forgotten how to apply them. And, amongst the mammals, it was always the smallest species that suffered most. *Goravi*, *momonofomo*, *hunembetaia*—three Rofaifo species reputed to plant the seeds of the forest pandanus that were jealously prized for their protein rich nuts, yet except for an occasional specimen named by an old man, I might have imagined I had never collected them, or had them brought to me. A man named Pamundi described *goravi*: large blunt snout, long whiskers and tail, ricochet leaps—a perfect fit for the New Guinea jumping mouse *Lorentzimys nouhuysi*, but when I showed him one he said that he had never seen any-





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it was a *Pogonomys* and *P. sylvestris* was the smallest of this genus in the New Guinea Highlands. **Lufi** had to be *P. sylvestris*, there was no other choice. Certainly too, Sem did know **lufi**. He knew the **lufi** of fireside talk and of hunting exploits, he knew the **lufi** half asleep and half-dazzled by light that screwed up its eyes upon capture and he knew the **lufi**, so delightfully small, that in redescription after redescription it had vanished entirely. Sem's **lufi** was in his mind and the real **lufi** was lost in the bush. *P. sylvestris* could only be "just **hiongo**".

So too with **goravi**, with **hunembetaia** and with **momonofomo**. They had vanished at the fireside. The small mammals of the bush had parted company with those of the mind. One by one and irrevocably they were going extinct. They were joining an anonymous assemblage of "em rat tasol, kainkain i stap". Contact with a new culture was destroying Rofaifo taxonomy. I had rediscovered **lufi** but already it was lost forever.

#### FURTHER READING

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Olubian, a wise naturalist, wears wing bones of a flying fox as decoration.

thing like it before and that it was too large to be **goravi**.

Rofaifo people have a fascination for small animals. They attribute special qualities to them. It is always the smallest of a related group that is in charge, it is a marsupial mouse that reigns supreme over larger mammals and can cleverly deceive them, and it is the smallest of all mammals that attend to the planting of pandanus nuts. This fascination has a light-hearted touch. It is delightfully captured in their formal name for their smallest species of frog, **hera namba** or the large frog.

Stories about small animals would often be told—older men recalling past hunts, perhaps exaggerating the size of the catch or remembering noteworthy encounters. Like Sem's description of **hiongo lufi**, their stories would be lengthy, they would digress to describe the animal or to capture some essence of its behaviour. Younger men would learn from their elders and build up a mental picture of animals they did not know from experience. Particular qualities would be impressed upon their minds. In turn they might retell stories so that through time these mental images of a species might digress from the actuality. So it was with **hiongi lufi**.

Sem had told me enough of **lufi** for me to know



Peter Dwyer

# DISGUISE, DEFENSE AND AGO

BY BARRY C. RUSSELL

The poison-fanged blenny, *Meiacanthus lineatus*, model of Batesian mimicry involving two other fish species.

On November 21, 1861, a young English Naturalist, Henry Walter Bates, read a paper before the Linnean Society in London. The lecture, innocuously titled "Contributions to an insect fauna of the Amazon Valley" summarised observations made during some eleven years of study in the forests of Brazil. It was a lecture which aroused considerable interest.

At the age of only 23, Bates had sailed for Brazil in the company of another famous-to-be naturalist, Alfred Russell Wallace, their object to explore the Amazon basin and to find evidence in support of the then controversial hypothesis of the origin of species. As part of their work and to help offset expenses, Bates and Wallace made extensive museum collections of the plants and animals of the Brazilian forest. One of the groups which interested Bates most was butterflies.

Sorting through his catches Bates noticed several groups containing two or more unrelated species which were virtually identical in colour pattern and wing structure. These mimetic analogies, as he called them, were particularly prevalent between species of *Leptalis* (family Pieridae) and the quite unrelated heliconiid butterflies (family Heliconiidae). In his published paper, Bates showed, in two beautiful hand-coloured plates, how some of the pierids have bright colours resembling those of certain heliconiids and differ sharply from their next relatives among the Pieridae. For these imitators, he reasoned, there must be some advantage in departing from the norm of the group; they must enjoy a greater chance of survival. Bates observed that the heliconiids were extremely abundant as well as conspicuously coloured and that "Although they fly slowly and are fragile in construction and apparently have no means of defence, they occur in areas where insectivorous birds hunt in flocks". It was this that provoked Bates to suggest that "they [heliconiids] enjoy by some means immunity from effective persecution, and that it is, therefore, an advantage to others not so fortunate, and otherwise provided for, if they [pierids] are so alike as to be mistaken for them [heliconiids]". Bates was quick to realise that "The process by which mimetic analogy is brought about in nature is a problem which involves

The blenny *Petroscirtes* sp., Batesian mimic of the noxious *Meiacanthus lineatus*.

that of the origin of all species and all adaptations", and it was his explanation of the phenomenon in terms of the newly-expounded Darwinian theory of natural selection which caused so much interest and, at the time, controversy. Today, of course, Darwin's theory of evolution is a firmly established biological principle and the concept of mimicry is widely accepted.

The type of mimicry described by Bates—that of the resemblance of a harmless or palatable species to a harmful or noxious species—is now known as *Batesian* mimicry. The imitating animal is known as the *mimic* while the animal which is imitated is called the *model*. A condition of Batesian mimicry is that the mimic normally must be rare compared with its model. Without this condition mimicry would no longer be effective; the predator would tend to sample the harmless mimic more often than the model and would not learn to associate distastefulness with the mimic colour pattern. An exception to this rule occurs where the model is particularly noxious, and where a single experience may be sufficient for the predator to learn to avoid it.

A problem which puzzled Bates was that he found several cases of inedible, unrelated pairs of butterflies which were also very similar in appearance to one another, but it was not until 1878 that a German zoologist, Fritz Muller provided a plausible explanation. Muller, who had also worked on butterflies in Brazil, suggested that if several inedible species looked alike, fewer individuals of each would be sacrificed before predators learned to avoid them. This type of mutually beneficial warning, in which two or more harmful or noxious species resemble one another, has come to be known as *Mullerian* mimicry.

A third type of mimicry is *aggressive* mimicry, sometimes known as *Peckhamian* mimicry after E.G. Peckham who first described this form of mimicry. Aggressive mimicry can be defined as the resemblance of a 'predatory' species to a harmless or non-predatory form. It is the reverse of Batesian mimicry; the mimic in this case is a predator which exploits its resemblance to a non-predatory species in order to deceive its prey organisms.

A basic pre-requisite of all forms of mimicry is that

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Juvenile of the coral bream, *Scolopsis bilineatus*, also is a Batesian mimic of *Meiacanthus lineatus*.

# SESSION

both model and mimic should co-occur in the same habitat or at least have the same chances of being encountered by animals at which the deceit is aimed. Most important, there should be some survival value to the mimic in its impersonation of the model.

There are now numerous examples of mimicry amongst insects and also amongst other animals, and plants as well. Most known cases, however, involve terrestrial organisms, particularly those of tropical rainforests. It is only comparatively recently, in the past two decades, that the phenomenon of mimicry has been discovered also amongst marine animals. It is perhaps not surprising that many of these new discoveries have been made on coral reefs—ecosystems which equal or surpass their terrestrial forest counterparts in their diversity of life.

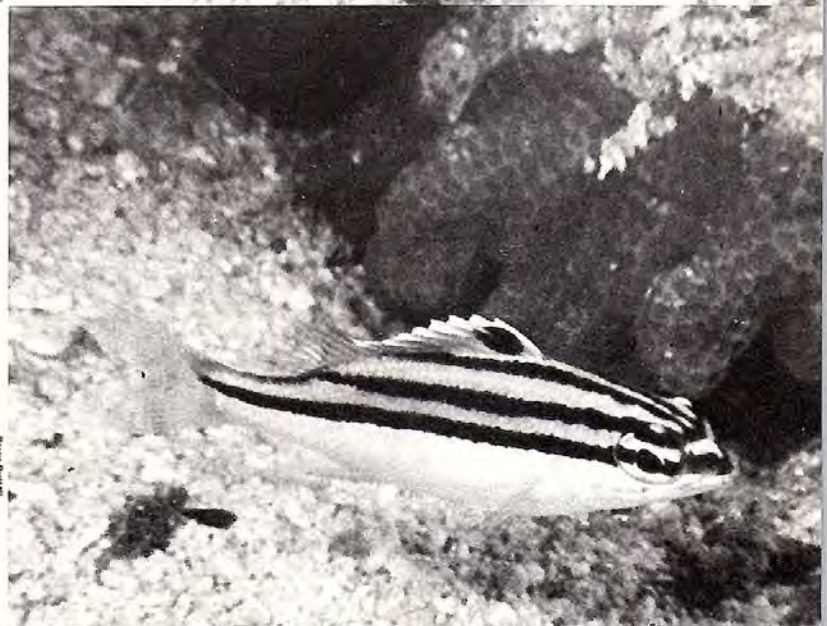
Some of the more exciting new cases of mimicry have been found amongst fishes. Perhaps the best known and one of the first discoveries of mimicry amongst fishes is the aggressive mimicry of the cleaner wrasse *Labroides dimidiatus* by a blenny *Aspidontus taeniatus*. Keppell Barnard, a South African ichthyologist noted a close resemblance between these two unrelated fishes as early as 1927. He observed amongst the fishes he collected, two colour forms of the wrasse—one with and one without a dark stripe at the base of the pectoral fin. Barnard noticed also that the blenny likewise displayed two comparable colour varieties. It was Dr. Jack Randall, however, who confirmed that the blenny actually mimics the wrasse. Diving at the Gilbert Islands and in Tahiti during the 1950s he made detailed observations of the behaviour of the two similarly coloured species. Underwater, the fishes are scarcely distinguishable. The cleaner wrasse picks at parasites on the bodies of other fishes with its small terminal mouth, advertising this service with an exaggerated jerky up and down dance. The blenny, a predator, has adopted these same body movements, reinforcing its already close resemblance to the cleaner wrasse. Using this disguise it is able to approach fishes at a close range, then suddenly dart forward to bite off a piece of fin with its sharp teeth. Cases of mimicry have since been discovered amongst several other blennies. A number of these, involving mainly members of the tribe Nemophini, have been reported by ichthyologists Victor G. Springer and William F. Smith-Vaniz.



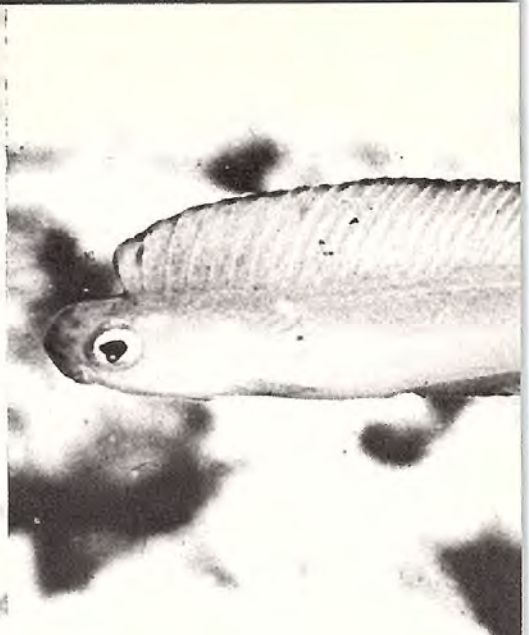
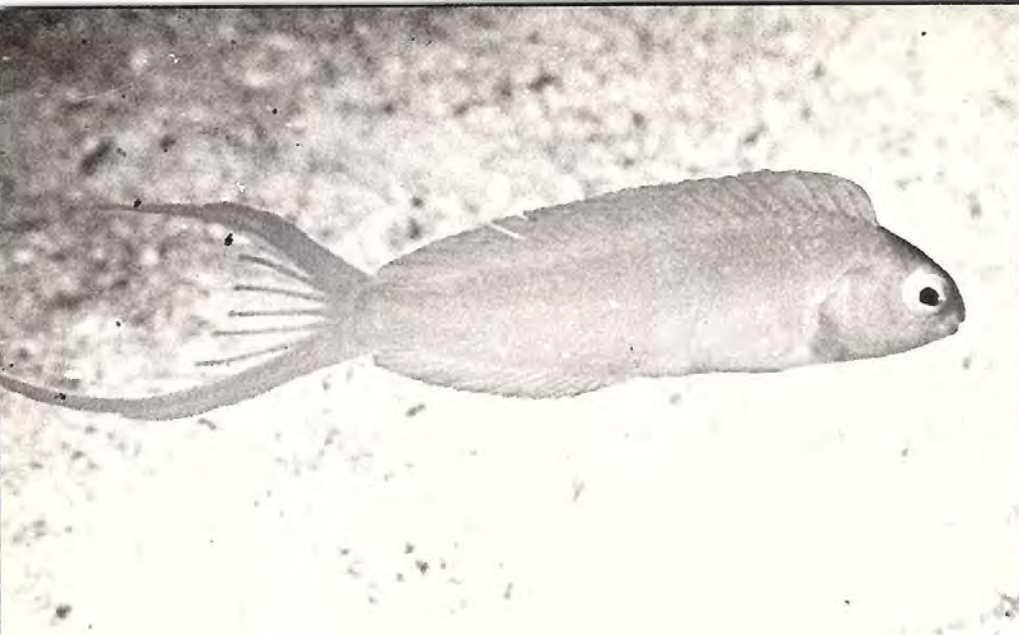
BARRY BARNARD



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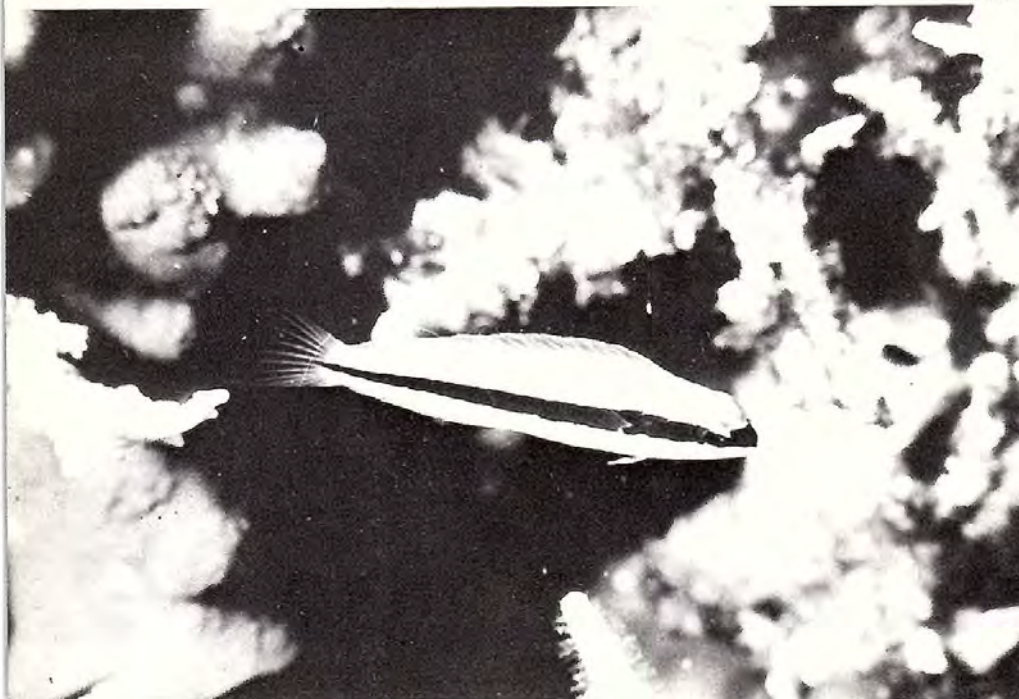
Above left: the poison-fanged blenny, *Meiacanthus atrodorsalis*. This uniform yellow colour morph from the Fijian islands is the model in a mimicry ring involving two other species. Centre: the sabretooth blenny *Plagiotremus laudandus*, yellow colour morph from Fiji. is an aggressive mimic by the model's distastefulness. Right: juveniles of the coral bream *Scolopsis bilineatus* in Fiji are uniformly yellow, quite unlike their relatives on the Great Barrier Reef. This species is involved in the *Meiacanthus atrodorsalis*-*Plagiotremus laudandus* mimicry ring in the Fijian islands.

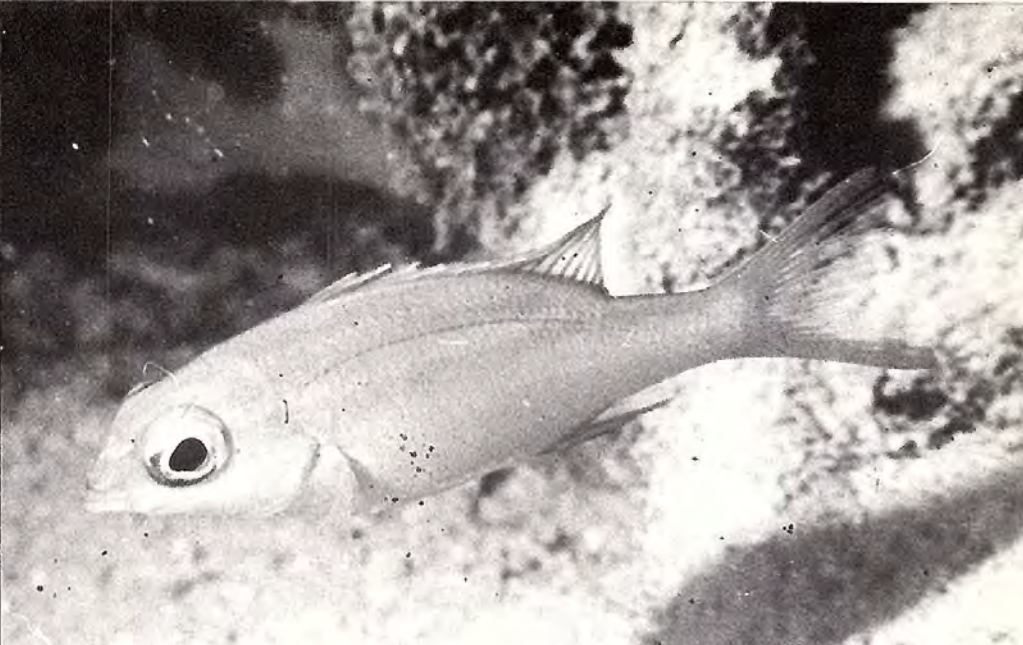
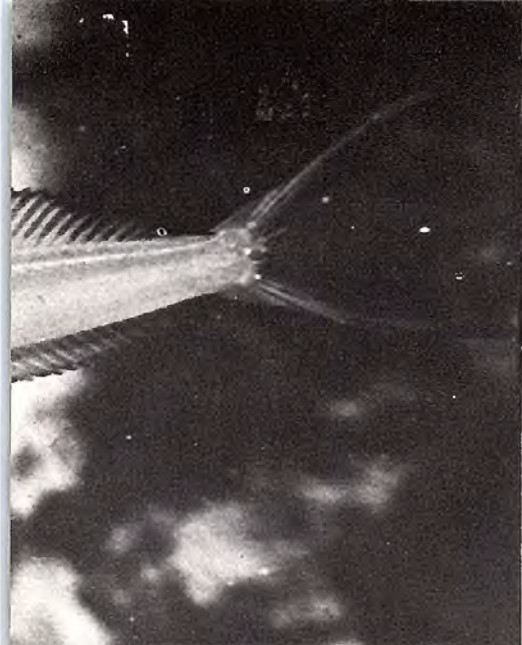
One of the more interesting cases reported by Springer and Smith-Vaniz is an example of classical Batesian mimicry. Whilst visiting One Tree Island on the Great Barrier Reef, Springer observed two small yellow and black-striped blennies, *Meiacanthus lineatus* and an undescribed species of *Petroscirtes*, swimming together. Both showed a striking resemblance to one another, so much so that at first it was thought that the fishes were one and the same species. Not until they were actually collected and examined was the discovery made that there were two types. Both species possess a pair of well developed canine-like teeth at the back of the lower jaw. The teeth of *Meiacanthus*, however, are grooved and have a dentary gland at the base of each tooth, the cells of which secrete a milky fluid which readily flows from the groove. Suspecting this secretion to be a toxin Springer and Smith-Vaniz experimentally fed living specimens of *Meiacanthus* to predators. All the *Meiacanthus* were promptly rejected and it was concluded from these

preliminary experiments, that the bite of this blenny probably is noxious. The interpretation of the apparent mimicry was that *Petroscirtes* sp. would be avoided by predators because of its resemblance to the poison-fanged *Meiacanthus lineatus*.

A third species, the small coral bream *Scolopsis bilineatus*, recently has been found also to mimic the poison-fanged *Meiacanthus lineatus* at One Tree Island. Small juveniles of the coral bream, unlike their adults, have strong black and yellow bands along the upper sides of the body, resembling *Meiacanthus lineatus*. Although deeper bodied than the blenny, the belly is white, in pale contrast to the colours above, so that at first sight, especially when viewed from above, the small coral bream appears to be a blenny. The mimicry is further enhanced by the darting, blenny-like swimming behaviour of the scolopsid. Clearly there is a real advantage to the coral bream in adopting such a disguise. As a juvenile it is probably highly vulnerable to predation. By mimicking a distasteful species its

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chances of survival are greatly increased. Both *Petroscirtes* and the juvenile *Scolopsis* tend to be less numerous than their model *Meiacanthus lineatus*, thus satisfying the conditions of Batesian mimicry.

It is not unusual for mimic species to adopt the behavioural traits of their model. Indeed, similar behaviour patterns probably are important pre-adaptations in the evolutionary development of many mimic-model relationships, providing a point of attack for selection pressure. The typical darting-swimming behaviour of juvenile scolopsids for example, probably predisposes them as potential mimics of *Meiacanthus* species. The way in which even such generally similar behavioural traits may become refined under selection pressure has been shown in the case of the cleaner mimic *Aspidontus* by a German behaviourist, Wolfgang Wickler. By studying the behaviour of other closely-related blennies, Wickler has been able to reconstruct a possible evolutionary pathway leading to the development of the un-blenny-like 'dancing' movement of

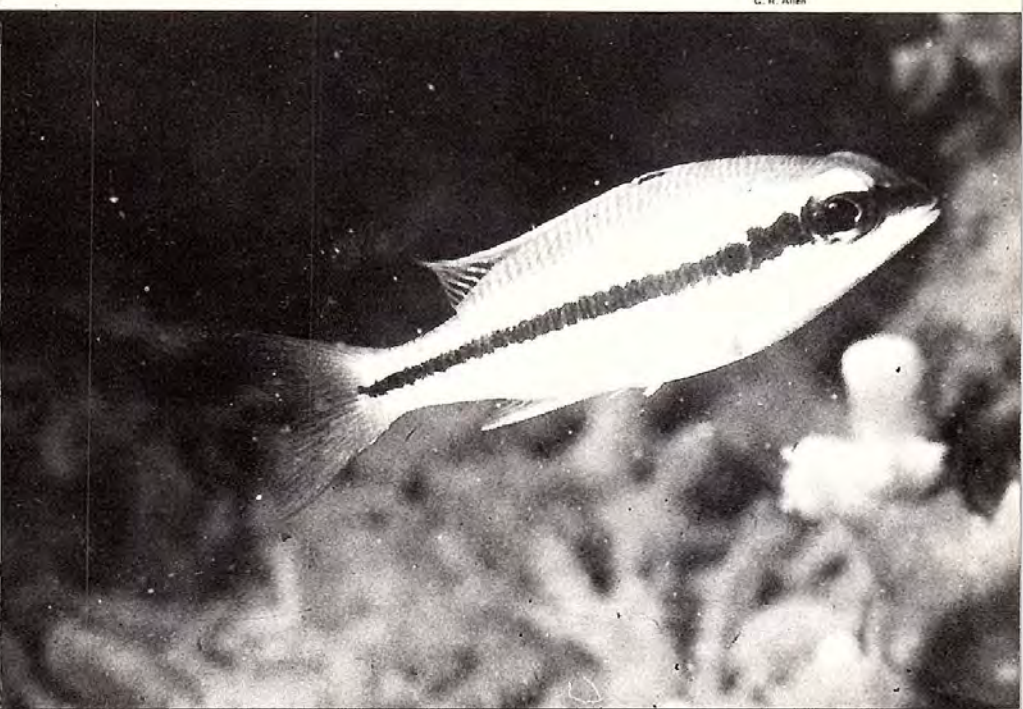
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*Aspidontus taeniatus*. This behaviour seems to have originated from the up-and-down movement of the head, a motor pattern which occurs in all blennies during conflict between the tendencies to approach an object and to flee from it. This may occur simply as a nodding movement or, when superimposed on swimming, become a sort of dance. In *Aspidontus* these movements seem to have become specialised as an interspecific signal important in mimicking the movements of the cleanerfish model.

Not all fish mimics, however, are as well adapted to their model as *Aspidontus*. Amongst the various species of the sabretooth blenny *Plagiotremus* we find varying degrees of mimetic specialisation. Like *Aspidontus*, these blennies feed almost exclusively by biting pieces of skin and body tissue from other unsuspecting fishes. Most species of *Plagiotremus* are not particularly deceiving to the underwater observer. Some, however, such as the eastern pacific species, *Plagiotremus azaleus* regularly occur amongst

Below left: a new species of poison-fanged blenny, *Meiacanthus* sp., recently discovered at Madang, New Guinea, is model for a Batesian mimic ring involving a cardinalfish and a coral bream. Centre: the cardinalfish, *Cheilodipterus conatus*, is a close Batesian mimic of the poison-fanged *Meiacanthus* sp. Unlike most cardinalfishes, this species is diurnally active further reinforcing the deception. Right: juveniles of the coral bream, *Scolopsis marginifer*, also bear a resemblance to *Meiacanthus* sp., and when small probably are Batesian mimics of the poison-fanged blenny.

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Left: the sabretooth blenny, *Aspidontus taeniatus*, aggressive mimic of the cleanerfish, *Labroides dimidiatus*. Right: *Labroides dimidiatus*, cleanerfish inspecting a customer coral trout for parasites.

aggregations of similarly coloured fishes which they superficially resemble. This apparently confers a real mimetic advantage; prey fishes are less likely to notice the predatory blenny, thereby increasing its chances of successful attack. The widespread Indo-west Pacific *Plagiotremus tapeinosoma* behaves in a similar way to *P. azaleus* but is additionally interesting because it associates with different species over its wide range of distribution. On the Great Barrier Reef, this species often swims amongst groups of the small wrasse *Thalassoma amblycephalus*, a harmless plankton-feeding species which aggregates in large numbers on reef crest areas. In Sydney Harbour, it mixes with aggregations of the quite unrelated hula fish *Trachinops taeniatus* which it also resembles, and at the offshore islands of northeastern New Zealand where it occurs during the warm summer months, *P. tapeinosoma* often swims amongst schools of a small similarly coloured free-swimming tripterygiid species. In each case the resemblance is only superficial. Similarity, nonetheless, is sufficient to deceive passing prey fishes and this loose form of aggressive mimicry is an effective means of exploiting a rather difficult-to-get source of food.

Other species of sabretooth blenny such as *Plagiotremus rhynorhynchos* are slightly more specialised. *P. rhynorhynchos* has similar colours to the cleanerfish *Labroides dimidiatus*, although the resemblance is only really convincing between juveniles of the two species. Juvenile cleanerfish have a black body with a brilliant blue band running along each side of the back from head to tail. Juvenile *P. rhynorhynchos* are virtually identically coloured and probably benefit from the resemblance in a similar way to *Aspidontus*

*taeniatus*. As they grow older, however, the colour pattern of *P. rhynorhynchos* changes and a second blue stripe develops along the lower side of the body. Although the blue and black colouration generally resembles that of *Labroides* there the similarity ends; the blenny is much more elongate in form and swims with an undisguised sinuous body movement. At this stage *P. rhynorhynchos* usually is solitary and does not aggregate with other fishes. Its superficial resemblance to the cleanerfish, however, seems to give some mimetic advantage. Although small territorial reef fishes recognise the predatory blenny and avoid it, larger roving species such as snappers, parrotfishes and siganids often approach unaware. At a distance these fishes may well mistake the blenny for a cleanerfish—a common and harmless species. The deception is sufficient for the blenny to benefit. By employing a sneak hit-and-run type of attack strategy and concentrating on roving fishes—prey which in effect never learn to recognise their attacker—a loose form of aggressive mimicry can be maintained. A further degree of evolutionary specialisation is shown by *Plagiotremus laudandus*. On the Great Barrier Reef, this species mimics a poison-fanged blenny, *Meiacanthus atrodorsalis*. *P. laudandus* has identical colours to *M. atrodorsalis* and also closely resembles the poison-fanged blenny in form and behaviour, having a much-shortened body and swimming with short dashes in typical *Meiacanthus* fashion. So convincing is the impersonation that *P. laudandus* is able to openly approach prey fishes. The relationship in this case is a highly co-evolved one; not only is *P. laudandus* an aggressive mimic of *M. atrodorsalis*, but it probably also benefits from the latter's distastefulness to predators.

The mimic ring is a complex one with elements of both aggressive and Batesian mimicry involved.

Such are the selection pressures involved in mimicry that many of the more highly specialised mimics resemble even local races or subspecies of the model. The cleanerfish mimic, *Aspidontus taeniatus*, for example, shows geographic colour pattern variation which parallels that of its *Labroides* model. Such local variation may extend to all members of a mimetic ring. In the Fijian islands *Plagiotremus laudandus* is a uniform bright yellow and mimics the local subspecies of *Meiacanthus atrodorsalis* which also is bright yellow. Involved also in this mimic ring are juvenile *Scolopsis bilineatus*. In Fiji, this species too has adapted to mimicking the yellow subspecies of *M. atrodorsalis*, the typical yellow and black banding having been replaced by a uniform bright yellow colour.

Cases of multi-species mimetic rings such as that involving *Scolopsis bilineatus* are not isolated discoveries. In Madang, New Guinea, Gerald R. Allen and Walter A. Starck recently discovered a similar mimetic ring, involving a new species of *Meiacanthus* mimicked by an apogonid *Cheilodipterus zonatus* and a juvenile coral bream, *Scolopsis margaritifera*. At Lizard Island on the Great Barrier Reef, at least two other species, a juvenile snapper *Lutjanus* sp. and a lethrinid juvenile also are similarly coloured and may well be additionally involved in the same mimetic complex. Other groups of fishes in which mimics are known now include groupers (Serranidae), dotty backs (Pseudochromidae), gobies (Gobiidae), Surgeonfishes (Acanthuridae) and triggerfishes (Aleuteridae).

The phenomenon of mimicry amongst fishes, however, is by no means limited to mimicking other

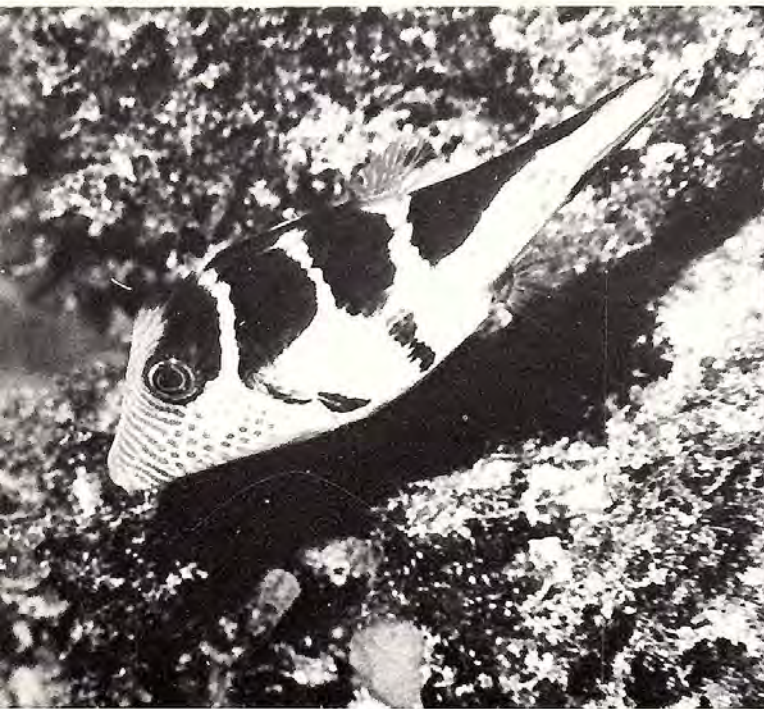
fishes. At Lizard Island, Neville Coleman recently discovered a tiny sole which closely resembles a turbellarian flatworm. At least two other species of fish apparently mimic noxious invertebrates. Dr. Jack Randall and Alan R. Emery have reported that the young of the ehippid fish *Platax pinnatus* closely resembles a flatworm, and that juveniles of the pomadasyd fish *Plectorhynchus chaetodontoides* are conspicuously coloured and behave in a manner resembling a soft bodied invertebrate such as a nudibranch or turbellarian. These seem to be clear cases of Batesian mimicry.

Mimicry amongst other marine groups seems to be rare but one reason for this may be that few people have looked closely at other organisms. Amongst fishes, mimicry is certainly much less rare than was previously thought. In less than five years the number of known fish mimics has more than doubled—mainly because of the increased awareness of underwater naturalists. Mimicry is not distinct from other adaptive processes and may well be equally as general and widespread a phenomenon as camouflage and protective resemblance.

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Left: the pufferfish, *Canthigaster valentini*, a common coral reef fish is highly toxic. Right: the comparatively defenseless triggerfish, *Pataleuteres priourus*, is a close mimic of the poisonous pufferfish, *C. valentini*.



# THE WAYANG WORLD OF THE

BY ZOË WAKELIN-KING

The Balinese people are a major ethnic group within the Republic of Indonesia. Their homeland, the fertile volcanic island of Bali, supports a population of over two million in an area approximately one-twelfth the size of Tasmania. Their culture is derived from the neolithic agriculturalists of the Malayo-Polynesian linguistic stock, who populated the islands of Southeast Asia from about 2500 BC. However, modern Balinese culture is a highly complex and rich mixture of this 'proto-culture' with the social and philosophical ideas and forms of various types or schools of Hinduism. These derive from India, and reached the island via trade and migration from Java during the 10th to the 15th centuries AD. The basic village-agricultural society is stratified into a caste system. The three 'high' castes, the *Brahmanas*, *Ksatriyas*, and *Wesias*, are traditionally the priests, rulers, and statesmen, while the remaining 90% of the population are the 'common people' or *Jaba*, most of whom are wet-rice farmers. Thus, a highly stratified, almost 'feudal' system of Hinduized courts exists alongside, and intermixed with, the co-operatively organised village 'peasant' communities. In association with this, the Balinese language, though within the Malayo-Polynesian linguistic group, has been heavily modified by Sanskrit, and is a three-level language, i.e., it has three forms and vocabularies—'high', 'common' and 'low'—according to the social status of the person being addressed (or spoken about). Balinese religion is also an elaborate syncretic system, in which the various 'animistic' and magical beliefs of the village people can be appropriately rationalised within the intellectual and philosophical format of Hinduism.

Associated with this complex culture is a plethora of art, dance, music, and theatre forms including the *wayang kulit* or shadow puppet theatre. This is closely related to the *wayang purwa* of Java, the *wayang siam* of the Malay Peninsula, and to various forms of shadow theatre which occur in Thailand, Cambodia, and India. In common with these other Southeast Asian forms, it probably originated in India, and it draws its content heavily from classic Indian literature. However, since at least the 15th century, the Balinese shadow-play has

developed independently of its regional counterparts, and has evolved locally in many aspects of its form, content, and social significance. Indeed it has found itself a place in the fabric of village life at such a 'grass roots' level that, in many details, it appears to be indigenous. The task of unraveling the historical process of integration which has occurred is very difficult, if not impossible. Such a 'time-depth' approach is for me of secondary interest to the nature, significance, and popularity of the shadow play *within* modern Balinese culture. Indeed, an understanding of this theatre form can best be reached from the perspective of the Balinese people themselves, rather than from any standpoint of cross-cultural comparison, be it historic or aesthetic.

In Bali, performances are usually held at night, either in the village hall or square or in the street. A cotton screen is set up stretched between bamboo poles at the front of a raised platform or a small bamboo hut especially erected for the occasion. Along the base of the screen is placed a freshly-cut banana trunk, into which the puppeteer or *dalang* can insert the pointed handles of the puppets to stand them up. The *dalang* sits cross-legged immediately behind the screen, and a heavy coconut-oil lamp is hung just in front of his head, illuminating the screen with a warm yellow flickering light. To the *dalang's* left is the puppet box in which the seventy-odd flat leather puppets are stored between performances. To his right is a dish of offerings, usually flowers, rice, eggs and fruit. In the 'wings', on either side of him sit two assistants who help him sort out needed puppets, and file those not in use at the outer ends of the banana trunk. All the actual manipulation of the puppets and the vocal accompaniment is done by the *dalang* alone. A skilled *dalang* can coordinate the movements of the puppets so well with the variations in his voice and remarks that, from the other side of the screen (where only the shadows are seen), the effect is one of cinema-animation—the shadows appear to come to life and act out a flickering drama in their two-dimensional world. The performance is usually accompanied by a team of four musicians playing two pairs of *gender wayang*, metal xylophones suspended over bamboo

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# BALINESE

resonators. (In certain circumstances gongs and drums may be included.) The *dalang* 'conducts' his small orchestra, who sit behind him, with a wooden chock held in the toes of his right foot and knocked against the side of the puppet box at his left. The musical accompaniment ranges from set pieces opening and closing the performance to love songs and atmospheric battle music.

The whole atmosphere of a shadow-play performance is informal, even when it accompanies an important social or religious ceremony. It is a social event for the whole village, from the smallest toddler to the oldest folk in the community. Many people eagerly watch the *dalang* and his team setting up their equipment, while little stalls are set up in the background selling coffee, peanuts and *sate*. The actual performance gets under way about 10pm and usually lasts until at least 2am. In Bali, unlike Java, the majority of the audience watches the shadow side of the screen. The smaller children crowd in close to the front, on the ground, and doze through much of the story, waking up to participate in the funny scenes and exciting battles. Only a handful of curious small boys and friends of the *dalang* perch on the platform behind

the screen to watch the musicians and the *dalang* in action.

To the foreign observer, it is evident from watching even one performance that the *wayang kulit* is a complex theatrical event, incorporating considerable skilled artistic, literary, musical, and social 'facets'. What is not readily apparent is the relative importance and significance of these facets to the Balinese audience. What stories are told in the plays and what characters are the favourites? How important is the form of the puppet and what is the contribution of the shadows to the effect of the performance? On what occasions is the shadow-play performed, and why? What is the social role and status of the *dalang*? What, indeed, is the meaning of the *wayang kulit* as a total social event in the everyday life of the Balinese? During one month of field work in Bali, I sought the answers to these questions through two different angles of investigation.

Firstly, I inquired into the culturally prescribed aims and philosophy of the *wayang*. I asked what a *dalang* (or related expert) thinks he should be trying to achieve. By discussing their roles with various *dalangs*, and by observing and analysing the content

Behind the screen:  
A performance by  
*Dalang* Ida Bagus  
Rai held for a girl's  
'coming-of-age'  
ceremony at a  
community hall in  
Denpasar.





The opening sections of a shadow-play performance: While the introductory music is played, *Dalang* Bhasma lines up the puppets, gives prayers and offerings, and introduces the story with the *Kayonan*.

of performances, the making of puppets and the training of a *dalang*, I formed an idea of the 'blueprint' significance of the shadow theatre—the Balinese theory of the meaning and functions of the *wayang kulit* according to its cultural experts or 'promoters'.

Secondly, to complement this facet of my research, I used a short questionnaire in Indonesian designed to discover the meaning and value of the shadow-play as perceived by the Balinese audience. Four hundred students of various ages and backgrounds were asked to select their favorite stories, characters and *dalangs* and to give reasons for their choices. In order to elucidate the degree of understanding and agreement between the *wayang's* promoters and its audience, some interpretive questions were also included about the philosophy behind the content and form of the performance and about the *dalang's* role. A comparison of results from these two approaches pinpointed those aspects of the shadow-play which are, both in theory and in practice, significant factors in its popularity and meaningfulness to the Balinese people. Some discrepancies became apparent which allow interesting insight into the cultural role of the *dalang* and the shadow-play, and possibly enable us to predict the directions along which the *wayang* may develop in the future. Since my 1971 study, further research (see references) has yielded more quantitative information and more detail on some aspects of the shadow-play's significance and on the existence of local variations within Bali. Where this information is particularly relevant to the aims of my research, it has been included here.

The stories used as a basis for shadow-play incidents are of two types—the two great Indian epics, the Ramayana and the Mahabharata, and various Balinese folk tales, of which the best known are Cupak and

Calonarang. Both the 'Indian' epics are seen by the Balinese as the adventures of their own ancestral folk-heroes and deities. They are divided up into several chapters, from any one of which a large number of shadow-play incidents can be devised. No systematic study has been done on the total number of incidents in use, or on the extent of local or individual variation in content. It appears, however, that the range of incidents used regularly is not large, and that variety is obtained by the individual *dalang's* adaptation and elaboration of the incident within its skeletal story framework.

The Mahabharata centres around a long conflict between the five good Pandawa brothers, and their 100 evil cousins, the Korawas. With the help of many other personalities including kings, gods, demons, and monkeys, the Pandawas use all the 'power-for-good' that they can command—via inner spiritual strength, magical trickery, and physical prowess—to thwart the many evil plots and schemes of the Korawas. An incident taken from the Mahabharata will inevitably include at least one major battle between these two sides, which makes it particularly popular with the smaller children. In the Ramayana, Prince Rama and his brother Laksmana enlist the help of Hanoman, the white monkey, and his followers to rescue Princess Sita from the evil demon Rahwana, who has carried her off to his kingdom. When she is finally rescued, Sita proves her devotion and faithfulness to Rama by submitting to an ordeal by fire and emerging unscathed. Though Mahabharata incidents are much more commonly played, there are *dalangs* who specialize in the Ramayana, and this more romantic tale is popular with adolescent girls.

'Cupak' is a simple moralistic tale about two half-brothers—one fat, greedy, and rude (and according





to Hinduistic interpretation, the son of Brahma); the other elegant, polite, and refined (and supposedly the son of Vishnu). In the story of Calonarang, an evil witch-woman lays waste to the countryside by reading white *mantras* (prayers or magic formulae) backwards to create black magic. She is thwarted through the spiritual strength of a holy man who learns the *mantras* correctly to create equally powerful white magic. It is hard to assess the popularity of these and other folktales, as they are comparatively rarely played.

A major philosophical theme in all these stories is the conflict between good and evil—a conflict which is seen as unresolvable and which exists as a balance between opposing forces. Depending upon the incident, these forces may be purely physical, as in a battle, or they may be in the form of an internal spiritual struggle such as Arjuna has in the *Baghavad Gita*, or they may be magical as in Calonarang. Even the younger members of the audience are appreciative of the 'moral message' inherent in the stories. Over a quarter of the students explicitly said they liked the stories because they were 'good examples' or 'moral lessons' for everyday life.

In line with this theme most of the characters in the *wayang* are 'stereotyped' and divided into 'goodies' and 'baddies'—the noble warrior, the wise councillor, the evil genius, the ruthless villain, the libertine, the faithful wife, and so on. Four important local characters are the Balinese servants, Twalen and Merdah, who are followers of the 'good' side, and Delem and Sangut, who follow the 'bad' side. Their official function in the stories is to interpret and expound the significance of the goings-on of their superiors. In fact, they function as a comic foil to the serious characters and their antics can include political jibes, verbal punning, obscenities, and pure slapstick situational comedy.

Their low status in the Hindu social hierarchy is in many aspects of the shadow-play belied by their philosophical significance. This is particularly true of Twalen (the Balinese equivalent of the Javanese Semar). Although in personality a gross old man, he is regarded in the *wayang* as a wise and holy (*sakti*) individual whose character is associated with that of the *dalang* himself. (Indeed, he seems to fulfil the function of a 'patron saint' of *dalangs*.)

The most popular part of a shadow-play performance, for over two-thirds of my sample, was "the *dalang* telling the story"—the verbal content, dialogue and storytelling—whilst less than one-third preferred the visual action of the characters or puppets, or the musical accompaniment. The verbal content of the Balinese *wayang* is undoubtedly the most complex and, as yet, least researched part of the performance.

Generally speaking, there are two 'levels of communication' within any particular incident's structure. The major characters in the stories, or 'Hindu' characters, use the literary language of Old Balinese or *Kawi*. Today in Bali, this language is only used in the shadow-play and for certain priestly chants and poems, and it is not understood by the average village audience. However, its use in the *wayang* appears highly formalized into set phrases and passages, introductory prayers, and story synopses which, though not literally understood, are recognised and appreciated in context by the audience. (This is perhaps comparable with the use of Latin in Christian church services.) At the other extreme, the Balinese servant characters use the appropriate level of modern Balinese and, nowadays, the occasional expression in Indonesian. This part of the verbal content seems totally flexible and 'ad libbed' by the *dalang*. However, an aspect that does seem to be well-established and fairly constant is the interpreta-

The performance in progress: Court scenes are interspersed with funny scenes and battles, and the story ends with the placing of the *Kayonan* and *Atyintia* in the centre of the screen.



tion of 'vocal character'. All the major characters, and particularly the four Balinese servants, have set 'voices', speech habits, and even 'themes' such as lovesongs which, when combined with their characteristic musical accompaniment or signature tune, enable the listener to recognise them, even without seeing the shadows. These verbal patterns are such an established part of the story that one of the main sources of humour derives from the exaggerated vocal impersonations and 'send-ups' of their superiors indulged in by the Balinese characters.

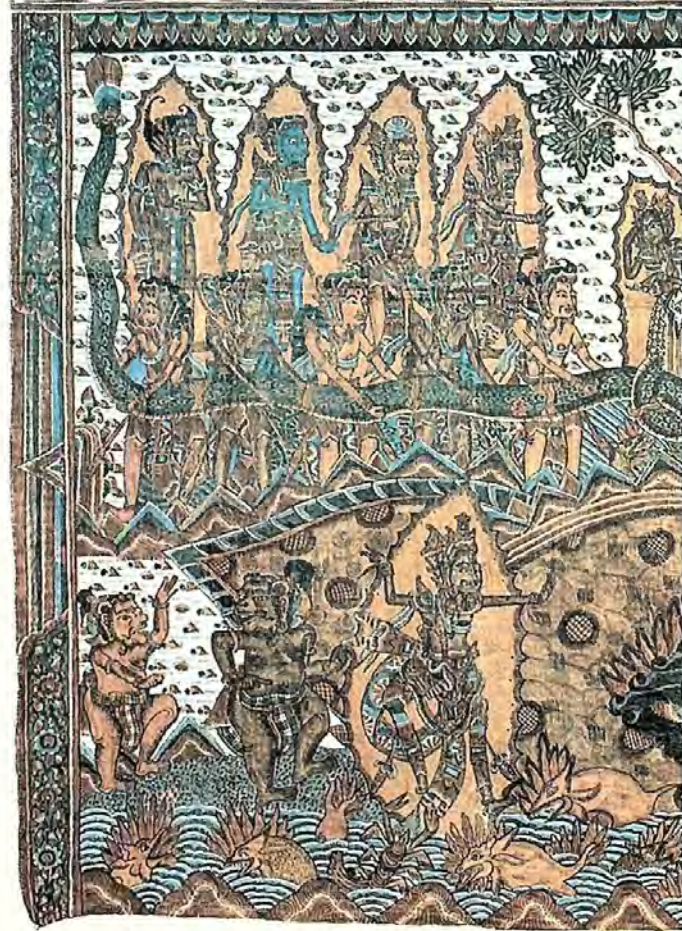
Contrary to some assumptions, it is not the 'comic' characters who are the audiences' favorites, nor any of the stereotyped characters. In fact, the four most popular characters are those who, within their own personalities, display a pragmatic synthesis of the good and the bad, the weak and the strong, the crude and the refined. Arjuna, one of the Pandawa brothers, though noble and refined, tends to succumb to the weaknesses of the flesh. Bhima, another Pandawa, though of noble birth, is a fierce warrior who is inclined to forget the proprieties of politeness for the sake of his cause. Hanoman, the white monkey (and undisputed hero of the Ramayana), has a similar tendency to get carried away in the excitement of the moment. Finally, the only servant character who is particularly popular is Sangut, a cowardly but good-hearted little soul who quietly sabotages the nasty temperament and tricks of his associate Delem, and is not really in sympathy with his evil masters. It appears that though the Balinese audience is well aware of the 'point' of the more idealized characters, their appreciation of the stories' message is seen more in terms of the realistically mixed personalities with identifiable human strengths and weaknesses. The image of the various *wayang* characters in the popular imagination is so well established that they are often used as nicknames—sometimes inspired by a physical similarity, but more often by some characteristic of behaviour or personality.

One of the most easily appreciated facets of the *wayang* theatre is the haunting atmosphere and dramatic effect generated by the visual medium of the oil lamp and shadows. For the Balinese philosopher, the relationship between the cut-out leather puppets and the shadow silhouettes which they create is a complex one, and is the key to the religious significance of the *wayang kulit*. A common interpretation is to see the screen as a 'filter' or dividing line between the spirit world of the Balinese gods and ancestral beings and the world of man. The *dalang* uses his religious knowledge, holy power and the puppets to call up onto the screen the shadowy spirit beings and to make them re-enact their adventures for the benefit of the human audience. This shamanistic interpretation of the performance is supported by the fact that what magical properties the *puppets* have are derived from their use in the making of the

*shadows* rather than vice-versa. There is a ceremony sometimes carried out at the close of a performance which clearly demonstrates this. By dipping the handles of certain key puppets into a container of water (with appropriate offerings and prayers), a *dalang* can cause the 'power-for-good' generated by the actual creation of the shadows to pass from the puppets into the water (making it 'holy'), and thence to its human recipient.

The actual making of the puppets is a highly skilled craft practised today by sixty-four puppetmakers throughout Bali, though some *dalangs* make their own. The main criterion in evaluating the quality of

George Milien/Australian Museum



a puppet is the fineness of the leatherwork, particularly of the facial expression. The raw leather must be carefully and clearly tooled according to set patterns of dress, hairstyle, and physical appearance to enable the instant recognition of any character by its silhouette. The puppets are then elaborately painted according to more-or-less standardised 'colour-character codes' and mounted on wood or horn handles. However, as would be expected from the symbolic interpretation of the *wayang*, the making of the puppets is not accompanied by any particular ceremony, and it is only after a set of puppets have been used in performance by a *dalang* that they gain any

context of sacredness. In theory, once a set of puppets has been ceremonially 'married' to a *dalang*, nobody else (except his eventual successor) can handle them, and they cannot be sold, but are stored away carefully in their box between performances. There is a feeling that the older a puppet is, and the more it is used, the more it accumulates a quality of sacredness, magical potency, or *sakti*. There are many folktales about old puppets, particularly Twalen (who is always stored on top of the other characters in the puppet box), making noises in the night, or speaking to their *dalang*. A *dalang* will go on using a puppet long after its paintwork has worn off, as long as it still casts a clear



section during which the *dalang* lines up all the puppets on either side of the centre, according to their affiliation. At the extreme left (to the *dalang's* right) is the 'manifestation of Vishnu' and at the extreme right (the *dalang's* left) is the 'manifestation of Brahma'. In the centre, overlapping one another, are placed the only two puppets which are 'neutral'. The *kayonan* (Javanese = *gunungan*), is a large leaf-shaped puppet which variously represents the forested world, the mountain at the centre of the Balinese universe, and the wind, and is used as a 'scene changing' device throughout the performance. Superimposed over it is a small puppet representing *Sang Yang Widi*, the supreme god (sometimes interpreted as *Atyintia*, the 'soul of the world'). These two together symbolise the spiritual equilibrium between good and evil in the Balinese cosmos and, at the end of every performance, are placed once again in the centre of the screen. This formalized left/right view of the world is carried over into traditional Balinese painting, where figures are also portrayed in a 'wayang' style. A tendency to draw—and therefore, presumably to perceive—"through a wayang lens" has been strikingly documented by Jane Belo in her study of drawings by very young Balinese children. It appears that as soon as they can draw, they structure their pictures into a shadow-play format.

*Wayang kulit* performances are incorporated into a wide range of social and religious occasions. They can occur at temple festivals and religious holidays, as part of ceremonies for ancestors, and at any of the 'age grading' ceremonies in the Balinese life-cycle (for example, three months after birth, adolescence, tooth-filing marriage, cremation.) On some occasions, a type of 'day-wayang, (*wayang lemah*) is performed, in which the screen is replaced by a rope of bound cotton. It is not clear what particular ritual meaning underlies this variation, or on what occasions it is appropriate. Neither is it always clear to what extent a shadow-play performance is an integral part of some ceremonies, or an 'optional extra'. For each occasion, there are one or more stories which are regarded by the *dalang* as most philosophically appropriate. At a girl's puberty ceremony, an incident extolling the beauty and womanly virtues of Sita may be chosen. The incident 'Bhima Swarga' from the Mahabharata is frequently performed at death ceremonies because it underlines the responsibilities of the living toward the dead. In one way the shadow-play is seen as teaching the community about the significance of the event that it accompanies. However, there is also the conviction that the actual performance will positively influence the outcome of the event. Frequently at age-grading ceremonies, the performance finishes with the making of holy water which is then given to the subject of the social occasion, thus ensuring that he or she will benefit from the positive spiritual energies generated in the performance. A performance of the Calonarang

A modern Balinese painting on cloth, in the traditional 'wayang' style.

shadow. Many *dalangs* use puppets whose articulated arms and support-sticks have been repaired several times, and which are known to be over a hundred years old.

Many aspects of the actual staging of a shadow-play are also highly symbolic. The screen, lamp and banana trunk respectively symbolise the air, sun and earth—the world of the shadow characters. Within this there is a sharp division in the orientation of the characters into a left (good) and right (bad) side, as seen by the audience, which reinforces the idea of conflicting forces in the stories. Before the actual start of any shadow-play incident, there is an elaborate introductory



David Corne

As a trainee *dalang*, Ida Bagus Bhasma practises coordinating story-telling and hand movements with his team of musicians.

story has a folk-reputation for being able to restore the balance between good and evil forces in a community affected by famine, sickness, or spiritual malaise. It is said that a *dalang* needs to be particularly *sakti* (possessing inner spiritual strength) to be able to handle the magical forces generated in the playing of this tale, and many *dalangs* will not use it, claiming that "a *dalang* who plays Calonarang has a short life."

A *dalang*, then, would appear to be not just a virtuoso entertainer, or a teacher of Hindu lore and literature, or a priest, but a combination of all three. This is reflected in the social and personal prerequisites for becoming a *dalang*. It is not necessary for a *dalang* to be of the priestly caste, nor to have inherited the role from an ancestor, though quite frequently both these conditions occur. Nor is the role of *dalang* a highly-paid professional position. Payment varies according to the means of the sponsor and the reputation of the *dalang*. Of the 300-odd *dalangs* currently practising in Bali, the vast majority are ordinary villagers, who rice-farm during the day, and who perform irregularly on demand within their local orbit, which may be only a few villages. Where the role of *dalang* is inherited, it is most often passed from grandfather to grandson, rather than from father to son. The pragmatic explanation given for this is that there is a shorter period of 'overlap' during which the 'old' and 'new' *dalangs* are potentially local rivals.

The one *essential* pre-requisite for becoming a *dalang* is the desire—the divine inspiration or 'calling'—to become one. Frequently associated with this is an innate skill, seen as a gift of the gods, which may express itself at an early age. A young child may, for instance, handle leaves or sticks as if they were puppets. Any such interest or talent is fostered in the child, though intensive training does not usually start until adolescence.

The training of a *dalang* is broadly-based and largely personal. The religion, literature and philosophy of the *wayang* is learnt from palmleaf manuscripts in *Kawi*, as are some of the set texts and stories used in the shadow-play. Sessions are held with a team of musicians, during which the student learns to coordinate his voice with the music, but only during

one week a year (the '*wuku wayang*') can he practise with the puppets themselves. I observed one trainee practising the movements of the *kayonan* during an introductory chant using a flat book as a puppet-substitute. Though a student may establish himself in an apprentice-type relationship with one particular *dalang* (sometimes a grandfather), frequently he simply attends as many performances by different *dalangs* as possible, and learns by observation of different techniques. A further facet in the personal development of a student is the fostering of physical and spiritual strength, principally by meditation—for a *dalang* must be healthy both in mind and body in order to handle the spiritual forces in the performance. According to Hindu philosophy recorded in the *Dharma Pawayangan* there is ultimately an identification or fusion of the *dalang's* body with his skills, equipment, and even the characters themselves. For example, the puppet handles are said to lie in the fingers of the *dalang*, the screen in his abdominal wall, the lamp in his eye sockets, and so on.

Once a student is sufficiently versed in the language, music, technique and religious background of the *wayang*, he undergoes a ceremony of 'marriage' (*maskapan*) to his puppets (which may be inherited or newly made), and earns the title of '*Manku Dalang*'. His first performance is particularly important and must be held from a *tingga* or specially-constructed bamboo hut, rather than from an ordinary village hall. It is evident that though most *dalangs* and their assistants and musicians play as an established 'team' who divide payment between them, a *dalang's* reputation is essentially personal, and the other members of the team remain relatively anonymous.

Even the younger members of the audience displayed a good understanding of the diverse qualities, skills, and education that 'make a good *dalang*'. Almost all my sample chose their favorite *dalang* on the basis of his technical skills (of voice and handling the puppets), or his ability to amuse and entertain. The spiritual, philosophical, and literary expertise of the *dalang* were not included. Here we have pinpointed the basic duality (and implicit contradiction) in the *dalang's* roles. Though he is *expected* to be a learned, priestly philosopher for the moral and spiritual benefit of the community, he is *appreciated* for his ability to entertain. It is up to the individual *dalang* to strike a balance between his two roles. Presumably, there are *dalangs* who sacrifice popularity for philosophy, and vice versa, however, the most renowned ones are those who are versatile enough to integrate the two roles. *Dalang Buduk*, the most popular *dalang* in south Bali, considered that the most effective and entertaining format was to contrast scenes of purely serious content, which further the 'point' of the story, with scenes of purely lighthearted 'comic relief'. *Dalang Banjar*, one of the most popular *dalangs* in north Bali, stated

his ideal to be rather a smooth harmonious blending in every scene of the serious and the entertaining. The challenge in his contradictory roles is perhaps what puts the Balinese *dalang* in a dominant position in the culture. While being a keeper of traditional philosophy and literary lore, he is also at the forefront of change as a political commentator, linguistic innovator, and astute social critic. No matter what his wealth or social rank, a *dalang* is a highly respected member of the Balinese community.

In the modern context of rapid social change, many Balinese cultural officials are worried that the shadow-play may not be able to maintain its popularity and community significance, particularly with the younger generation. They point to the impact of international tourism and the competition offered by cinemas showing Italian-Japanese cowboy movies. It is difficult to assess whether recruits to the role of *dalang* are on the decline, or whether standards of performance have changed, but there can be no doubt about the current popularity of the *wayang* with the younger generation. More than three-quarters of my sample of students saw the *wayang* "as often as they could" or "at least once or twice a year". Only eighteen of them had never seen a performance and of these, ten were Islamic, Javanese, or Chinese, and therefore outside the 'mainstream' of Balinese culture. Their general enthusiasm at being able to participate in such a questionnaire was undeniable. As for the effects of tourism, in 1972 there was already at least one specially presented 'tourist performance' of the *wayang*, held once a week in the old palace in Denpasar. Despite a shortening of the performance to one hour, program notes, the provision of chairs, and a very small entrance fee, the whole show seemed totally lost on the small foreign audience, but was highly appreciated by the hordes of local children crowding behind the official seating area. Compared with the more easily appreciated and spectacular Balinese dance forms, it appears that the *wayang* seems obscure and, after the novelty of the shadows has worn off, boring to the average tourist.

A number of innovations have occurred under government sponsorship in an attempt to ensure the continuing vitality and standards of the *wayang*. One of these is the highly successful monthly broadcast from the Denpasar radio station, and another is the establishment of a *dalang* training school at the local conservatorium of the performing arts ('Kokar').

A particularly interesting innovation in 1973/4 was an intra-regional, and then inter-regional *dalang* contest. *Dalangs* were evaluated on a wide range of aspects, from technical skills to the correct performance of rituals and associated philosophy, and a committee of judges included experts in the literature, music, and religion. This brought to light for the first time an enormous amount of comparative information on all facets of the shadow-play and, in particular,

on the existence of considerable regional variation in style and content of performances. The question faced by Balinese officials, which has important implications for the future development of the shadow-play, is whether all such variations should be judged as greater or lesser 'deviations from orthodoxy' which undermine the purity of the art form, or as dynamic developments which help keep the shadow-play relevant and stimulating to its audience. I hope that government sponsors will recognise the dangers inherent in over-standardisation and admit to the traditional ability of the *dalang*, and the *wayang* itself, to adapt to change while maintaining both meaningfulness and entertainment value. I am optimistic that, as one 17-year-old youth declared:

"... di pulau Bali ini kebudayaan yang paling kuat dan yang paling cocok, untuk di pulau di masa ini adalah satusatunya Wayang Kulit."

"... in the island of Bali, the item of culture strongest and most fitting to the island today is, above all else, the Shadow-Play."

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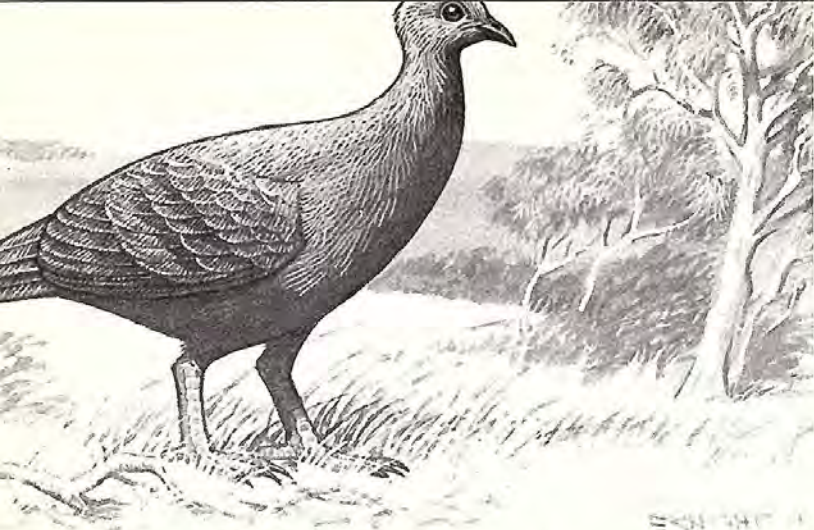
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The close of a performance: The *Kayonan* and *Atyintia* are placed between *Twalen* and *Merdah*.

I. Gusti Bagus Arthanegara





Reconstruction of a giant megapode from eastern Australia, *Progura naracoortensis*, painted for the South Australian Museum.

*In an instant the whole flock of some 500 great, pink birds took to wing with long necks outstretched as the cries of the young, not yet able to fly, broke the stillness of a warm afternoon. The focus of such panicked confusion was the rapid advance of a 25-foot dusty brown and ochre-coloured lizard into the flamingo rookery that ringed this shallow lake in northeastern South Australia . . . . . a few thousand years ago.*

The avifauna of Australia and New Guinea is a highly distinctive one, exceeded only by that of South America in the number of unique forms. It is even more unusual when one takes a few steps back into the past, by studying fossil forms that come from many different localities all over the Australian continent. Surprises not hinted at by the modern bird fauna were encountered by the first scientists to work on these fossils, and certainly more are in store for those continuing this work.

The first fossil bird from Australia was found in the early 1830s by Major T.L. Mitchell in the Wellington Valley of New South Wales. It was a single, rather battered bone of an emu-like *Mihirung* (Family: *Dromornithidae*) to which Mitchell's caving companion tied a rope in order to secure his climb. Fortunately the bone pulled loose and was collected without a freefall! Geological reconnaissance of other states, as well as amateur collecting, continued to net fossil birds throughout the 19th century, and then a major find—Lake Callobonna in South Australia. Bones were first discovered in 1892 and excavated by the South Australian Museum before the end of the century, resulting in the recovery of several skeletons, as well as several pounds of gizzard stones from

A new owl-nightjar from the Warrumbungle Mountains in eastern New South Wales, at least 13 million years in age.

PAT VICKERS RICH, Assistant Professor of Geosciences and Associate Curator of Vertebrate Palaeontology at Texas Tech University, has been involved in researching the origin and evolution of Australia's avifauna. She is presently involved in avian fossil projects in North America, New Zealand, Africa, South America and Eurasia. G. F. VAN TETS, Senior Research Scientist (Birds) with the Division of Wildlife Research, CSIRO, Canberra, is mainly concerned with the behaviour, ecology, prehistory and zoogeography of cormorants and related birds.

*Genyornis newtoni*, a medium-sized *Mihirung*. Another expedition to northeastern South Australia in the summer of 1901-1902 led by J.W. Gregory and manned by his camel-riding students from Melbourne University amassed a sizeable collection of vertebrates, including birds, that ranged in age from a million years to recent. These were studied by C.W. DeVis at the Queensland Museum, who had carried out much of the work on Australian fossil birds found up until that time.

Not until the 1950s was there much renewed interest in fossil bird collecting. Beginning in 1952, Dr. R.A. Stirton from the University of California (Berkeley) led a group of Australian and American palaeontologists into northern South Australia, much the same area where Gregory had discovered Pleistocene bones. Stirton, however, found much older material, some of which is now thought to be at least 20 million years in age. This was the beginning of a series of expeditions that continue to produce a vast array of fossil birds, which are allowing palaeontologists to reconstruct Australia's avifaunal past.

Most fossil birds in Australia are found in deposits younger than 22 million years. At Koonwarra in southern Victoria, however, fossil feathers have been recovered from lake sediments along with fish and insects that are at least 120 million years in age. Unfortunately, the detailed microstructure of the feathers is not preserved, so the kinds of birds represented are unknown. What is certain is that some kind of bird was present in Australia during the early Cretaceous Period over 100 million years ago!

Bird fossils are exceedingly rare in sediments that represent the time span between the first occurrence of birds in Australia and some 22 million years ago. Several different kinds of penguins have been reported from southeastern Australia, including a truly gigantic





# BIRDS FROM AUSTRALIA'S PAST

BY PAT VICKERS RICH AND G. F. VAN TETS

form, *Pachydyptes*, which stood about 1.4m high, from sediments slightly older than 40 million years. Similar fossil penguins have been found in New Zealand and on an Antarctic island south of South America. A feather from Victoria's western district and an unidentified bone from southeastern Queensland are the only other fossil bird specimens from the Paleogene.

Marine, lake, and river sediments from the late Tertiary period, ranging in age from 2 to 22 million years, have yielded a large collection of bird bones from many localities in central and eastern Australia that, for the most part, include families of birds still present in Australia. An emu, although decidedly smaller than the living species (*Dromaius novaehollandiae*), is present in the oldest of the central Australian avifaunas, as are cormorants, pelicans, eagles, ducks, rails, stone curlews, owl-nightjars, and cranes. Most of these belong to the same genera but to different species from those now living in Australia and are associated with other vertebrates such as koalas, platypii, lungfish, crocodiles, and dolphins, which suggest a much better-watered countryside and a decidedly denser vegetation than Australia has today.

As the opening sketch to this article implies, flamingoes once inhabited much of central Australia and today range widely over the world—but have not survived in eastern Asia or Australia. Their absence in Australia is relatively recent, however, for their history here spans at least 20 million years, and bears witness to the development of several kinds unique to the Australian continent. Their preferences today are for highly alkaline, freshwater lakes in which to nest and feed with their peculiar sieving beaks, and certainly such habitats must have been available through much of the past 20 million years in many parts of interior Australia. Unfortunately, with the prolonged periods of dessication of these lakes came extinction of the flamingoes and some other water birds.

Collected alongside the flamingoes are bones of the gigantic Mhirungs, a group of birds unique to Australia that became extinct only relatively recently. Although there is no known overlap in time between European settlement and these birds, there may have been with aboriginal man. Species within the group are known to range in size from a truly gigantic form to a slender and smaller form only moderately larger than the living emu. The gigantic *Dromornis* from the Northern

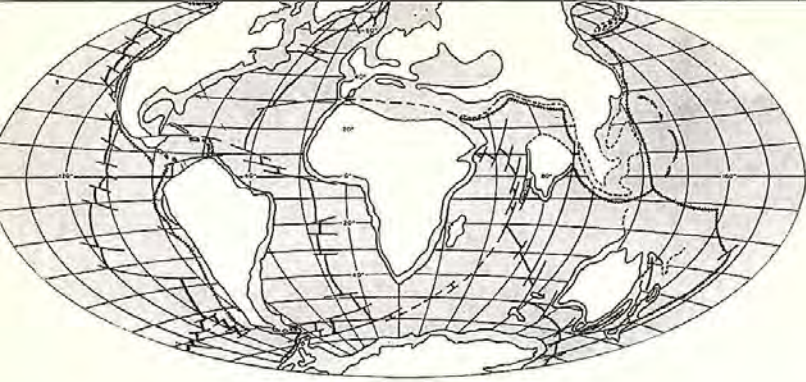
Territory probably surpassed the Malagasy Elephant Bird in weight and volume (about 460kg) as well as height (3m). Even the smallest Mhirungs, however, were not as slender as the emu, and most dromornithids were apparently much more ponderous birds. All appear to have been herbivores or omnivores, a conclusion based on the small size of the cranium with its apparently weak beak and the conformation of the feet with their 'hooved' rather than 'clawed' terminal toe bones. Although the main record of the Mhirungs is one of bones, they are also known from a series of tracks that were found in northeastern Tasmania and southern Victoria and possibly an egg



collected some years ago in Western Australia.

From the Pleistocene limestone caves, primarily in southern and eastern Australia, come the first records of many bird families present on this continent today, including quail, pigeons, parrots, owls, and songbirds. Some represent remains of meals brought into the caves by both mammalian and avian predators, while others are accumulations at the base of vertical entrance shafts. Lake and river sediments in South Australia and Queensland have likewise contributed a large sample of the Pleistocene avifauna. Most species found in such young sediments are inseparable from living forms, although until recently many had been recognized, on the basis of work by C.W. DeVis, as extinct species or even extinct genera. A few forms, however, are truly unique, including *Progura*, a giant

Fossil feather from 120 million year old lake sediments in southern Victoria, the first record of birds in Australia.



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Geographic position of Australia 35 million years ago during the Oligocene Epoch when it no longer was attached to Antarctica but was approaching its present latitudinal situation.

ground-builder that was about the size of a living domestic turkey (7kg) and closely related to the scrubfowl, brush turkey, and mallee fowl of present-day Australia. Flamingoes persisted into the Pleistocene, and some other species, such as the Tasmanian Native Hen (*Tribonyx mortierii*), known only from Tasmania today but as a Pleistocene fossil in Queensland, had much broader geographic distributions.

By far the most numerous in Pleistocene deposits, particularly in caves, are the bones of small songbirds. Because of the inadequate series of modern comparative skeletons in this group (Order: Passeriformes), species determination of many fossils is presently impossible. As modern collections improve, these minute bones may tell us a great deal more about the former environments and climates of Australia.

Aboriginal middens have yielded bones of man's preferred prey species including a wide variety of birds from the sea and inland waterways of Australia. The primary species taken in northern Tasmania, for instance, less than 8000 years ago was the Pied Cormorant (*Phalacrocorax varius*) which has not occurred in Tasmania within historic times, excepting

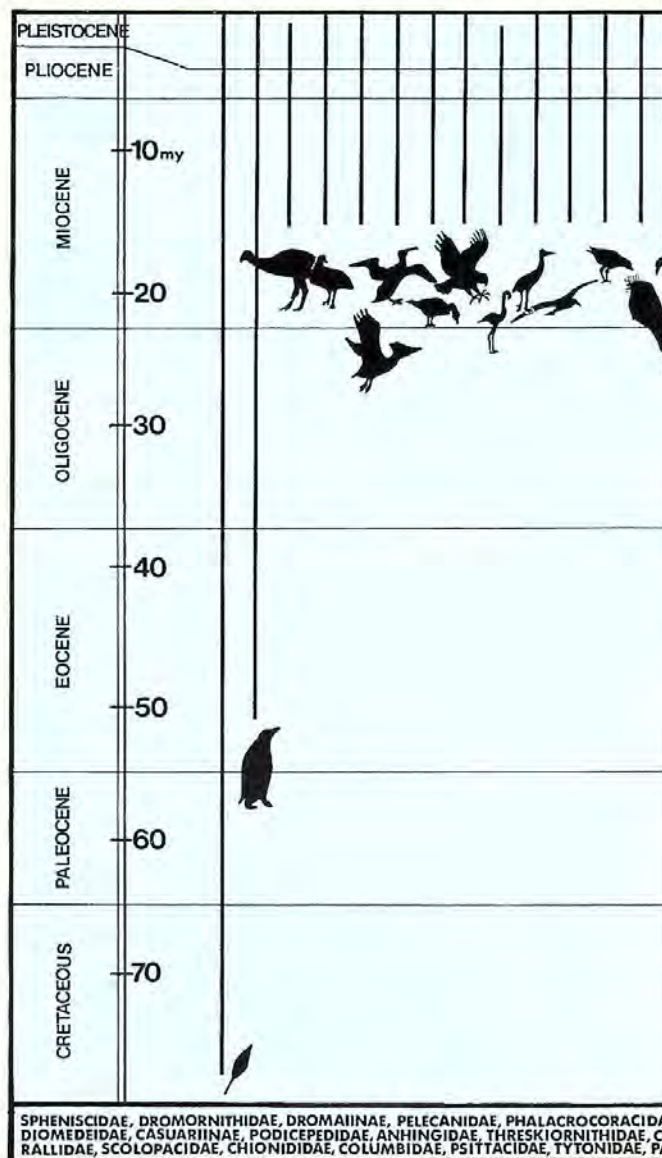
Localities where fossil birds have been found in Australia ranging in age between 120 and 2 million years. White square indicates the Koonwarra locality from which 120 million year old feathers have been recovered (Cretaceous in age); white circles represent younger fossil occurrences, both Paleogene and Neogene.

© V. Rich



a few vagrants. Another midden on Kangaroo Island contains numerous emu egg shell fragments but no bony remains. Certainly, a great deal more information needs to be gleaned from avian archaeological analyses.

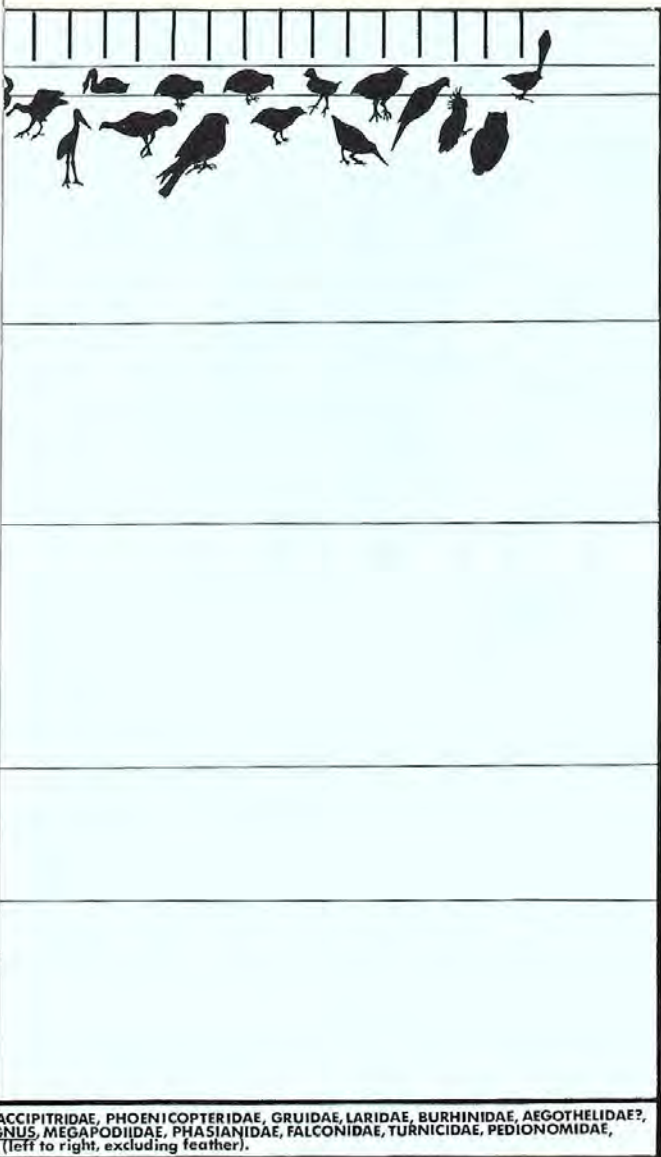
Unfortunately, because the fossil record of birds in Australia is far from complete, it is of limited use in answering questions concerning the origins of this continent's avifauna. Instead, the answers have been sought by studying the modern species familiar to most bird watchers. These birds can be divided into two



major groups, one being those entirely or nearly unique to the Australia-New Guinea region such as cassowaries, emu, the Magpie Goose (*Anseranas*), plains wanderers, frogmouths, owlet-nightjars, and lyrebirds. A second group consists of birds whose ranges include not only Australasia, but other continents as well. This latter category can be further subdivided into two sub-groups: one in which most of the forms are Australian

and only a few occur elsewhere, e.g. megapodes, and another in which there are few Australian representatives but many that occur elsewhere, e.g. falcons, bustards, and thrushes.

Until recently, ornithologists have theorized that the ancestors of most of Australia's colourful avifauna had entered from the north, from Asia, over the past fifty or sixty million years, and this is probably correct for some groups. These ideas were developed when continents were thought to have remained forever



ACCIPITRIDAE, PHENICOPTERIDAE, GRUIDAE, LARIDAE, BURHINIDAE, AEGOTHELIDAE?, INUS, MEGAPODIIDAE, PHASIANIDAE, FALCONIDAE, TURNICIDAE, PEDIONOMIDAE, (left to right, excluding feather).

in their present latitudinal positions. It seems, however, that continents have moved with respect to one another. Australia was one of the most profoundly affected continents, being connected to Antarctica until about 50-55 million years ago and then moving north to its present position in the ensuing years.

When Australia lay much further south, connected to Antarctica, there was certainly a good possibility



H. V. Rich

of exchange of plants and animals between it and South America across Antarctica. The fossil pollen record indicates that the climate in Antarctica at this time (prior to 50 million years) was decidedly milder with true forests being developed in several locales; thus, it did not offer the inhospitable barrier that it now does.

Geographic position of Australia with respect to other continents during the Jurassic Period, 135 million years ago.

Perhaps, then, some birds (e.g., cassowaries and megapodes), as well as many other organisms, used this route to travel between Australia and other southern continents. This southern exchange, coupled with a later northern exchange across the Malay Archipelago (e.g., falcons and thrushes), can explain an end result, the Australian bird fauna.

Localities producing fossil birds that range in age from 2 million years to present, the Pleistocene.

H. V. Rich





A Malagasy lemur, *Indri indri*, one of the world's endangered species.

THE MITCHELL BEAZLEY ATLAS OF WORLD WILDLIFE, *Mitchell Beazley Publishers Limited, London, 1973. Published in Australia by Macmillan Company of Australia Pty. Ltd., Melbourne; 208 pages, illustrated; \$30.*

This is undoubtedly one of the most aesthetically-pleasing books that one could own, whether or not one has a prior interest in natural history. Certainly, the sheer beauty of many of its photographs and the quality of its art work could scarcely fail to instill an interest in its subject matter.

The book sets out to cover an enormous amount of ground, so that it is almost inevitable that, despite its

size, the treatment of most subjects is cursory and superficial. Nevertheless, it crams a vast amount of anecdotal information into its 208 pages. This information, together with the multitude of fine illustrations must whet the appetite of anyone who opens the book, and will surely stimulate the reader to delve more deeply into those topics which attract him.

The organisation of the contents is conventional, which, in the book's role of a popular over-view of its subject, is a strength rather than a weakness. A brief opening chapter entitled 'The Living Earth' introduces the concepts of evolution, zoogeography and ecology. This is followed by a series of chapters on the major zoogeographic realms of planet Earth, including separate chapters on the Arctic, the Antarctic, the

## GENERAL AND IN PARTICULAR

Oceans and Island Habitats. The final chapter—'Man and Wildlife'—examines the history of man's relationships with the animals and plants in his environment, and the impact of Man on that environment through his agricultural pursuits, his industrial revolution, his technological skills and his exploding population; though doubtless unintentional, the brief account of his efforts to ameliorate this impact—through zoos, game laws, national parks, and the recognition of endangered species—leaves one with the feeling that we are simply whistling in the dark.

Major principals and concepts tend to be glossed over with a few trivial lines of text and some pretty drawings. Perhaps inevitably in a book of this size and scope, minor errors abound, the most common being the mis-spelling of scientific or local names and the incorrect identification of the animals illustrated. Unfortunately more serious biological errors are scattered through the book.

All of these errors are to be found in the section on Australia and New Guinea, of which some typical examples, taken largely from those groups with which this reviewer is most familiar, are: the erroneous distribution of Australian rainforests (p. 138), deserts (p. 140) and coral reefs (p. 169); the sea snake *Aipysurus laevis* does not lay eggs on reefs (p. 163), but produces live young in the sea; the illustration of a tiger snake, *Notechis scutaris* (SIC) on (p. 147) is that of a Copperhead, *Austrelaps superbus*; in the drawing of a Thylacine on (p. 190) the animal is shown with the prepuce of a male dog, whereas the penis of a Thylacine is not visible externally since it is contained wholly within the cloaca, except during erection; the drawing of a Tiger Cat *Dasyurus maculatus* on (p. 147) lacks the spotted tail which is characteristic of this species; Australia is not ". . . the home of . . ." the Monitor Lizard *Varanus griseus*, but is indeed the home of *Varanus gouldii*, the lizard illustrated under the name of *V. griseus* (P. 175); New Zealand readers will certainly not take kindly to the reference in the late Sir Julian Huxley's preface to the survival of the Tuatara ". . . only on an isolated Australian Island"!

The choice of items for inclusion in the brief glossary seems to have been made without rhyme, reason or logic, while the bibliography is also uneven in its treatment.

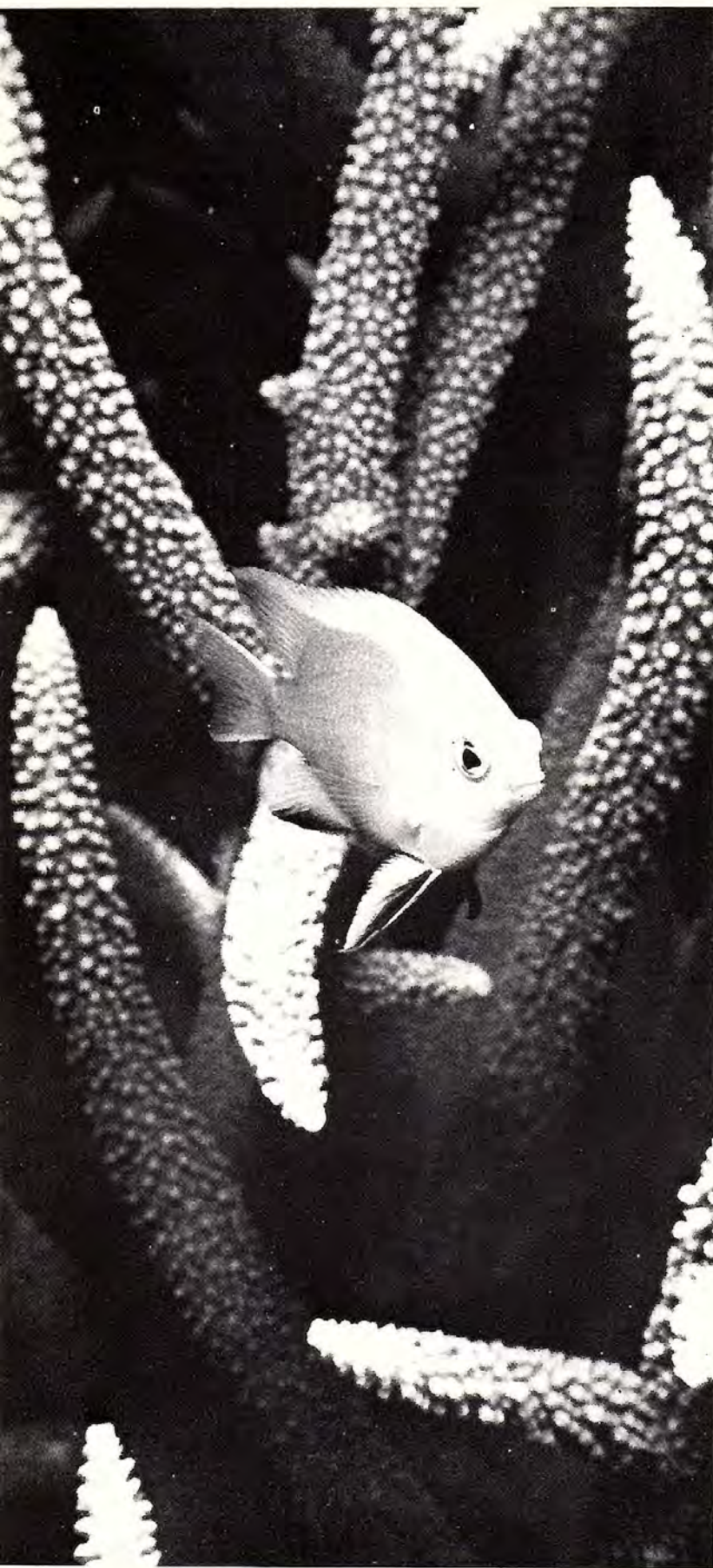
In summary, despite numerous minor errors which should have been found by the eminent biologists on

the editorial board, the Mitchell Beazley Atlas of World Wildlife is an admirable production which, in these days of escalating publishing costs, is excellent value for money. It is delightful and constructive reading for anyone concerned with the rich diversity of animal and plant life with which our planet has been endowed.—*H.G. Cogger, Curator of Reptiles and Amphibians, The Australian Museum.*

*THIS LIVING REEF* by Douglas Faulkner, *Quadrangle/The New York Times Book Co.; New York, 1975; 183 pages; illustrated; US\$27.50*

*This Living Reef* is a book of unusual beauty, an extraordinary combination of fantastic imagery and vivid colour, poetry and science. Douglas Faulkner is considered by many to be one of the finest marine life photographers in the world and in this book he reveals a sensitivity for writing as well as a masterful skill of photography. More than just another coffee table book, *This Living Reef* achieves a balance between aesthetic reflection and careful technical comment which cannot fail to impress even the most serious scientific worker.

The book concentrates on the islands and reefs of Belau (Palau), an archipelago of Micronesia located in the western equatorial Pacific. The reef environments though, and the animals and plants depicted, are typical of reef complexes anywhere in the tropical Pacific and the book is relevant to the Australian reader with an interest in the Great Barrier Reef. The book is a photo-essay that takes the reader on a visual exploration of the life on the reefs and islands of a coral reef. It is logically divided into five parts. The first part, "Belau Genesis", is the legendary Belauan story of the origin of the islands of Belau. In the second part of *This Living Reef*, Faulkner gives a detailed geological explanation for the origin of the reefs and islands then goes on to describe the complex of environments—the outer reefs, passes, lagoons, coves and marine lakes—that comprise the Belau Group. These are illustrated by more than 100 superb colour plates,



each capturing in essence some character of the particular environment, its communities and the details and habits of its plant and animal inhabitants. While by no means a comprehensive compendium of the life forms of a coral reef, the reader is nonetheless impressed by the enormous complexity and beauty of the reef environments. Following on is a commentary on each photograph. This has been carefully researched and Faulkner has taken great pains in obtaining the correct scientific names. As well as giving common names, he records other useful information for the technically minded, including the approximate size of the subject, the location and approximate depth and the date the photograph was made. The remainder of the commentary contains specific information about the subject and its behaviour and importance within the reef environment.

The format of the book (oblong 248mm x 342mm) makes it an awkward size for most book shelves; this size, however, allows a much freer presentation of the photographs, some of which are double-page spreads. Some readers may find it disconcerting to have to continually turn to the back of the book to find an explanation for each plate. The book, it should be remembered though, is presented primarily as a photo-essay and the plates are arranged so that the reader may first gain a visual impression of the reef environment for himself. As moments of beauty the photographs need no explanation, but as Faulkner points out, there is much that can be missed when viewing a photograph and it is the purpose of the commentary to draw attention to certain aspects of the plant or animal's relationship to its environment. The reader is given more than just an impartial description, however. Faulkner imparts his own experience and philosophical view of nature—"At some point science encounters philosophy and poetry and I have never seen these realms as mutually exclusive. I have tried to avoid errors of fact but whenever possible I have revealed what the facts mean to me. To appreciate facts, we needn't know their ultimate meaning, or [whether] they even have one, but facts never quite explain themselves. They exist but they aren't alive for us unless transmuted through poetry and philosophy as expressions of our encounter with the world that surrounds us. This commentary is, then, an imperfect attempt to make sense of an experience of which I am a part. In it, I have expressed my feelings about the reef's creatures and the need for man to have a more intimate understanding of and appreciation for all living things."

Anyone reading *This Living Reef* must certainly come away with some of the same deep feeling and appreciation of the subjects that Douglas Faulkner captures in his photographs and text.—*Barry C. Russell, School of Biological Sciences, Macquarie University.*

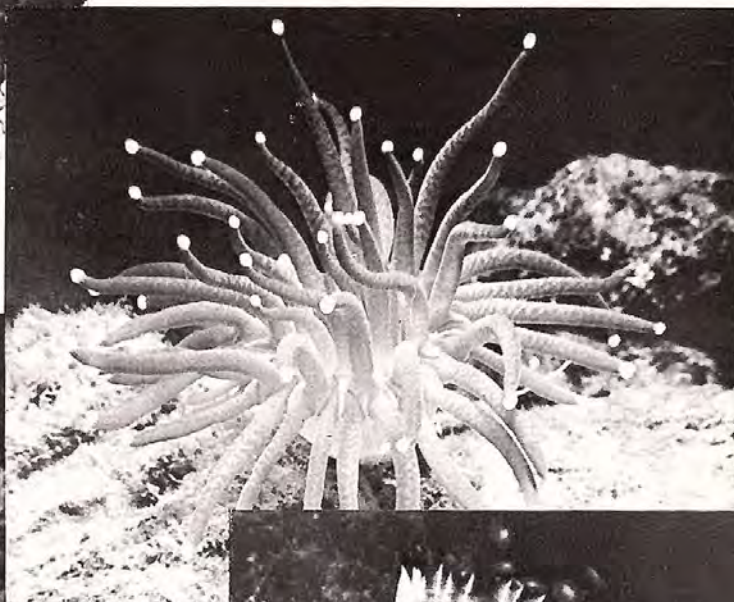


Opposite page: Golden-crested Damselfish, *Abudefduf xanthonotus* and Staghorn coral, *Aeropora formosa*

Left: Freckled Groupers, *Epinephelus coatesi*.

Below: Anemone Mushroom Corals, *Itelioufungia actiniformis*.

Below: Chrome Yellow Sponge, *Psammaplysella purpurea*.



Right: Feather-duster Worm, *Sabellastarta india*.



Below: The 'Ngerukuid' islands of the Belau (Palau) group.



