AUSTRALIAN NATURAL HISTORY

JANUARY—MARCH 1979 VOLUME 19 NUMBER 9 $1.50*

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SILVEREYE

GOLDFINCH

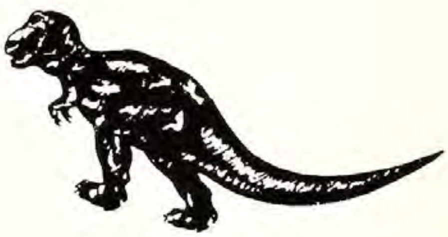
GANG-GANG COCKATOO

PRINCESS PARROT

AUSTRALIAN NATURAL HISTORY

PUBLISHED QUARTERLY BY THE AUSTRALIAN MUSEUM, 6-8 COLLEGE STREET, SYDNEY
PRESIDENT, JOE BAKER DIRECTOR, DESMOND GRIFFIN

VOLUME 19 NUMBER 9
JANUARY-MARCH 1979



COVER: Glistening with *Campnosperma* oil, a colourfully painted Wola girl whirls in a dance in the Highlands of Papua New Guinea.
(Photo: P. Sillitoe)

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New Zealand Annual Subscription: $NZ8. Cheque or money order payable to the Government Printer should be sent to the New Zealand Government Printer, Private Bag, Wellington.

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TRACKING DINOSAURS

THE WINTON EXCAVATION

BY MARY WADE

The Winton dinosaur trackways take their name from the nearest town, Winton, which is close to the geographic centre of Queensland. The sediments in which they were incorporated during deposition approximately one hundred million years ago, are also named after the town, although the Winton Formation extends over many hundred square kilometres. It consists of sands and muds of freshwater origin. A *trackway* differs from scattered footprints as it is a succession of prints made by the same animal. As such, it provides information about the movements of the animal, and the range of sizes and shapes of print its feet can produce.

The Winton dinosaur trackways owe most of their interest to the unique discovery of a dinosaur stampede at Lark Quarry in 1976. A much-trampled drinking spot has been described already from UK, and there appears to be a second here in New Quarry, opened in 1978. The walking steps of a single dinosaur also occur in another fossiliferous layer at New Quarry.

MARY WADE is Curator of Geology at Queensland Museum. Her main interests are Precambrian fossils, which she has studied for twenty years, and Lower Palaeozoic Nautiloids.

Three quarries opened in adjacent hillsides now expose portions of the Winton dinosaur trackways. The area is in the process of becoming an environmental park under Queensland's National Parks and Wildlife Service.

Dinosaur tracks have been known in the Winton district for many years since their discovery by Glen Seymour, now of Labrador, Queensland, when he was Manager of Cork Station. The site, Seymour Quarry, was near the foot of a hill. There drainage through the trackway layer has weathered the track-bearing shale to clay, leaving the sandstone covering layer with natural moulds of the footprints in raised relief on its undersurface. Only when the blocks of sandstone are overturned are the raised or 'positive' moulds of footprints visible, so their overall distribution on the hidden surface remained unknown until recently. The necessity to overturn each slab without losing its orientation, and to fit the fractured surface together again for study, slows scientific work. Most of this has been done at the neighbouring site of Lark Quarry, situated on a promontory up-dip from Seymour Quarry. On the promontory, good drainage allowed the original clay into which the prints were trodden to remain as a brittle shale like the other one-time mud layers

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in the sediments. The site was located in 1971 by Dick Tedford (USA), and independently discovered and reported to Queensland Museum workers by Ron McKenzie of Winton. Another friend of the Queensland Museum, Malcolm Lark of Miles, wielded a crowbar at this site for a long, hot week in 1976, and was largely responsible for developing this, the most important of the three quarries now open. Further search this year for possible extensions of the Lark Quarry trackway layer resulted in the third quarry, New Quarry, being opened on a neighbouring hill where two clay layers bear dinosaur tracks. Poorly preserved positive moulds, first discovered one kilometre away by Barbara Molnar of Sydney, have never been located in position.

The Winton dinosaur trackways fall into two main categories: the dinosaur stampede, now partly excavated at Lark and Seymour Quarries; and a much-trampled watering-place at New Quarry. The northwest dip of the trackway layer at Lark Quarry carries the bed down towards the trackway layer at Seymour Quarry, and the trackway layer can be traced through intermediate outcrops, the largest erosional break being only thirty metres across. The same two kinds of dinosaurs left running footprints heading in the same direction at both sites and the footprints are equally frequent. Since it seems unlikely that both of the world's known dinosaur stampedes occur apparently on the same bed, and were made by similar animals moving in the same direction, it seems more reasonable to view the two quarries as showing the same stampede over ninety-five metres continuous length. These ninety-five metres do not show the beginning or end of the stampede, but only the fully-established flight of a mob in which various sizes and two kinds of dinosaur ran side by side and after each other. A certain amount of veering or dodging can be seen. No dinosaur tracks are found above the stampede layer at either quarry, and the base of outcrop is hidden at Seymour Quarry.

At Lark Quarry there are a few tracks discovered in the next clay layer below the trackways, in one place only, though extensive edge views were prospected; these tracks are not clear, nor decidedly oriented. Across a gap caused by a small mallee creek, the hill southeast of Lark Quarry bears fossiliferous layers at a similar elevation: the dip is no longer to the northwest but to the southwest or south—the surface is not regular enough for anyone to

Left: Lark Quarry, western Queensland, at an early stage in the removal of the rock covering the dinosaur footprint level. Right: The same site seen from the hillside behind the quarry, shows the footprint layer after clearing and while it was being covered with latex for casting. In the background an opal miner's bulldozer cut near the spot where the first footprints were discovered.

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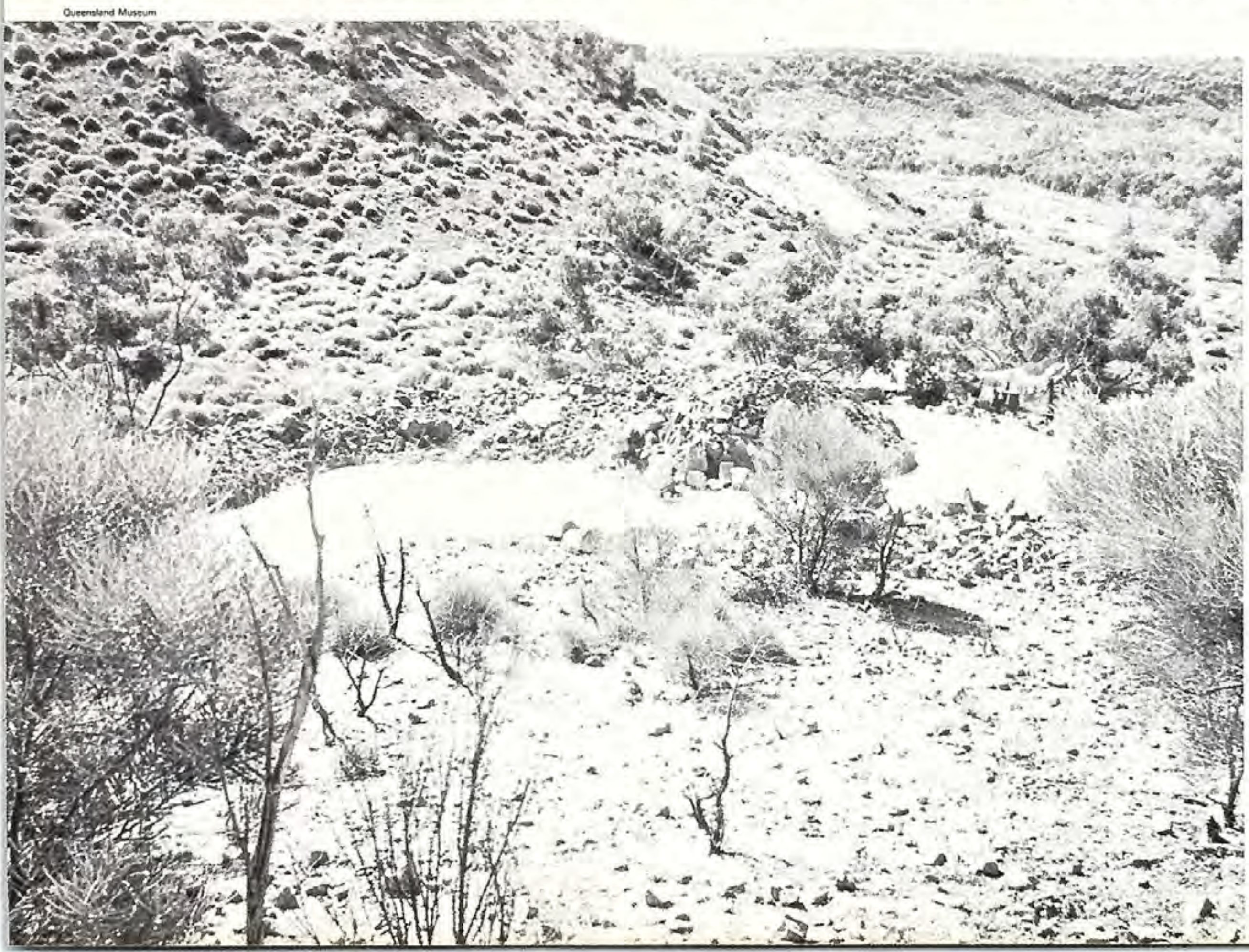

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be dogmatic until more is exposed. The top shale layer of three sandstone/shale couples bears the tracks of one ornithopod dinosaur whose short steps (for its size) show that it was sauntering slowly. The next shale layer below is utterly minced by deep, sand-filled footprints facing every direction. The shale surface still bulges between footprints, and many are over-trodden and incomplete.

A. Ritchie

They resemble those found at any muddy watering spot which animals have frequented. The third shale layer down appears to be unfossiliferous in both hillsides. While the stratigraphy of the layers above them shows fairly clearly that New and Lark Quarries occupy virtually the same stratigraphic position, there is nothing to indicate whether the layers were deposited by the same flood. The trackway layer in Lark Quarry is rather sandy at the nearest place to which it has been traced, and may well have changed to sandstone or lensed out in the creek valley between the quarries. Prolonged gentle flow or stands of quiet water are indicated by the thickness of deposited mud. The mud was probably originally three times thicker than the shale layers, while the partly dewatered, rather plastic mud that the dinosaurs trod would have been thinner, but not nearly as thin as the present shales.

It is clear that the stampeding dinosaurs were more agile than today's reptiles which lack the excellent structural engineering of the dinosaur hip joints. The earliest dinosaurs produced the first two solutions to the problem of attaching the thighbone to the body so that the weight was carried on a bone-to-bone contact. Both of the hip-joint types developed by dinosaurs allowed the head of the thighbone, or femur, to be inserted into a space enclosed by the three pelvic bones. The body weight was thus transmitted direct to the leg bones, whereas earlier reptiles and their other descendants had such shallow hip cavities that the muscles holding leg to hip also had to carry the weight of the body at the body-hip contact. The achievement of greater freedom of movement for less effort resulted in the bipedal locomotion of most of the early dinosaurs and, in general, in longer and straighter legs than modern reptiles possess. All modern reptiles are the descendants of more primitive reptiles than the early dinosaurs, and so could not inherit either of the dinosaur hip-joint types, or any other special adaptations of dinosaurs. That is why they are poor examples to use as comparisons for understanding dinosaurs.

We have referred the dinosaur tracks in the stampede to two species, representing both of the basic dinosaur hip-types. The most numerous are small saurischian dinosaurs called coelurosaurs. Their footprints and the length of their paces indicate individuals from the size of a bantam to a half-grown emu. Intermediate sizes of individuals with a step about thirty to thirty-five centimetres are more usual than extremes of size. They are not so numerous as they seem, since their steps are much shorter and their footprints more abundant than the larger species which belongs to a group of ornithischian dinosaurs called ornithopods. These range, in the stampede, from tiny bantam-sized forms to the size of an adult emu. A large walking ornithopod trackway is also attributed to one of this species of ornithopods. It has much larger footprints than any yet found in the stampede. They indicate an individual as big as an ostrich. Its walking steps average a little longer than the longest running steps in the stampede, one and a half metres, though the foot is about twice the area. This, of course, is one of the reasons we think this biggest ornithopod was walking.

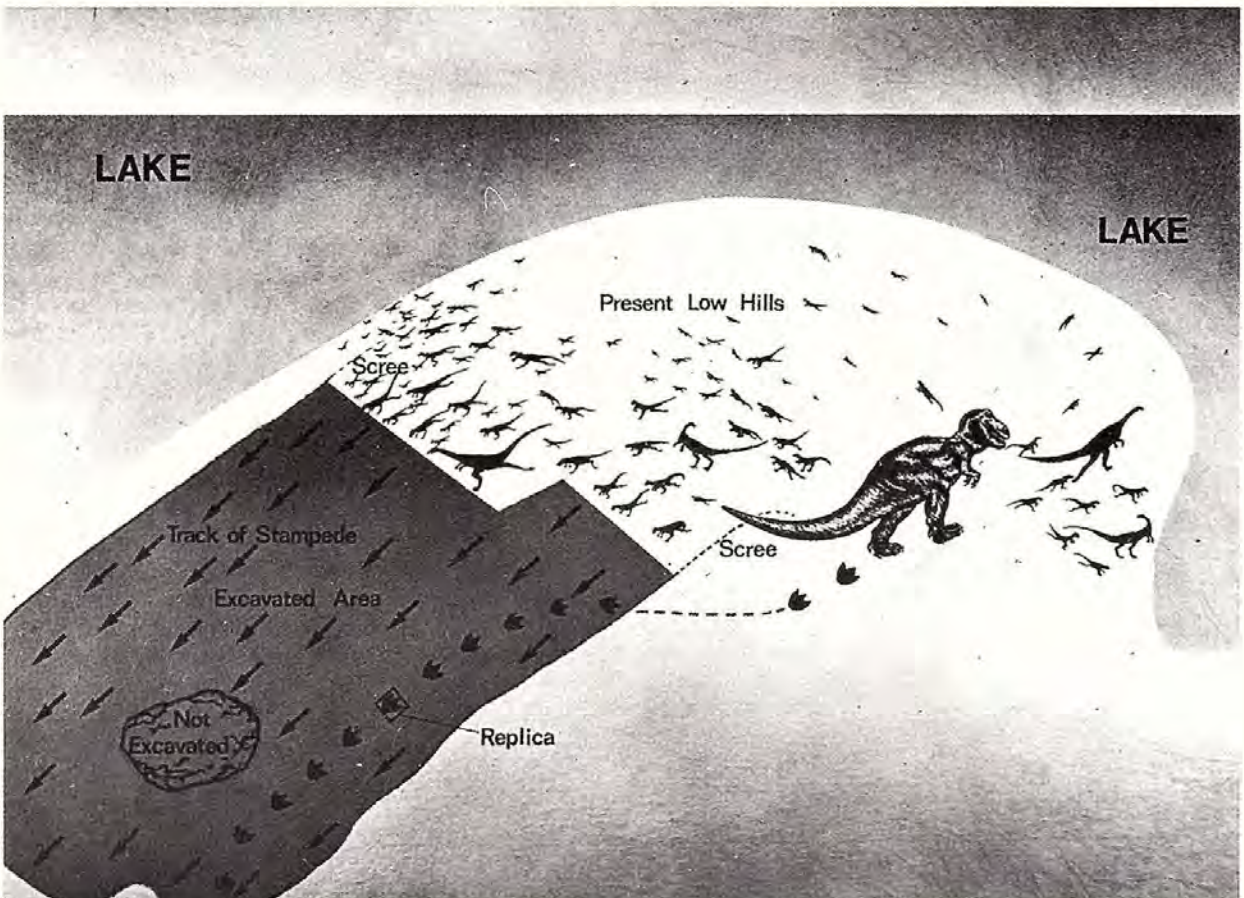
The coelurosaur tracks were made by feet with three long, thin, springy toes. Most of the tracks are incomplete—only toes touched the ground—but occasionally where an animal's pace was checked, as shortened paces indicate, it touched down the ball of its foot. Conan Doyle, a forensic expert as well as originator of Sherlock Holmes, pointed out that incomplete footprints may result from running, a fact which is easier to feel by running oneself than to find in scientific literature on footprints. The many incomplete coelurosaur tracks gave us the first hint that the animals were running. Calculations based on the measured stride length for the related foot length confirmed this. Similar calculations for the ornithopod gave a similar result. The ornithopods' average speeds were faster than the coelurosaurs' because they were bigger, but the two species were thoroughly mixed in one jumbled mob in which the only observable pattern is that the smallest animals *usually* contrived to avoid the paths of relatively large animals. Apart from that, the tracks of either species at any size have overprinted, or been overprinted by, the tracks of either species.

Was there a possibility that these animals went around together? The modern reptiles tend to be very casual to one another unless they wish to eat or mate, but dinosaurs may have been different. There are several recorded trackways of small herbivore groups. If the growth sizes and food habits are considered, the bantam-sized young of either species, particularly of the ornithopods, do not seem very likely to have kept up with large individuals, and both the walking trackways of ornithopods are solitary. This group comprised plant-eaters exclusively. The early coelurosaurs were close to the rootstock of both carnivorous and herbivorous saurischian dinosaurs. The later coelurosaurs are the most conservative-looking branch from this stock, so presumably their eating habits did not change much. They were always agile, lightly-built and mostly with long-fingered forepaws suitable for grasping rather than carrying the weight of the animal. Their teeth were usually sharp although in some late forms they were replaced by beaks. The beaked forms are commonly thought to have been egg eaters, but birds use beaks for eating many things. When we consider that egg-laying was virtually the only form of reproduction practised by land animals throughout the whole time of the dinosaurs, it is clear that eggs were a major food source during this period. Specialized or unspecialized as regards a beak, our coelurosaurs probably ate eggs in quantity, as well as insects, lizards, and less mobile food. Apart from eggs, their diet was probably very varied. The minor predator/omnivore way of life tends to be followed rather independently—though doubtless the sight of a batch of eggs being uncovered or the sound of a tussle would bring other hopeful contenders along for a share, as it does today when a lizard captures noisy prey too big to swallow.

The likeliest life habits we can imagine do not suggest

Far top left: Two small, running dinosaurs apparently veered sideways slightly to avoid stepping into the deep, earlier footprint of a much larger dinosaur, in this case a herbivorous ornithopod, which had headed in the same direction.

Far bottom left: Part of the main footprint surface, Lark Quarry, western Queensland, showing the variation in size and shape of the smaller dinosaur footprints all of which however are heading in the same direction. (Scale equals half metre.)



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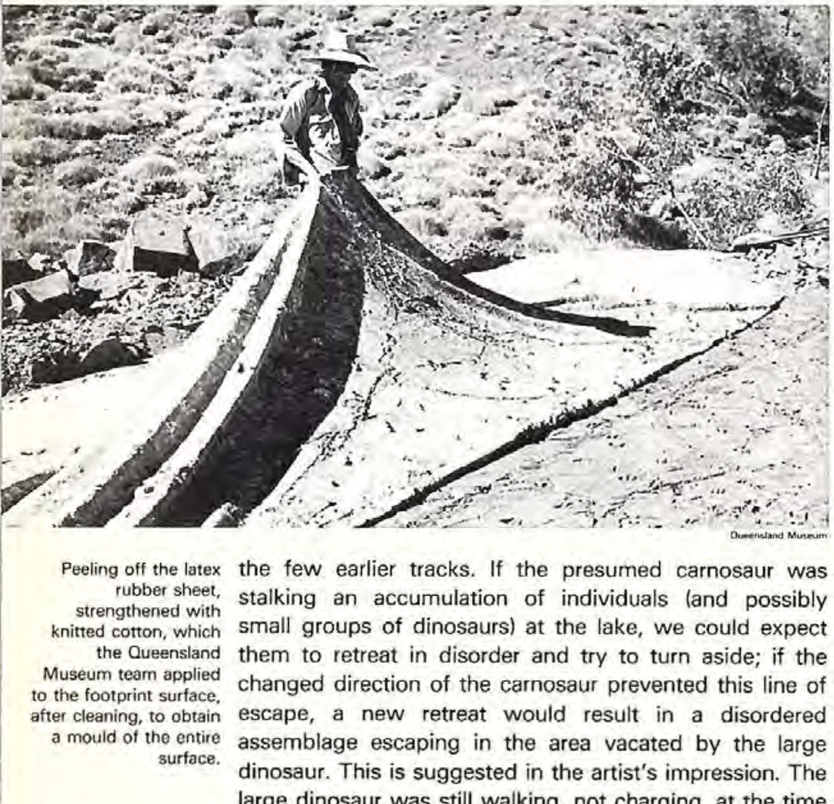
An artist's reconstruction of the scene of the stampede. A large carnivorous dinosaur (carnosaur) walking towards the lake (eleven of its footprints are preserved) may have stampeded the herd of smaller dinosaurs. Their direction of flight is marked by arrows.

that the stampede group lived as one or two entities. The sediments suggest a solution. Mud layers behind the hills southwest of Lark Quarry are thickened, and indicate a usual position for standing water: in other words, a lake. A large number of individuals drinking, resting or eating by the lake is compatible with what we can infer of the lifestyles, but the genesis of the stampeding mob with its direction of flight away from this lake still require explanation.

Other tracks on the Lark Quarry surface, which could explain both the assemblage of the mob and its flight, are those of a large, three-toed dinosaur currently thought to be a carnosaur—a large carnivorous dinosaur. This walked toward the lake (and presumably toward the animals near its shore) and swung to the right into an area now eroded. The state of the sediment shows a time when the mud was rather firm, but not cracked by drying. This was still the state of the sediment when the stampede crossed the trackway of the big dinosaur, and



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Peeling off the latex rubber sheet, strengthened with knitted cotton, which the Queensland Museum team applied to the footprint surface, after cleaning, to obtain a mould of the entire surface.

the few earlier tracks. If the presumed carnosaur was stalking an accumulation of individuals (and possibly small groups of dinosaurs) at the lake, we could expect them to retreat in disorder and try to turn aside; if the changed direction of the carnosaur prevented this line of escape, a new retreat would result in a disordered assemblage escaping in the area vacated by the large dinosaur. This is suggested in the artist's impression. The large dinosaur was still walking, not charging, at the time it formed the tracks we see. Most of the dinosaurs in the stampede were far too small to attract a predator with sixty-centimetre feet and a two-metre step (i.e. an animal about four to five metres long). Such a carnosaur would select a fairly large individual. However, the valid fear of being trampled would scare the little ones, many of which, as animals which could grow into the size range of food for a carnosaur, also may have had inherited fears of the shape. The trackways have now been seen by many experienced stockmen. The only alternative to a stampede as the interpretation of the tracks has been: "Someone was driving them!" We have considered that, of course, but to control a mixed mob so that it holds a straight course at a run, without scattering, demands at least three musterers. There is evidence of no more than one possible predator, and that on the wrong side of the mob for a musterer. While 'driving' remains a possibility, scientists are not entitled to assume that several predators were hunting in concert without trace of at least two. Anyway, a stampede is a stampede even if it is partly under control by musterers. Ask someone who has tried to control one! A more serious doubt was cast on our predator by Dave Norman of England, who has worked on *Iguanodon* skeletons and thinks the largest tracks could be made by one of that family. The tracks are poor, because the animal squashed all the mud out from below its feet and effectively walked on the sand layer below the mud. Iguanodonts are plant eaters and would not normally start a stampede. We have not seen large claw-marks in the large tracks, and this is no doubt a reason why Norman compared them to blunt-toed *Iguanodon,* but some claw-marks do appear, and the deeper footprints appear to have the toes set two closer together than the third, a debatable point because of the bad preservation but, if it can be demonstrated, typical of the large carnosaur track *Tyrannosauropus* and not of Iguanodontidae. Until further tracks are uncovered we may not know the answer, but further digging is out of the question until the site can be covered from the weather. We have already exposed all that legitimate scientific curiosity can justify, and it is time to let preservation of this 'natural wonder' get ahead of exposure.

Faced with the record of a seeming horde of dinosaurs running for dear life across thick mud, we gasped to think of a 'geologic instant' not the usual half-million years long, but of maybe a minute, snatched into the geologic record one hundred million years ago. How to record it for posterity has been a serious problem. To roof it is beyond the resources of the Queensland Museum, to rebury it a shame, to show the original to very large numbers of visitors impossible in its present position. We decided to cast a large area for future display, and National Parks and Wildlife Service plans to roof the most critical part of the site.

When the track-bearing layer was exposed by quarrying and swept clean, the tracks were not empty—each toe contained a wedge of sandstone and usually these were attached to a larger sandstone-filled depression above, because the near parallel toes pushed the sediment down as a whole. Every time the surface is reswept, washed or rained on, more tracks show up. The problems of overtreading, failure to sink in at all, our failure to clean out some tracks before casting, and some unidentifiable tracks, mean that total numbers of animals must be calculated from the number of prints in a measured distance. The sections where tracks were counted to estimate the total number of individuals have been chosen for a seemingly full registry of tracks: there are other patches where lightweight animals did not always break through the surface of the mud. A figure of 130 individuals was derived from two short cross-sections of the quarry, which suggested 132 and 127 animals respectively, and from a carefully identified and calculated standard section one metre long which suggested 130 animals. The standard metre contained over 350 tracks but an average cross-section is poorer—

perhaps 300 footprints per metre of quarry length would be about average, but not all of the twenty-two metres of the quarry length has been cleared. We have cleaned at least four thousand footprints by hand with blunt awls, aided by hand-blowers, brushes, brooms and a vacuum cleaner, in order to make casts of the original surface. After cleaning, the quarry surface was damped with water and painted with latex, and re-painted when dry. The tracks were then covered with squares of knitted cotton cloth, also latex-wetted, and carefully worked into the hollows. Then the hollows were filled with more of the cloth damped in latex, a job almost as bad as emptying them in the first place, and finally, sheets of cloth impregnated by latex were added as backing. Deep hollows, such as the large tracks, were reinforced with fibre-glass to hold the flexible moulds to the correct shape. When all was dry and the reinforcing pieces numbered and removed, the moulds were pulled off and rolled up for return to the Museum. Here they are being cast in fibre-glass for display in the new building (scheduled for opening around 1984).

Meanwhile, the scientific work on the trackways proceeds slowly, for too many individuals have overtrodden each other. Gradually we have learnt characteristics of gait and variability in foot shape. This is quite different from variability in foot*print* shape, which is very strongly influenced by the angle at which the individual foot hit the sediment. Already we know that the coelurosaurs, when their speed was checked, touched the ball of the foot down. They were *digitigrade,* the 'heel' and metatarsal bones being carried clear of the ground throughout life. The larger ornithopod species, with a backward-facing small toe not much higher up the leg than the three front-facing toes, was necessarily more than ordinarily digitigrade. Its walking tracks are identical to its running tracks, but the pace is much shorter.

This was toward the end of the era in which ferns occupied many of the habitats taken over by grasses during the last thirty million years. Conifer wood and leaves of flowering plants are the most common identifiable plant remains. Flood plain conditions normally batter to pieces far more organic remains than they bury, and identifiable remains are characteristically sparse in this area. Deep weathering has removed local spores and pollen so that dating relies on correlation to rather distant dated portions of the Winton Formation. These are probably early in the Cenomanian, near the beginning of Late Cretaceous times, about one hundred million years ago. One should remember that the much-illustrated Late Cretaceous dinosaurs of the Northern hemisphere represent thirty-five million years of dinosaur history. The Australian Late Cretaceous record consists of the first one to five million of these thirty-five million years. When, or if, we discover the skeletal remains of the three dinosaur species which formed the Winton trackways, and studies of contemporaneous sauropod dinosaurs from the Winton Formation have been completed, we will be better able to compare the as yet poorly known Australian Late Cretaceous dinosaur faunas with those of the Northern Hemisphere. The fauna is not nearly as poor as we have been taught—and the conditions of preservation are worse.

The dinosaur hunters' worst enemies are the prolonged deep weathering periods that affected much of Australia in the Late Cretaceous and Tertiary periods, and the combination of ignorance, fear and greed which even now can result in skeletons being kept hidden "because they belong here", "because someone might keep them at the museum" or "in case they become valuable". Even, alas, the misplaced generosity of a discoverer who gives a bone to everyone who sees the find, can scatter a skeleton beyond recovery.

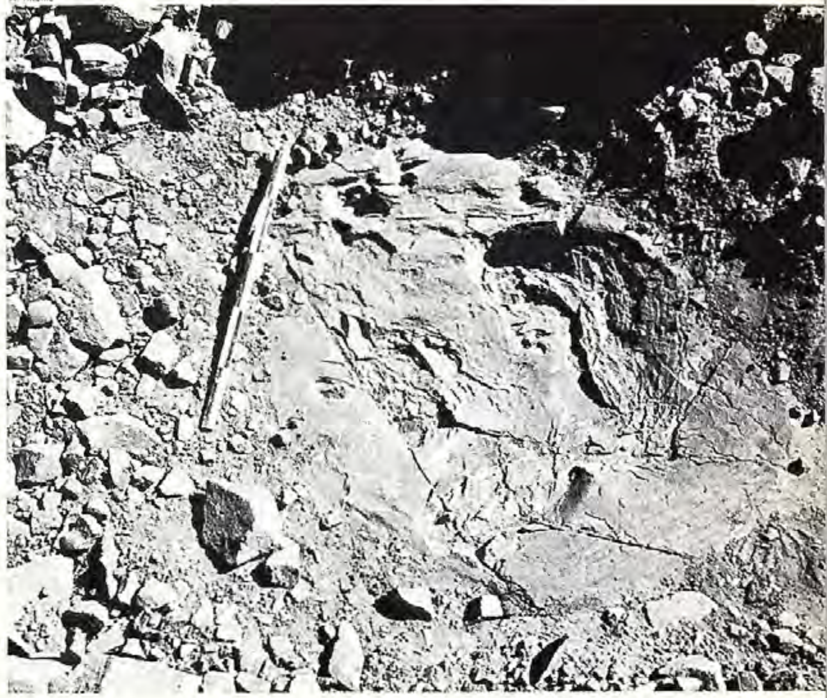
FURTHER READING

Wade, M. A Minute—A Hundred Million Years Ago. *Hemisphere* 23(1) Jan/Feb 1979.

Thulborn, R.A. "Dinosaur polyphyly and the classification of archosaurs and birds". *Aust. J. Zool.,* 23, 249-70, 1975.

Ritchie, A. and B. Matzick *A Family Tree of Dinosaurs and Their Relatives (chart),* The Australian Museum, Sydney, 1978.

Above: Part of the trackway of the large carnosaur showing four separate footprints. Below: Close-up of the carnosaur print indicated by an arrow on the previous photograph. The large dinosaur is heading to the left; the footprints of a small form heading in the opposite direction are clearly seen inside the large print, having been made slightly later.



P. Sillitoe

A Foi Longhouse.

Throughout a large region of Papua New Guinea, people value as a cosmetic an oily sap tapped from a tree. The tree, *Campnosperma brevipetiolata,* grows only at low altitudes in areas of high rainfall, but the oil it produces finds it way to the Highlands where it is rated highly for body decoration. This valued exchange commodity has received little attention, unlike other trading items such as stone axes and salt.

Although the tree grows in many lowland parts of the country, the people who tap it regularly for oil live in the southwest, around Lake Kutubu, on the Papuan Plateau and in the Papuan Delta. From here it passes to Huli, Wola and Kewa speakers in the Highlands, and some of it travels on over considerable distances to reach the Hageners and beyond to the Chimbu.

Cutting the scoop-shaped nick, the first step in obtaining the oil is a delicate procedure.

P. Sillitoe

Campnosperma brevipetiolata is a lowland swamp forest tree, also found in periodically flooded forests. According to the Foi speaking people who live around Lake Kutubu and along the Mubi river, the tree grows best in wet swampy places and on ground with a dry top soil which is moist and soggy below; it will grow in dry soil but very slowly, and when mature, yields little oil.

A large tree with a straight trunk topped with a spreading crown of horizontal branches, it grows up to forty-nine metres high with a trunk one metre in diameter at the base and has buttress roots up to four and a half metres. The outer bark is scaly with shallow fissures and varies from creamy yellow to grey and brown. The inner bark is streaked cream and pink, the sapwood varies from off-white to pinkish yellow and the heartwood from pink to reddish brown. Leaves are simple and grow up to forty centimetres long and fifteen centimetres wide. They are smooth and glossy, paddle-shaped, with broad rounded ends and grow attached to a stalk radiating from the branches like broad spokes. The stalk grows up to thirteen centimetres long, has fine hairs and bears small green flowers and oval-shaped fruit between 0.2 and 0.5 centimetres across.

The Kutubuans distinguish two varieties of tree. The one from which they tap oil they call *kaeraergow,* and it has reddish shoots and new leaves. The other they call *kaeraergow kuwbalow.* It has white shoots and new leaves, but yields oil which is useless for decoration because it is caustic, blistering the skin and causing sores.

The Foi say that although the tree has been in their area since time immemorial, their ancestors have not always tapped it for oil. The following story accounts for the discovery of oil in the mythical past:

PAUL SILLITOE of Trinity College, Cambridge, has been conducting research into the life of the Wola for the past five years, three of which he spent living with them in the Southern Highlands of Papua New Guinea. He is currently looking at their subsistence economy and how it relates to their natural environment.

COSMETICS FROM TREES

AN UNDERRATED TRADE IN PAPUA NEW GUINEA

BY PAUL SILLITOE

Long ago a woman called Verowmay was wandering along the Mubi valley to the longhouse community at Hegiso. One night she slept near a kaeraergow *tree and took it into her head to cut a hole in its trunk. She was menstruating at the time and some of her menstrual blood fell into the hole she had excavated. When this happened the tree started to 'menstruate' too and oil gushed from the hole. It produced an incredible amount of oil and in one day she filled two long bamboo tubes, one of which today takes a man with a number of trees several months to fill. She gave the oil to some men and they were delighted with it and used it to anoint their bodies and give them a beautiful glistening appearance. Soon they asked Verowmay how she had obtained the oil and when she told them, they decided that tapping the oil from the tree was not women's work and forbade her to continue. They searched for* kaeraergow *trees and started cutting holes in them but they produced no oil. They were furious and started to curse and threaten Verowmay, and as a result their trees started to yield oil. Today men still have to curse her in a spell as they cut holes in new trees or else they will not produce oil.*

The tapping of oil, which the Foi call *tigaso* (they also call it *kaeraergow*, after the tree, or *kaymamay*), is not quite as simple as the above myth suggests. Firstly, when a tree has a girth of a metre or more, the owner cuts out a scoop-shaped nick. This is an operation requiring great skill. If a man cuts it wrongly he ruins the tree and will receive no oil. The cut must be big enough and go through to the heartwood so that the tree starts to rot which is essential for oil production, but if the cut is too extensive or too deep, it kills or weakens the tree. It is

P. Sillitoe

Oil trickling down collects in the cavity. The white spots are *kaguw* jelly, to the left is a completed initial nick cut in a new tree.

also essential that the cut be made on the lee side of the trunk because if the hole faces the sun and the wind it will dry up, and ruin the oil-producing capacity. One way of judging the most sheltered side of a trunk is to observe where moss and epiphytes grow on it.

When the owner makes this first cut in a tree he mutters a spell, as the myth says, to ensure that it produces plenty of oil and to guard against unforeseen uncontrollable forces. One such Foi spell runs as follows:

Verowmay	*na'a ka'ora*	*hiygaydayrahabuwbaygay.*
The name of the woman in the myth	your skin	I cut now.

This spell has a number of inter-related meanings connected with the myth. On one level the reciter is making a stylised threat to axe Verowmay, as the men in the myth threatened to do when their trees failed to yield any oil. She is closely identified with the *kaeraergow* tree and so chopping a nick is a symbolic assault. To cut someone also draws blood and the spell likens the flow of oil to the blood which comes from a deep wound. In addition, Verowmay's blood has a special significance as the catalyst which started the tree 'bleeding' oil, and likewise the spell induces the tree to 'menstruate' much oil.

The owner leaves the tree for three to five years after cutting the initial hole in it, and returns when it has almost healed over with flaps of bark. He cuts these away and reopens the hole. Then he pares off a thin layer of wood round the inside of the hole to expose the capillaries from which the oil will seep out. The sap runs down the sides of the hole and collects in the bowl-shaped cavity at its bottom where the heartwood has started to rot. After paring down the inside of the hole the owner covers over the bowl with some leaves supported on a frame of sticks, making sure they do not touch the sides down which the oil trickles. He will also stuff some leaves into the hole formed in the roof of the cavity by the rotting of the heartwood. These leaves keep rain water and pieces of debris from falling in and fouling the oil.

To collect the oil, the owner returns to the tree after two or three weeks, depending on the weather and how quickly he thinks the oil is accumulating. He may need to return two, three or even four times at two to three week intervals. After this, a film of jelly-like sap lines the inside of the hole blocking off the capillaries and reducing the oil flow to almost nothing. The Foi call this jellified sap *kaguw* and sometimes feed it to their pigs. They say it promotes the growth of fat because *kaguw* resembles fat, and being the residue from oil wealth, is considered particularly suitable for increasing the size of animal wealth.

If the owner wishes the tree to produce more oil after his fourth visit then he must pare off another thin layer of wood from the inside of the cavity and so open the capillaries again for the sap to trickle out. Each time he pares off wood the man will say another spell. This is one such Foi spell:

Wa'ow	*vraymow verow,*	*hinanuw*	*vraymow verow,*
Mineral oil	like swirl round,	*Zinjerberaceae* plants	like swirl round,
biduw haemagiy	*vraymow*	*verow.*	
leech blood	like	swirl round.	

The association of sap with two other sources of oily liquid is believed to induce a prolific flow which will collect as plentifully as mineral oil wells from the ground and thick greasy sap oozes from a type of *Zinjerberaceae* plant (which the Foi call *hinanuw maegananay*) when it is squeezed. The spell will also cause the oil to swirl down the sides of the cavity as blood runs from the wound where a leech has sucked and injected its anticoagulant substance.

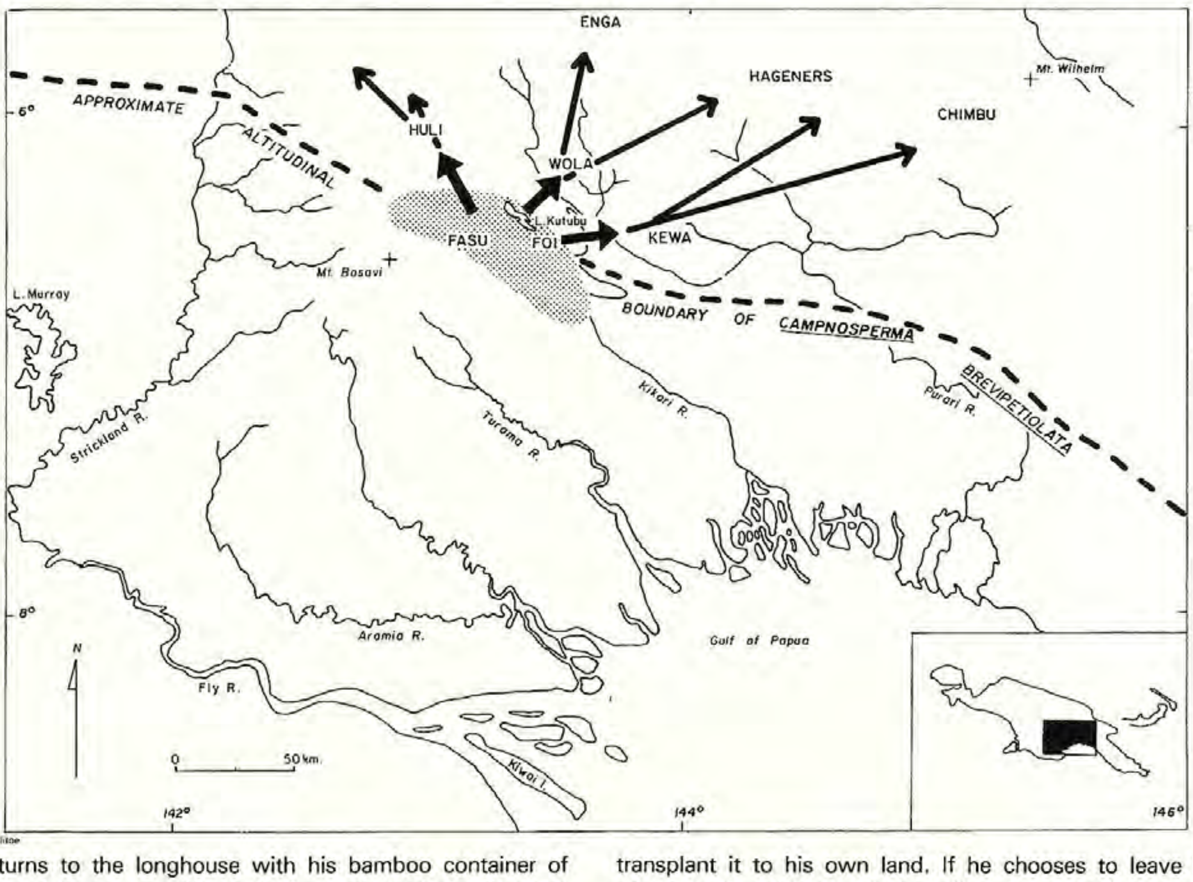
P. Sillitoe

The Kutubuans' principal means of transport—a dugout on the lake.

The oil is collected from the tree in a short length of bamboo with a node closing one end. Despite the protection of leaves over the bowl, there is invariably some rainwater in it on which the oily, light brown sap floats. The owner collects this with a rough funnel—a leaf folded into a conical scoop with the bottom torn off—which he dips into the bowl and holds up to allow the water to run out. As oil starts to drip out he pours the contents of the funnel into the bamboo tube. When only a thin layer of oil remains floating on the water in the bowl, this is collected by putting the palm of the hand on the surface, and then scraping the hand over the lip of the bamboo container so that the adhering film of oil runs inside. When as much oil as possible has been collected, the water is scooped out with a rough leaf ladle and the cavity is covered over and left to fill again. The owner tree he is the sole owner with rights to tap it for oil.

Men establish their rights to *kaeraergow* trees when they are saplings. *Campnosperma brevipetiolata* seeds are very small and rarely found, and men do not search for them to plant. New saplings belong to those men with local land rights. Each longhouse community claims tracts of forest to which all resident members have rights. Within this territory there are areas over which individual men have sole rights. It is common to find *kaeraergow* trees there transplanted as saplings by the owner or one of his ancestors. Saplings usually take root near their parent tree and any new trees that come up on a garden site or in the nearby forest belong to the landowner.

Any sapling in the communally owned forest belongs to the first member who finds it. If it is small, he may transplant it to his own land. If he chooses to leave it where he found it, the finder will make a small clearing and plant some sticks making a rough fence to protect and mark it. When he returns to the longhouse he should stake his claim to the tree by telling everyone about it. Without this, someone else may later claim the tree and a dispute will result.



The map shows the major oil producing region and trade routes from the region to the highlands.

returns to the longhouse with his bamboo container of oil and bores a small hole in the node enclosing the end to drain off any water. He seals the hole when oil begins to drip out, and will probably pour the contents into a long bamboo tube called a *yornay* which, when full, he will sell. Men make these by knocking through the internodes of a length of bamboo with hardwood pokers. They wait for them to dry before pouring in any oil because green bamboo is porous and would soak up some of it.

The owner of a tree continues periodically to tap oil in this way until the heartwood in the bottom of the cavity has rotted right through the trunk to the roots and soil below. He then abandons the tree because although it will still produce *tigaso,* this will run down the rotten hole and drain into the earth. Until a man abandons a

If a man finds an unowned sapling in the forest belonging to a longhouse to which he is related but where he is not resident, then he ought to ask their permission before digging it up and replanting. He cannot own the tree if it remains on the territory of another longhouse because this can lead to claimants' disputes after his death.

This attitude influences inheritance customs. Normally the trees of a dead man pass to his closest male

P. Sillitoe

The owner scrapes a film of oil from his hand over the tip of the bamboo tube.

relatives living in his longhouse, who are usually his sons or brothers (if the heir is too young to tend them then another relative may extract the oil until he is old enough to do so himself). If the deceased leaves no close relatives in his longhouse, his trees will go to his more distant relatives living there; not to closer relatives living elsewhere. But if these closer relatives come to the deceased's longhouse and ask for help to fill a long bamboo oil container, it is customary for the inheritors to help them.

The Kutubuans use *tigaso* to decorate their bodies for dances. They dye the oil with red seeds from a bush they call *kordaebuwla (Bixa orellana)* and anoint themselves with this red mixture. They also use some *tigaso* mixed with nicotine scraped from tobacco pipes as an effective repellent against lice. The bulk of the oil the Foi produce is traded with the *Wayamow* as they call Highlanders. These people also use it to decorate their bodies and clothing for special events but they mix it with powdered charcoal to give their torsos a shining black appearance. As F.E. Williams remarks in a quaint phrase that rings today of colonial condescension "there is no denying that the naked savage, oiled to the very eyelids with this unlikely mixture, presents a really smart appearance."

Other greasing cosmetics like mineral oil and pig fat are available but *tigaso* rates highest and is used in preference to anything else. As the supply of tree oil is limited, people must sometimes accept an alternative. On the Poru Plateau, mineral oil seeps are exploited in trade, but the Wola Highlanders and the Kutubuans do not regard it highly and dislike its smell.

The high value placed by the Highlanders on *tigaso* oil goes up as it travels away from its source. It ranks as acceptable wealth in the important ceremonial exchanges which characterise these societies, such as bridewealths, mortuary payments and war reparation exchanges and these transactions are a significant factor in regional distribution.

The oil passes from the lower producing regions into the Highlands in trade transactions between strangers. Both sides are frightened of each other. The Wola, one of the Kutubuans' Highland neighbours, fear them as the owners of diabolical poison and a powerful sorcery they call *hayowtok*. The Foi consider the stocky *Wayamow* argumentative, aggressive and likely to fight if angered. These fears make them careful and accommodating in their dealings with the Wola; ironically this quiet behaviour reinforces the fears of the Highlanders' who see it as the cold calculation of people who, unlike them, do not flare up and argue when crossed, but resort to nefarious practices. The resulting suspicion and aggressive self assertion in turn reinforces the lake dwellers' fears.

Some Wola men living nearest the lake have acquaintances there, and their relatives or friends, when buying oil, usually ask them to go on their behalf or accompany them. They stay only a night or two, and deal through those to whom their faces are known. No lingua franca has developed—a few men on either side know several words of the others' language and they manage with this, with signs, and sometimes today with Pidgin.

The price for a *wombok uwguw* or long bamboo tube of oil varies with its size—usually about six metres long and eight centimetres in diameter—and other factors like bargaining ability. The prices paid by forty-five men living in the Was valley varied from between one and three pearl shells, one or two pigs, bundles of salt, marsupials and money up to twenty kina, and various combinations of these items.

An impromptu attitude to the production of *tigaso* makes it difficult to estimate the amount of oil produced and exported to the Highlands. Variables like weather, tree size and growth rate increase the problem. In a recent survey around Lake Kutubu, fifty-one men were found to own 152 *Campnosperma brevipetiolata* trees, of which fifty-six were currently producing, while twenty-two were old and useless. The Foi say that the oil produced diminishes at each collection and that an average tree will yield somewhere between 570ml and 1140ml at the first collection, 430ml and 1000ml at the second, 290ml and 570ml at the third, and 140ml and 280ml at the fourth.

It is possible to estimate with these figures how much *tigaso* the Kutubuans could produce in a year. The 225 adult males own an estimated 248 trees currently yielding oil. If they pared down the cavity in each tree every six months, which they could do without damaging them, then the area could produce 987 litres of oil per annum. A bamboo oil container 5.18m long by 5.59cm in diameter held 10.65 litres of oil, giving an estimated total of 93 of them for use and export.

These figures represent only the estimated capacity of the region; the relaxed local attitude to oil production reduces actual output considerably. For instance 72 men living in the Was valley of the Highlands could only remember ever purchasing between them a total of 90 bamboo tubes and 39 gourds of oil from other Wola or directly from the lake (and 12 of these men had never purchased any oil at all). Only 7 of the Foi men surveyed can remember selling tubes of oil. They had sold a total of 180 (148 long ones and 32 short ones), of which one particularly energetic and successful man had supplied 153.

The production of this cosmetic oil will continue for the foreseeable future. Contact with the outside world has not influenced fashion, nor has it resulted, as with some traditional practices, in the adoption of a western substitute.

FURTHER READING

Hughes, I. *Recent neolithic trade in New Guinea.* PhD thesis ANU; Canberra, 1971.

P. Sillitoe

A small hole is bored into the end of the bamboo collecting tub to drain off any water.

van Royen, P. *Manual of the forest trees of Papua and New Guinea: Part 4—Anacardiaceae,* Department of Forests, Port Moresby, 1964.

Sillitoe, P. "Ceremonial exchange and trade: two contexts in which things change hands in the Highlands of New Guinea", *Trade and exchange in Oceania and Australia* (ed. J. Specht & J.P. White), Sydney University Press, 1978.

Williams, F.E. "Natives of Lake Kutubu, Papua", *Oceania* 11 (2) 121-57, 1940.

P. Sillitoe

A Highlander carrying a long bamboo containe full of oil.

FLYING CATCHERS

BY ELIZABETH CAMERON

Perhaps while enjoying the company of a colourful, noisy party of small birds around your picnic spot or campsite you have wondered how so many different species manage to share the food, shelter and other resources of the area. Or glancing through the illustrations of a bird book you have been struck by the strong resemblance between some species; do the differences between these birds extend beyond subtle variations in colour, wing length or the inflection of a song?

In southeastern Australia, two of the most frequently encountered small bush birds, the Willie Wagtail and Grey Fantail, are members of the same genus *Rhipidura.* A third coexisting species, the Rufous Fantail, has a much more restricted distribution. The constant activity and friendly nature of these small birds make them conspicuous wherever they occur. These three species illustrate the way in which animals share or 'partition' environmental space. In appearance, these fantailed flycatchers resemble one another by having short rounded wings, long tails which may be spread fan-wise, small bills and long 'rictal' bristles surrounding the bill. Typically, they feed by catching flying insects. How similar are these birds in shape and form and in their lifestyles?

The Willie Wagtail weighs roughly twice as much as the fantails—approximately twenty grams. In most linear measurements of the body it is one and a half times larger than the Grey Fantail, and the Rufous Fantail is slightly larger than the Grey Fantail in all but the length of some wing bones.

The bill is a bird's major organ of food capture and ingestion and slight differences in diet between species are often reflected in modifications in bill shape and size. In this way greater feeding efficiency is achieved and different portions of a food source (eg: different sizes of flying insects) can be shared by several species of birds. The bill lengths of the three *Rhipidura* species are proportional to their other dimensions but the bill of the Grey Fantail appears disproportionately weaker.

To flycatchers which obtain much of their food on the wing, aerial dexterity is particularly important. With their short rounded wings the fantail flycatchers are generally rather slow fliers that employ flapping flight, can manoeuvre in small spaces, and negotiate dense vegetation. The wing-loading of a bird (the ratio of body weight to the surface area of the wings) contributes to determining the amount of energy needed to launch it and keep it air-

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E. Cameron

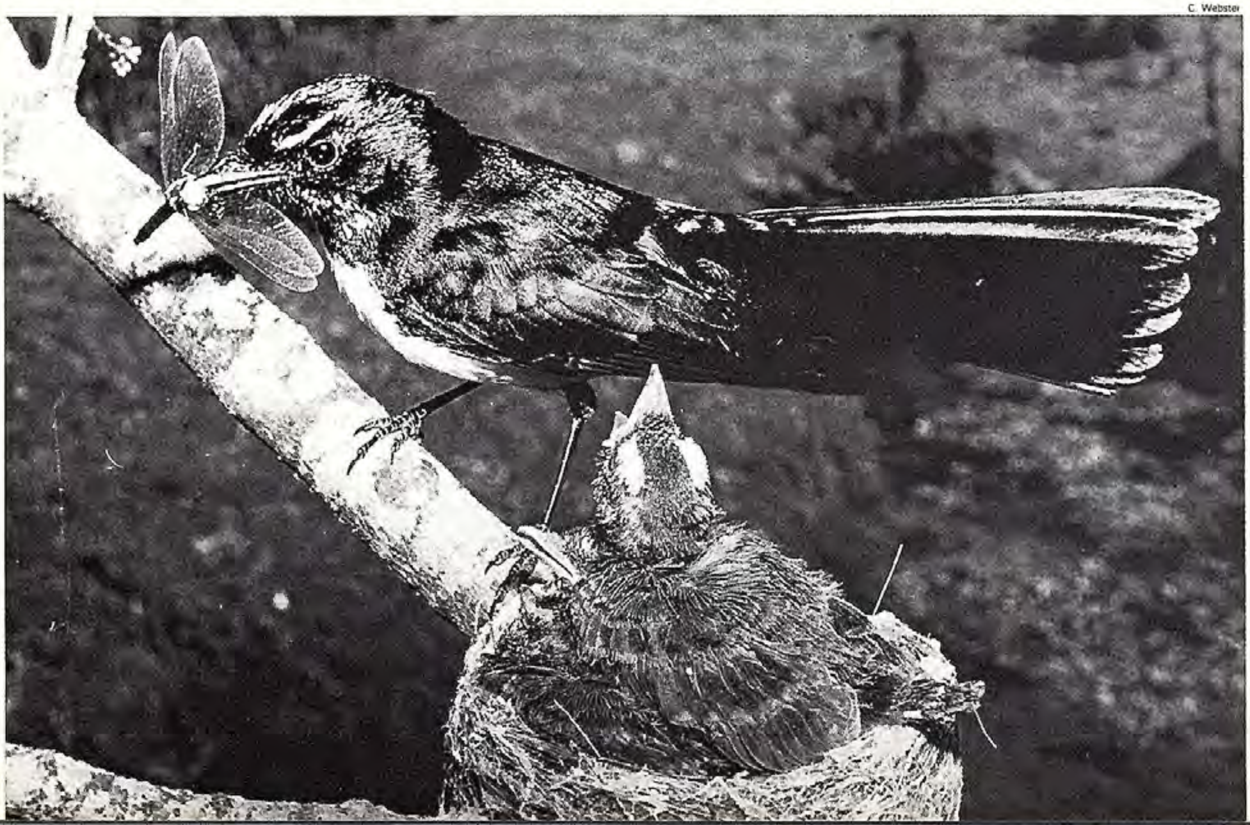
Five Day Creek, the site for the field study of fantail flycatchers.

borne. Tail size and shape also influence bird flight—a large tail when spread out considerably increases 'lift', and birds steer with the tail as well as the wings. Compared with many other small perching birds, the three fantail flycatchers have low wing loads and the Grey Fantail has a significantly lower loading than the other two species. As a result, the Grey Fantail needs to expend less energy to take off and remain airborne. The Grey Fantail's wings and tail are larger than those of the Rufous Fantail although it is a smaller bird in all other respects. These various properties suggest that flight manoeuvrability is potentially more important to the Grey Fantail than it is to the Rufous Fantail.

Although size, shape, colour and aerodynamic characters can be compared in museum collections of preserved birds, by themselves they reveal little about the haunts and habits of the living animals. To explore the ecology of the *Rhipidura* genus, the author studied Grey and Rufous Fantails and Willie Wagtails in the field over a three-year period.

The Five Day Creek valley on the Macleay River watershed in northeastern New South Wales was the main study area. Although the three species occurred there, some major differences existed between their populations. The Rufous Fantail, a summer migrant, was only present between October and March. It started nesting about three months after the Willie Wagtail and Grey Fantail. Some individuals of the latter two species were present throughout the year, but a portion of their populations left the area in winter. In summer, Grey Fantails were almost three times as abundant as the other two species. All three birds defended territories from others of their species during the breeding season and Willie Wagtail territories were two to three times larger than Grey Fantail territories. There was very little aggression or other apparent interaction between species. Because of these yearly fluctuations, the fantail flycatchers were studied most intensively between October and March, when all three species were present, population levels were high and breeding occurred. At this time it could be expected that potential competition for resources would be most intense.

At the Five Day Creek study area there was a mosaic of natural and disturbed vegetation habitats varying from grassy paddocks and eucalypt woodland to regenerating rainforest. Twelve habitats could be distinguished on structural features. In four, the dominant plant stratum (grass, bracken or shrubs) was less than two metres tall and there were fewer than 100 trees per hectare. In contrast to these 'open' habitats, the remaining eight had 'closed' canopies with more than 100 trees per hectare and a dominant stratum of trees or shrubs taller than two metres. Over the three years of observations, Grey Fantails were seen in all twelve habitats, Rufous Fantails in



C. Webster

Willie Wagtail presenting a dragonfly to nestlings. Note the larger, shallower nest which lacks a tail; cow—and horse hair are used in its construction.

nine (which collectively covered about thirty-five per cent of the area) and Willie Wagtails in only seven (which, however, accounted for sixty-five per cent of the area). Each species was seen regularly in only four or five habitats and here emerged marked differences in preferred habitats.

The Rufous Fantails frequented 'closed' habitats of forest and woodland. These areas had dense broadleafed tree and shrub strata, more than fifty per cent canopy cover, low light intensities and sparse ground cover. In contrast, Willie Wagtails concentrated in open habitats in which a canopy was sparse or absent and light intensities were consequently high. Trees, predominantly eucalypts, were scarce and the ground cover was usually a grass sward. The habitat preferences of the Grey Fantail ranged from closed regenerating rainforest to grassland—the most open of all the habitats. In these preferred habitats the birds nested, roosted and performed most of their feeding, maintenance (preening, resting etc.) and social activities.

Activity of the fantails was concentrated in the lower levels of vegetation. However, whereas eight-five per cent of the Willie Wagtails observed were less than six metres above the ground and were often perched on the ground in the open, Grey Fantails used vegetation strata more evenly, ascending to the tops of the tallest eucalypts but rarely alighting on the ground. The Rufous Fantail was most frequently seen in the forest understorey and amongst shrubs and bracken, from ground level up to ten metres. Where Grey and Rufous Fantails were seen in the same patch of rainforest, the former generally flew about the foliage tips of the emergent trees whilst the latter flitted through the undergrowth.

Rufous Fantail at its nest. The nests of both fantails are made generally of bark fibres, grasses and rootlets bound together with cobweb.

N. Fenton

Each species had a characteristic repertoire of feeding strategies. Both stationary and active hunting techniques were employed. When stationary hunting, a bird remained perched for a long period while it carefully searched its distant surroundings for flying prey. Active hunting birds were constantly on the move in search of prey which was by contrast, usually stationary. Insect prey was caught by three types of manoeuvres—hawking a flying insect while the bird was on the wing, hovering to take a stationary insect from a surface such as a leaf, and pecking an insect while it and the bird were more or less stationary on the same surface, such as a log or the ground. Hawking was the principal feeding manoeuvre of all three species.

The Grey Fantail fed most consistently in the open air. Seventy-five to ninety-five per cent of its manoeuvres were hawking flights, and it had the highest feeding rate (one to four manoeuvres per minute). It sometimes hunted actively for food as it moved through foliage, but more often employed stationary hunting from lookout perches such as the tips of foliage or dead twigs and branches. The Rufous Fantail was predominantly an active hunter within foliage and eighty per cent of its hawking manoeuvres were less than thirty centimetres from vegetation. Up to thirty per cent of manoeuvres by this species were pecks and hovers. Its feeding rate was intermediate between those of the two other species but it was more constantly on the move, hopping from one branch to another and rarely returning to the same perch. The Willie Wagtail spent much time feeding on and close to the ground where it employed stationary and active hunting strategies. The time intervals between feeding manoeuvres were longer for this species; it averaged less than one manoeuvre per minute. Like the Rufous Fantail, up to thirty per cent of the Wagtail's manoeuvres in summer were pecks and hovers. In winter, when it fed almost exclusively on the ground, pecking was the most common method of catching prey.

When actively hunting, the Grey and Rufous Fantails both adopted a posture in which the wings were drooped very low and the tail was held at an angle of 120° to the back and fanned open; occasionally the wings were flicked half open and closed again. The active hunting posture had the effect of greatly increasing the apparent size of the bird and of the shadow it cast.

A Grey Fantail while actively hunting, often moved through the foliage of the outer crown in a series of short hops and flights, interspersed with hawking and hovering manoeuvres. When a Rufous Fantail hunted actively the ratio of hops to flights was higher than in the Grey Fantail's progress. Sometimes a Rufous Fantail flew up to hawk or hover close to leafy twigs or near a trunk and occasionally it pecked at small prey items in clusters of dead leaves. The upward direction of movement was frequently interrupted by a sudden tumbling drop when the bird fluttered downwards five or six metres like a leaf and came to land on another branch directly below. Steep dives after which the bird returned to an elevated perch, were also common. Downward tumbles and dives were more common in this species than in the Grey Fantail, and in the latter were associated mostly with stationary hunting. The active hunting posture and movements of the fantails appear designed to 'scare' hidden insects into movement or to dislodge them from twigs or foliage so that they became visible and accessible to the birds.

Active hunting by the Willie Wagtail was common only on the ground. The bird covered twenty metres or more in a zig-zagging series of runs, hops and low sweeping flights when actively hunting. Characteristic of these sorties were wing-flashing and tail-fanning movements which usually occurred simultaneously. They were executed when a bird stood alert and upright before a run or flight, or immediately afterwards, when they preceded a peck on the ground. These postures resembled the active hunting postures of the other fantail flycatchers but they were not maintained. They increased the apparent size of the bird and its shadow and also probably startled prey into movement.

When stationary hunting, the Grey Fantail sat alert and constantly looked about and turned around on the perch. Periods of searching were terminated by sudden flights in pursuit of insects. Three or four flights might follow in rapid succession from the same perch. Using low lookout perches, Grey Fantails performed dives, horizontal sweeps and ascending loops over surrounding shrubbery, grasses, and the flowing waters of the creek. From high lookout perches in blue gums, the birds launched into long hawking flights in the open air which covered distances up to five metres and involved as many as eight changes of direction. A bird appeared to catch a number of small insects in these long flights, and sometimes a column of gnats could be distinguished in the sunlight where the birds were feeding. When a Rufous Fantail occasionally hunted from a lookout perch, most of its feeding sorties were single manoeuvres in the forest under-storey and lower levels of eucalypt woodland. Unlike the Grey Fantail it did not make long multiple-manoeuvre hawking flights outside the canopy.

The stationary hunting posture of the Willie Wagtail was different from that of the fantails. Typically, the bird perched a few centimetres above the ground on a stick, stone or dry cowpat; the plumage was sleeked, tail and wings closed and wings held by the sides but not drooped. A tail wag was often combined with visual scanning so that as the body turned through an angle of about 100°, the tail was raised and swung through a 180° angle in the horizontal plane. When an insect was spied, the bird took off in pursuit, running along the ground with neck extended until it suddenly dived and pecked at the ground or hopped up in the air to hawk the insect above the ground. When stationary hunting from trees and shrubs this species preferred thick, horizontal, often dead, branches close to the bottom of the crown or protruding beyond it. The Willie Wagtail often hovered round the base of tree trunks both living and dead, but unlike the fantails, rarely alighted and hopped up them. Willie Wagtails repeatedly returned to the same perch when stationary hunting; Grey Fantails changed lookouts more frequently.

Association with other species of animals may enhance the feeding success of fantail flycatchers. Grey Fantails were twice seen hawking around cattle (compared with eighty-five records of Willie Wagtails doing so) and on five or six occasions a Grey Fantail hovered round the observer to catch insects attracted to her. This species participated in mixed-species foraging flocks of small birds on twenty-six occasions, mostly in autumn and winter. It is believed that more insects can be located and caught by a noisy bustling flock of birds feeding together but using a variety of techniques, than could be found by the same birds feeding alone. Rufous Fantails were not observed feeding in the company of cattle or bird-watchers at the study area, but on eight occasions they were members of mixed foraging flocks in woodland.

Willie Wagtails often fed in association with grazing cattle and up to fifteen per cent of feeding manoeuvres in summer were executed around cattle. Prey was most often caught in the air close to a cow's head or under its belly. The birds flew along beside moving beasts and hawked insects disturbed by their progress; they also perched on the backs of cows. Willie Wagtails did not obviously feed in association with man or other species of birds at Five Day Creek.

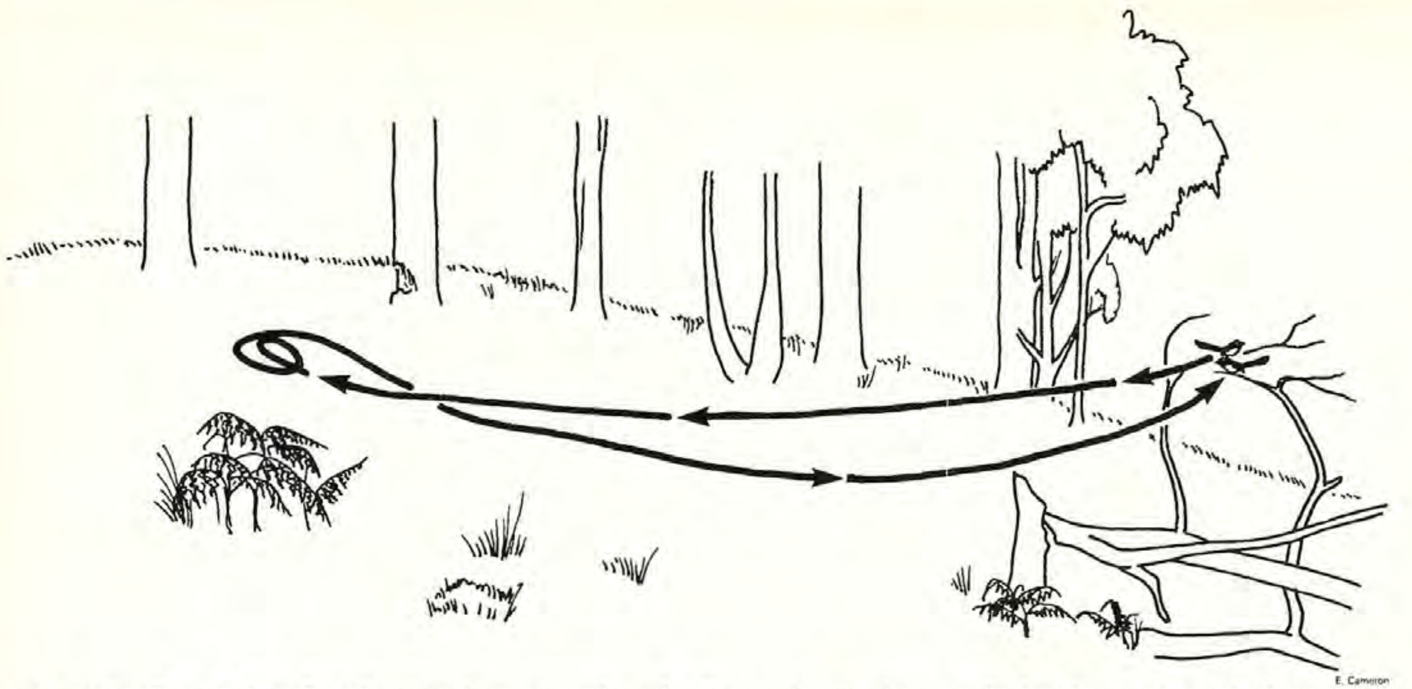
It was difficult to identify the small insects as they were caught and eaten by the birds, so diet was determined largely by examination of stomach contents. Insect remains composed ninety-five to ninety-nine per cent of stomach contents, spiders and one tick making up the balance.


N. Chaffer

Grey Fantail with nestlings. The nests of the three species were usually located in the densest patches of their preferred habitats. All Rufous Fantail and most Willie Wagtail nests were built less than five metres above the ground but half of the twenty three Grey Fantail nests were higher than this.

There was an average of thirty-five insects per Grey Fantail stomach, almost twice as many as were found in the stomachs of the other species. Most food items were two to six millimetres in length and small gnats and midges, and small wasps and winged ants were the most abundant prey items. Two stomachs each contained more than one hundred and twenty-five fragmented winged ants. The small flies and ants often congregate in swarms such as those around which Grey Fantails were observed making long hawking flights.

Prey of the Rufous Fantail was generally larger (two to ten millimetres) but many of the longest insects such as crane flies, provided little bulk. Although Grey and Rufous Fantails ate some of the same insects, the diet of the latter was more varied—few stomachs contained more than one individual of each kind of insect. Whereas insects consumed by Grey Fantails were mostly active



Flight path of a Willie Wagtail hawking a flying insect close to bracken.

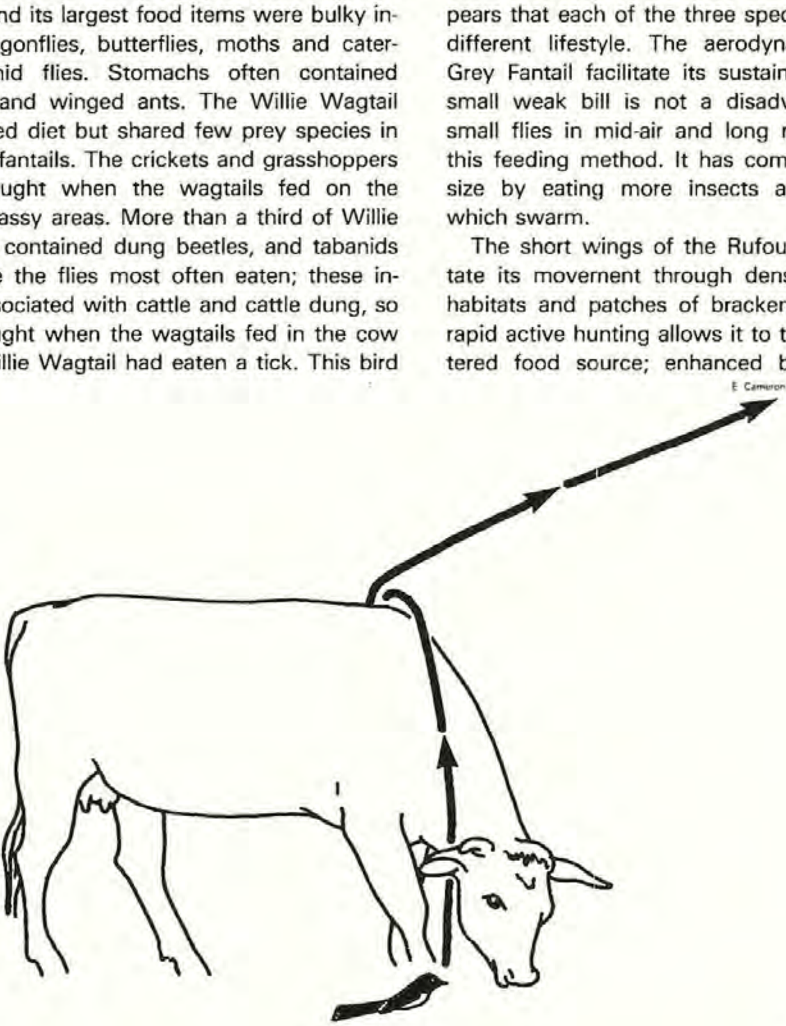
fliers, Rufous Fantails ate a large proportion of rather sedentary animals or weak fliers, such as spiders, bugs and beetles. Rufous Fantails caught many moths and caterpillars in the bracken.

The Willie Wagtail was the only species which caught prey bigger than its bill (insects up to twenty-three millimetres long) and its largest food items were bulky insects such as dragonflies, butterflies, moths and caterpillars, and tabanid flies. Stomachs often contained numerous wasps and winged ants. The Willie Wagtail had the most varied diet but shared few prey species in common with the fantails. The crickets and grasshoppers were probably caught when the wagtails fed on the ground in open grassy areas. More than a third of Willie Wagtail stomachs contained dung beetles, and tabanids and muscids were the flies most often eaten; these insects are often associated with cattle and cattle dung, so were probably caught when the wagtails fed in the cow paddocks. One Willie Wagtail had eaten a tick. This bird is sometimes credited with removing ticks from cattle but its small weak bill seems hardly strong enough to pull off a firmly embedded parasite and it is more likely that engorged ticks are caught as they voluntarily drop off their host.

When all the above observations are considered, it appears that each of the three species has evolved a rather different lifestyle. The aerodynamic properties of the Grey Fantail facilitate its sustained aerial acrobatics. Its small weak bill is not a disadvantage in scooping up small flies in mid-air and long rictal bristles may assist this feeding method. It has compensated for small prey size by eating more insects and feeding on species which swarm.

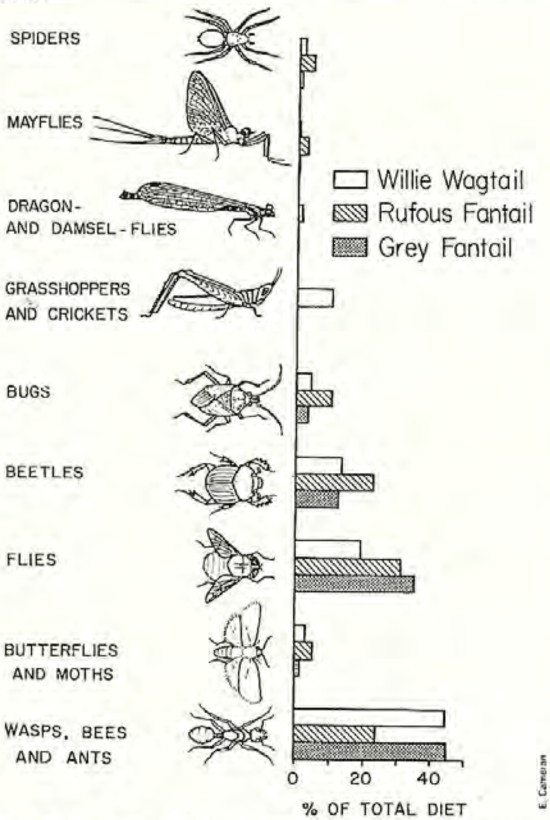
The short wings of the Rufous Fantail probably facilitate its movement through dense foliage in the closed habitats and patches of bracken which it frequents. Its rapid active hunting allows it to take advantage of a scattered food source; enhanced by a posture which in-

Willie Wagtail attending a grazing cow. This bird pecked at insects in grass close to the cow's head, then perched on its back and from there flew to hawk an insect it had sighted from this lookout perch.

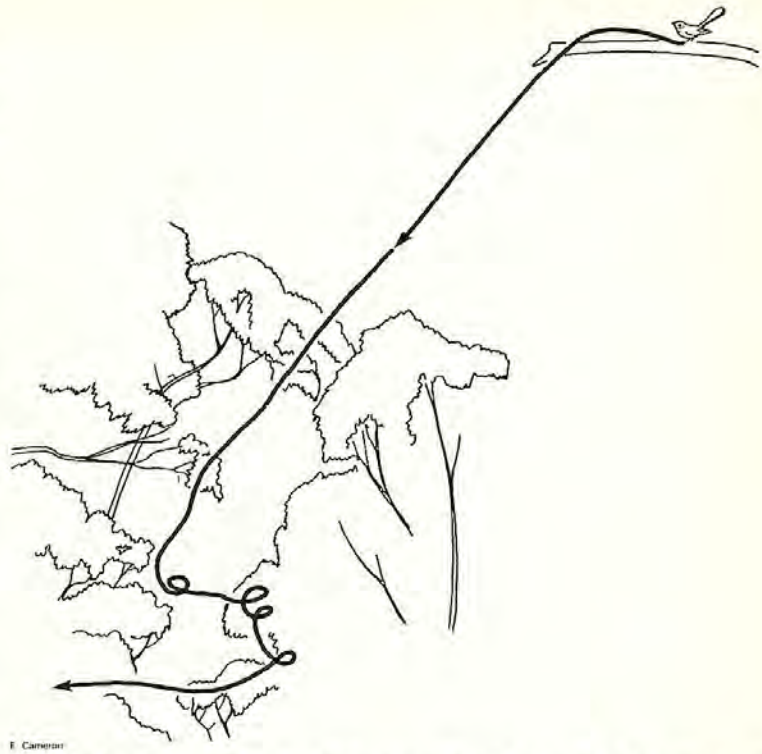


creases the surface area of the bird, this activity flushes many sedentary insects in foliage. That some insects are dislodged by its progress is illustrated by the tumbling manoeuvres associated with active hunting. Other birds in mixed foraging flocks probably perform this same service for Rufous and Grey Fantails. The larger, stronger bill of the Rufous Fantail enables it to peck on solid surfaces and to tackle larger prey.

The Willie Wagtail, the largest and heaviest species, utilizes the most solid substrate. Its longer, heavier bill can peck among stones and against firm earth and it can handle larger, stronger prey. Its low feeding rate and long bouts of scanning from a lookout perch are balanced energetically by the larger prey items it takes. Association with grazing cattle has benefited the feeding success of this species and its terrestrial feeding habits in open grassy habitats bring it into contact with some types of insect prey which are not readily available to the fantails.



The Rufous Fantail and Willie Wagtail have complementary habitat preferences so they rarely come into contact. The habitat preferences of the Grey Fantail broadly overlap with other species but it uses a deeper vertical range of vegetation, so potential competition for food and nest sites at any one level is reduced. The breeding seasons of the Rufous Fantail and its two relatives are staggered so peak demand for food does not coincide throughout the season. In winter when insect food is scarcer, the Rufous Fantails migrate north and some Willie Wagtails and Grey Fantails leave the area on nomadic wanderings. The feeding strategies of the Willie Wagtails and Grey Fantails which remain diverge more than at any other time of the year—the former concentrate on pecking at insects on the ground,



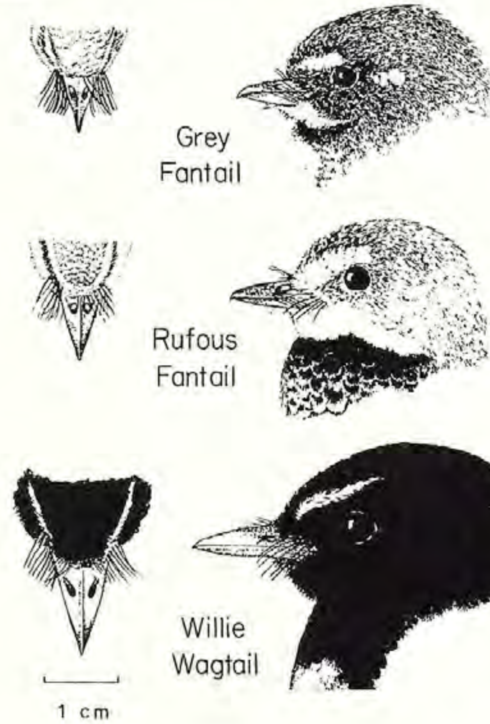
E. Cameron

A long roundabout feeding flight by a Grey Fantail from its elevated lookout perch on a dead branch.

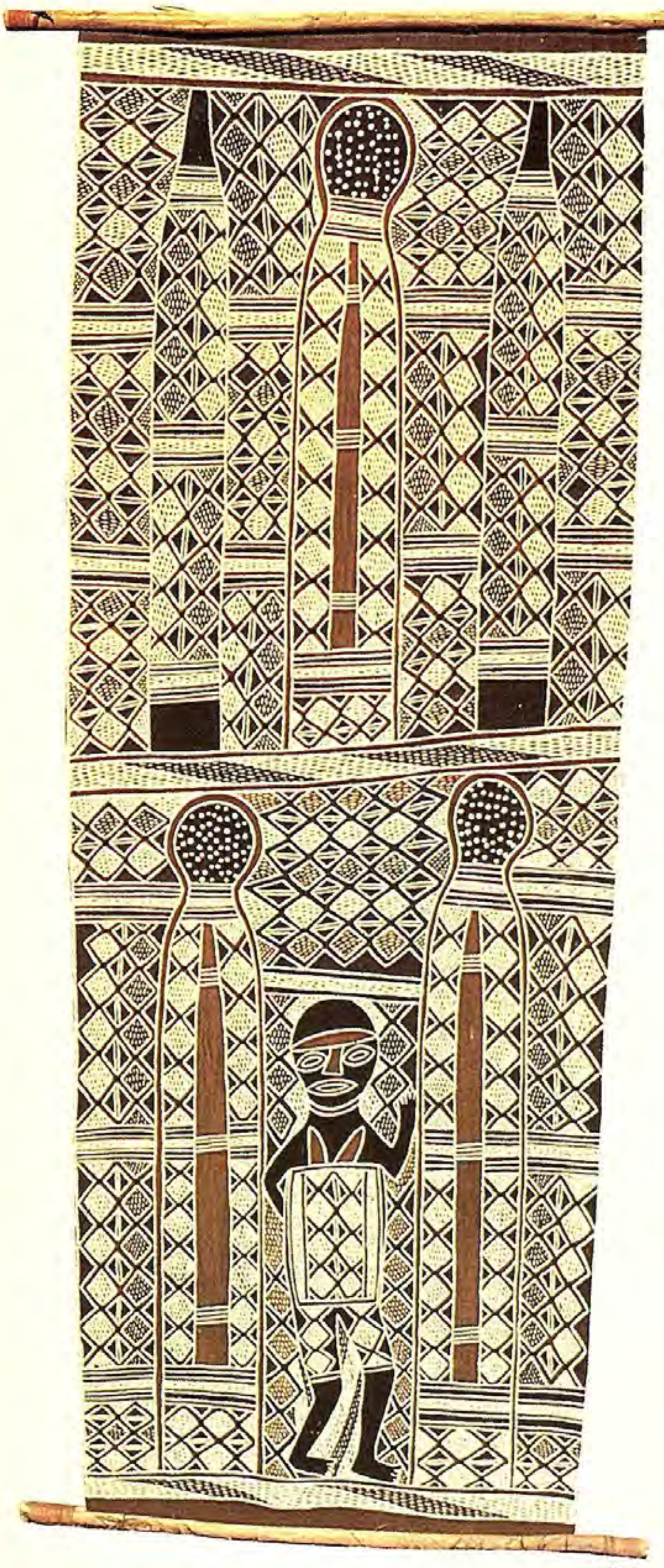
and the latter feed primarily by hawking small flying insects high up in the air around eucalypts.

From the Five Day Creek study it is apparent that the Grey Fantail, Rufous Fantail and Willie Wagtail are able to share the resources of an area by frequenting different habitats, using only some of the available strata of vegetation, and employing a variety of food-searching behaviour which brings them into contact with different types of prey. They have evolved adaptations in body shape and form which improve efficiency in their different lifestyles.

E. Cameron



The tip of the Grey Fantail's bill is very small and narrow and the 'rictal' bristles surrounding it are particularly long compared to the other species.



H. Morphy

Wild Honey Ancestral Being by *Dula Ngurruwuthun* of the *Munyuku clan* of the *Yirritja moiety.* This painting represents a number of sacred objects associated with the wild honey ancestor. The background diamond pattern signifies the cells of the hive filled with honey, grubs and pieces of stick. The human figure represents an Ancestral Being *Lanydjung,* in human form, showing the painting to groups of *Yolngu* (people) by painting it on his chest.

YOLNGU ART

COMMUNICATING IN PAINT

BY HOWARD MORPHY

The majority of people living in northeast Arnhem Land speak one of a set of closely related languages which can be grouped together under the term 'Yolngu' (meaning 'Aboriginal person' in all of these languages). Although this word is used by the people to refer to all Aborigines and not just themselves, it will be used here to refer specifically to the Yolngu-speaking people. There are three large settlements where Yolngu people predominate — Yirrkala, Galiwinku or Elcho Island, and Milingimbi. This article will be concerned mainly with the Yolngu of Yirrkala, where the author spent more than fifteen months living with the people and studying their art.

Yirrkala was founded as a Methodist mission station by the Reverend Wilbur Chaseling in 1935. Situated on the Gove Peninsula in the northwest of the Gulf of Carpentaria, it is twenty-five kilometres from the mining town of Nhulunbuy. The people of Yirrkala are drawn from an area of land stretching from Blue Mud Bay in the south to Arnhem Bay in the west. Today many Yolngu have returned to their traditional lands, living in small communities or outstations which may be as far as a hundred miles away from Yirrkala. The land is owned not by the population of Yirrkala as a whole but by small clans, each of which owns an area of land.

Clans are the most important social groups in northeast Arnhem Land, and it is to their own clan (people belong to their father's clan) and the clans to which they are most closely related through marriage that people owe their primary allegiance. As well as being the primary land-owning groups, clans also own the songs, dances and sacred objects connected with their land.

Paintings are important to clan members in two main ways. They establish links between living clan members and the world of the land—transforming Ancestral Beings who created the land, and they are seen as a charter of ownership. The intricate background patterns, a major stylistic attribute of northeast Arnhem Land paintings, are the unique property of individual clans and are often said to provide the clan with its 'permission' from the Ancestral world to occupy their land. A painting (page 309) by Yanggarriny that belongs to the Dhaḻwangu clan is such an example as it represents a place called Gäŋgaŋ, inland from the Blue Mud Bay. The background pattern of small equilateral diamonds belongs exclusively to the Dhaḻwangu and is thus a sign both of the

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ownership of the painting and of the land associated with it.

Yolngu paintings however are much more than 'title deeds' of ownership; they are objects of ritual power. Indeed it is their power as sacred designs that endows them with authority and enables them to function effectively as title deeds to the land. In order to understand their significance to Yolngu society, one must see them initially not as works of human creativity but as evidences of the actions of Ancestral Beings. Yolngu artists continually stress that the paintings they produce are not their creations, nor designs invented by man, but are forms created by the same Ancestral Beings who defined the contours of their land. These designs were subsequently given to the first human beings who occupied the land and passed on from generation to generation until the present day. In reproducing these designs, Yolngu are able to participate in this process of Ancestral creativity and keep alive some of the power of the Ancestral past.

The paintings are evidence of the reality of the Ancestral World in two senses. In the first sense, as physical forms that are believed to have been produced by the Ancestral Beings, they portray a world that is otherwise beyond the reach of mortal men. Belief in this aspect of their value is enhanced by the way in which they are presented and the rules which surround their ownership and production. They are not mundane objects encountered in everyday life, but objects that are produced primarily in the context of ceremonies, frequently away from women and uninitiated men. The paintings are only produced if senior members of the owning clan and of other clans which have rights in the paintings through marriage, give their permission. To be shown one of the paintings, and, more so, to be taught something of its significance, is a privilege. To be allowed to produce one of the paintings is a sign of a person's incorporation within the group of people with access to knowledge of the painting and such a right endows an individual with a certain amount of authority. A person must earn such rights and privileges by showing himself to be a responsible member of society, by showing willingness to learn the skills needed to produce the painting and by learning the songs and dances that enable him to appreciate the significance of the designs. Failure to fulfil these requirements may mean denial of access to knowledge of the paintings. In such ways as these, paintings are endowed with an aura of significance which reflects the real power over others achieved by a person who gains access to them.

The second way in which paintings are seen to provide evidence of the reality of Ancestral Beings is through the fact that they encode meanings that refer to

H. Morphy

Manbalala by *Bokarra Maymuru* of the *Manggalili clan.* This painting belongs to the clan of *Bokarra's* mother, the *Marrakulu*. The painting shows the river at *Manbalala* flowing from its source at a rock inland down to the sea. The watercourse was made by an Ancestral stringybark tree as it rushed overland to the sea. The geometric designs near the watercourse represent pandanus palms and water goannas play by the banks of the fish filled river.

H. Morphy

:eremonial painting is usually done to the accompaniment of ongs that refer to the journeys of the Ancestral Beings connected with the ceremony. In the foreground a song leader can be seen eating out the rhythm of the songs with wooden clapsticks. Behind him several tiates are having their bodies painted with clan owned designs. Elaborately decorated feather dillybags are suspended from branches above their heads.

events of the Ancestral past. Often they encode meanings that relate both to the topography of the land with which they are associated and to the mythological events which are believed to have shaped that land. To demonstrate this point, it is necessary to look briefly at the Yolngu concept of Ancestral creativity.

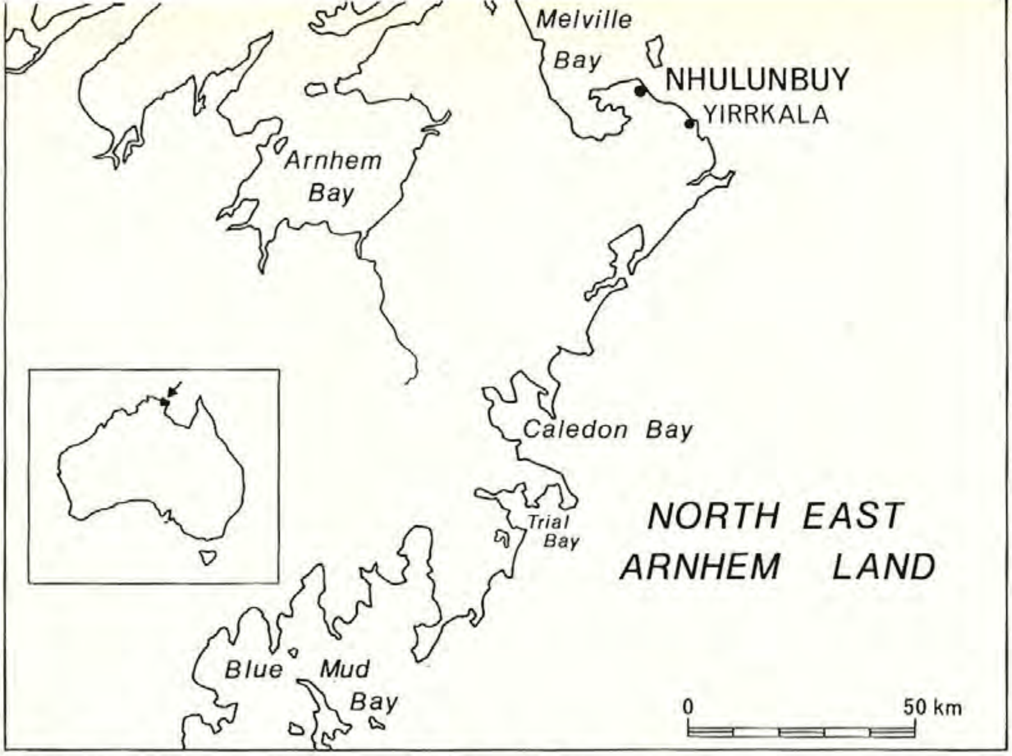
Yolngu refer to the Ancestral past as the 'Wangarr'. The 'Wangarr' was the period of time when the shape of the world in its present form was set. It was a time when superhuman beings travelled across Arnhem Land, creating as they went the hills and valleys, lakes and rivers, rocks and trees that characterise particular places. Where they cut down a tree a watercourse was formed, where they knelt beside a waterhole to drink they left the impression of their hands or feet imprinted in the rock. The Ancestral Beings took many different forms; some were anthropomorphic, others had the shape of plants or animals, others still were inanimate objects such as rocks. They were not, however, bound by the constraints of the everyday world: if they were trees they could walk, and if they were stones they could speak. Furthermore they could change their shape from one form to another. The Ancestral Beings were thus able to transcend the boundaries of the everyday world, dissolving the distinctions between animate and inanimate forms and between one species and the next. As well as creating the form of the world they gave it order by naming the species of plants and animals that they saw on their journeys and by establishing rules of behaviour and cultural practices that they expected the human groups who succeeded them to follow.

An example of this is provided by the painting (page 308) which represents part of the journey of an Ancestral Being, Gandjalala, who hunted for wild honey in the stringybark forests. This painting shows Gandjalala hunting a wallaby through rocky outcrops in the forest. Wherever she found a tree with a hive in it she cut it down to remove the honey. Where the trees fell they created features of the environment, ceremonial grounds and/or water courses. The river at Manbalala, inland from Trial Bay was created by one such stringybark tree that rushed headlong downhill to the sea gouging out the river bed. A painting (page 305) by Bokarra represents the water course and, by implication, the mythological events which formed it. Splinters from the tree shot off into the surrounding landscape creating smaller features where they fell. A mangrove tree found on the beach at Trial Bay is believed to have originated from one such splinter. In such ways, the land becomes a mnemonic for the world of the Ancestral Beings, signifying events that took place on their journeys. The more familiar a person becomes with the features of his environment the more detailed becomes his or her knowledge of the Ancestral past. Paintings play a major role in mediating between experience of the features of the 'real' world and the Ancestral events that led to their creation, by providing concrete objects that link the two realms.

Some designs are believed to be an intrinsic part of the Ancestral Beings themselves. The designs may be those that the Ancestral Beings painted on their bodies, or designs that represent aspects of the physical form of the Beings themselves. Such a design is that of the Yir-

H. Morphy

A memorial post at 'rial Bay, one of a set of three posts set up at Trial Bay during a *Djungguwan-molk* ceremony. Each post is associated with a particular deceased person and signifies the link between that person and the spirit vorld of the Ancestral Beings. The painting this case belongs to e *Marrakulu clan* and epresents fresh water nning through fissues in a rock.



ritja moiety Wild Honey Ancestor Birrkuḏa (page 304). The diamond pattern represents the cells of the hive and the cross hatching within the diamonds signifies grubs and honey, while the vertical bars that subdivide some of the diamonds signify sticks that are found mixed in with the honey. The human figure represents an Ancestral Being in human form with the wild honey design painted on his chest as he teaches people the design.

The Wild Honey Ancestor is however, a complex concept, for it consists of the whole set of things associated with wild honey, its collection and its use, the hive, the bees, the hollow trees in which the hives occur, the hunter searching for the hive and the smoke used to drive the bees out of the tree. The Wild Honey Ancestor consists of all these things or possesses all these aspects, which may be referred to separately in songs, and which may be manifest in different features of the landscape.

It is ceremonies which provide the main contexts in which art objects are produced and displayed. Paintings are produced on a variety of surfaces—on coffin lids, ceremonial posts, hollow log coffins and preeminently on the human body. Some paintings consist of little more than the casual daubing of the body with red or yellow ochre or pipe clay (page 307) while other paintings consist of elaborate designs requiring many hours of work.

In ceremonial contexts the act of painting is in some senses as important as the finished painting itself. The painting of a coffin for an important person may require several days to complete with two or more people working on it at a time. While the painting is being done, senior men will regularly check its progress and ensure that the design is being reproduced correctly. Yet once the painting is completed the lid will be nailed, often painted side down, onto the coffin containing the body, then the coffin will be wrapped in cloth and the painting not seen again. The finished painting, although it may be important to the dead can certainly not be admired by the living. As far as the living are concerned, what is important is that the painting is known to have been completed.

Most Yolngu paintings are produced either to be permanently hidden as is the case with coffin lids, or are intended to have only a temporary existence, as the case with body paintings, which tend to be wiped off soon after they have been completed. There are paintings, however, that survive much longer as visible forms. Memorial posts and hollow log coffins are intended to last for many years as semi-permanent reminders of a person and the ceremonies associated with his or her death (page 306). Beautifully executed, these posts are not produced primarily for their aesthetic impact, but are a visible means of connecting the dead with the living.

All ceremonial paintings, however simple or complex, are produced with a purpose and are significant components of ceremonial performances. Paintings can be said to have meaning in two senses—their instrumental function which consists of what they are intended to do or the purpose for which they are intended, and their referential function which concerns their relationship with the Ancestral World and what their components are said to signify. Thus the white paint daubed on the dancer's body during a burial ceremony may be said to protect him or her from the ghost of the deceased person—its

H. Morphy

Painting an initiate's body prior to circumcision. A young man can be seen having his chest painted. The painting takes several hours to complete during which time the person must remain still and relaxed.

H Morphy

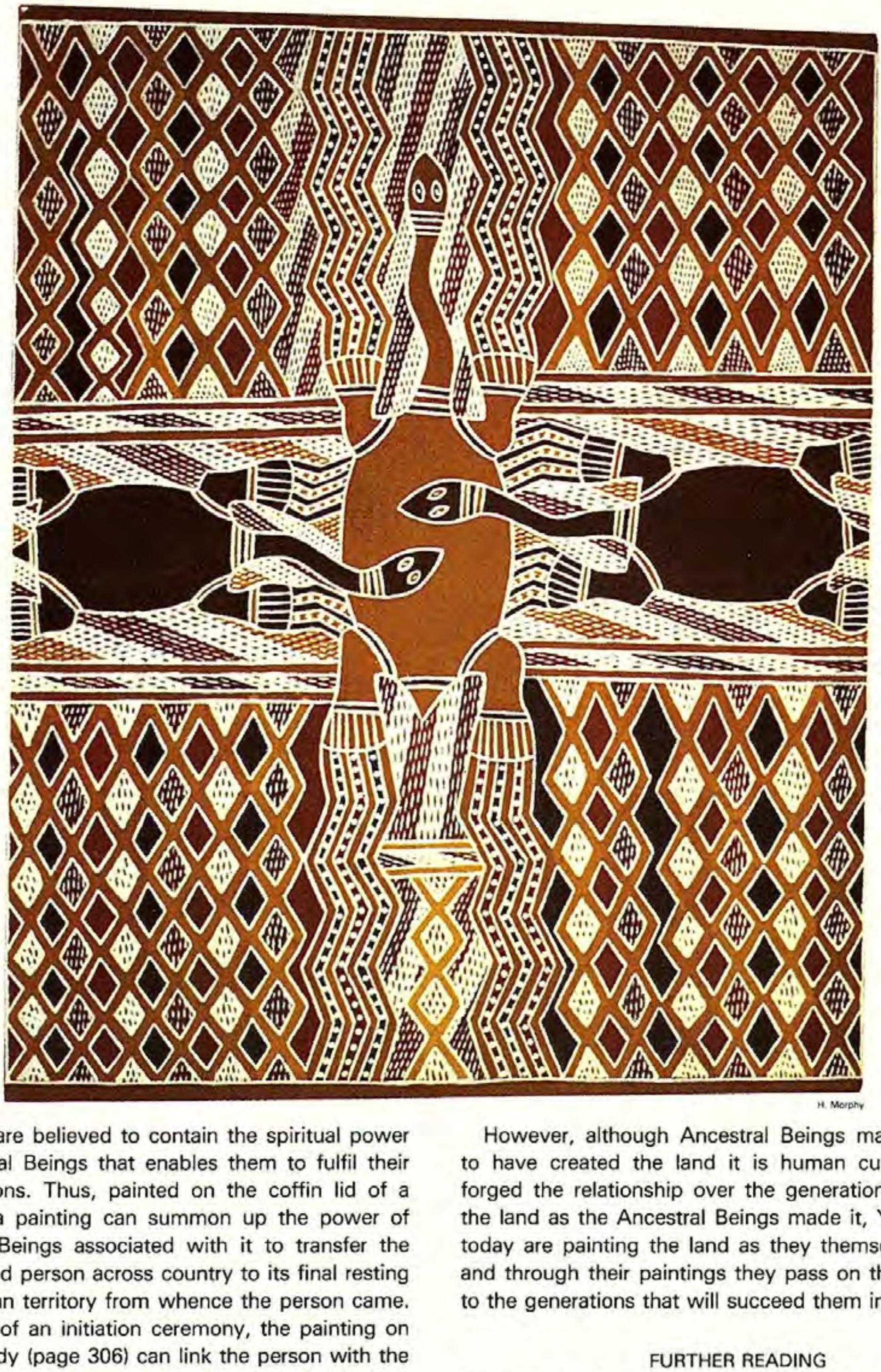
Gandjalala hunting in the forest by *Welwi* (deceased) of the *Marrakulu-Dhurrurrunga clan. Gandjalala* is shown chasing a wallaby through a stringybark forest. In her right hand she holds a spear thrower, in her left hand a spear and around her neck is a dillybag in which stone spearheads, resin and ochre are carried. The oblong and square shaped designs represent rocky outcrops. On her journey *Gandjalala* searched for wild honey.

instrumental function. The painting seen from a different perspective may be said to represent the white capped waves off a particular stretch of the Arnhem Land coast —its referential function.

Yolngu paintings have many different levels of meaning associated with them and the primary meanings may alter depending on the context in which they are produced. White paint on a dancer's body can refer to the white trunk of the paperbark tree as well as the white capped waves. A simple monochrome painting such as this however, does not signify meaning of itself, but has meaning in the context of a ceremonial performance as a whole. Thus, when songs and dances associated with the salt water and with the journeys of Ancestral Beings out to sea are performed, the reference to the white capped waves has priority; when the songs turn to the inland country of swamps and tree lined rivers, then the white paint alludes to the stark trunk of the paperbark tree. The meaning of such simple monochrome paintings arises out of a particular conjunction between the songs, dances and paintings at a specific stage of a ceremony —a conjunction that is the product of the overall theme and structure of the ceremonial performance.

The more complex clan-owned paintings do, on the other hand, encode specific meanings which exist independent of any one context. The Wild Honey design unambiguously represents the Wild Honey Ancestor associated with a particular clan and area of land. However, many of the points previously made with reference to the monochrome painting apply also to the complex clan paintings as they occur in the context of specific ceremonies. Each painting has many layers of meaning associated with it, only some of which may be articulated on a particular occasion.

Although at a most general level, the clan paintings all function as repositories of Ancestral power, the specific uses to which that power is put vary from ceremony to ceremony. One of the main attributes of such paintings is their capacity to symbolically associate an individual with a social group, with an area of land and with the Ancestral Being associated with the land and the painting. It is the potentiality to achieve this together with the



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Freshwater tortoise by *Yanggarriny* of the *Dhaḻwangu* clan. This painting represents a waterhole at *Gäṉgaṉ* in *Dhaḻwangu* country. The tortoises (minhala) are shown emerging from the mud at the bottom of the river with streamers of weeds clinging to their limbs. The waterweed is represented by the zigzag lines, the dots in between them signifying bubbles in the water, disturbed by the movement of the tortoise. The background diamond pattern represents the fresh water flowing through the waterhole in the wet season floods.

fact that they are believed to contain the spiritual power of the Ancestral Beings that enables them to fulfil their specific functions. Thus, painted on the coffin lid of a dead person, a painting can summon up the power of the Ancestral Beings associated with it to transfer the soul of the dead person across country to its final resting place in the clan territory from whence the person came. In the context of an initiation ceremony, the painting on an initiate's body (page 306) can link the person with the clans owning the ceremony, with the Ancestral Beings whose powers are celebrated in the ceremony and with the land that the Beings created.

Yolngu art is a highly complex yet subtle system of communication set within the framework of Yolngu society. If a single theme is transcendent in Yolngu culture it is the relationship between the people and their land. The paintings form a pivotal role in this relationship—the art is seen to come out of the land and in so doing encapsulates the creative forces of the Ancestral World and makes them subject to human influence and direction.

However, although Ancestral Beings may be thought to have created the land it is human culture that has forged the relationship over the generations. In painting the land as the Ancestral Beings made it, Yolngu people today are painting the land as they themselves know it, and through their paintings they pass on this knowledge to the generations that will succeed them in their land.

FURTHER READING

Berndt, R.M. (ed.) *Australian Aboriginal Art,* Ure Smith, 1964.

Groger-Wurm, H. *Australian Aboriginal Bark Paintings and their Mythological Interpretations.* Vol. 1. *Eastern Arnhem Land,* Australian Institute of Aboriginal Studies, Canberra, 1973.

Morphy, H. *Yirrkala Art,* Catalogue for an exhibition, Canberra, 1976.

Morphy, H. "Yingapungapu: ground sculpture as bark painting" In P. Ucko (ed.) *Form in Indigenous Art,* Australian Institute of Aboriginal Studies, Canberra, 1977.

Williams, N. "Australian Aboriginal art at Yirrkala: Introduction and development of marketing," In N.H.H. Graburn (ed.), *Ethnic and Tourist Arts,* University of California Press, Berkeley, 1976.

REBUILDING A GIANT

BY THOMAS H. RICH AND BRENT HALL

During the Pleistocene (1.8 million to 10,000 years ago), a giant goanna stalked the Australian landscape. Known to scientists as *Megalania prisca* (Owen) this extinct lizard grew to twice the length and eight times the mass of its closest living relative in size, the Komodo dragon. In Pleistocene times Australia apparently lacked large mammalian carnivores comparable to lions, tigers etc., found in Pleistocene terrestrial mammalian faunas on other continents. There were large herbivorous mammals in Australia (e.g. adult *Diprotodon optatum*) that would have been potential prey for such large-sized carnivores but they were virtually immune from predation by even the largest known Australian carnivorous mammal. *Thylacoleo carnifex,* a marsupial about the size of a large wolf was, quite possibly, not an active predator at all. This led Professor Max Hecht (1975) to speculate that *M. prisca* might have played the role.

On Queensland's Darling Downs, where most of the known *Megalania* bones have been found, the fossil remains of large, contemporaneous, extinct marsupials are quite common. In the Darling Downs deposits *M. prisca* is extremely rare. This may be partly due to the fact that a predator during its lifetime eats many times its own body mass; thus one expects to find fewer carnivores than herbivores in fossil collections if they accurately reflect the relative numbers of animals in former com-

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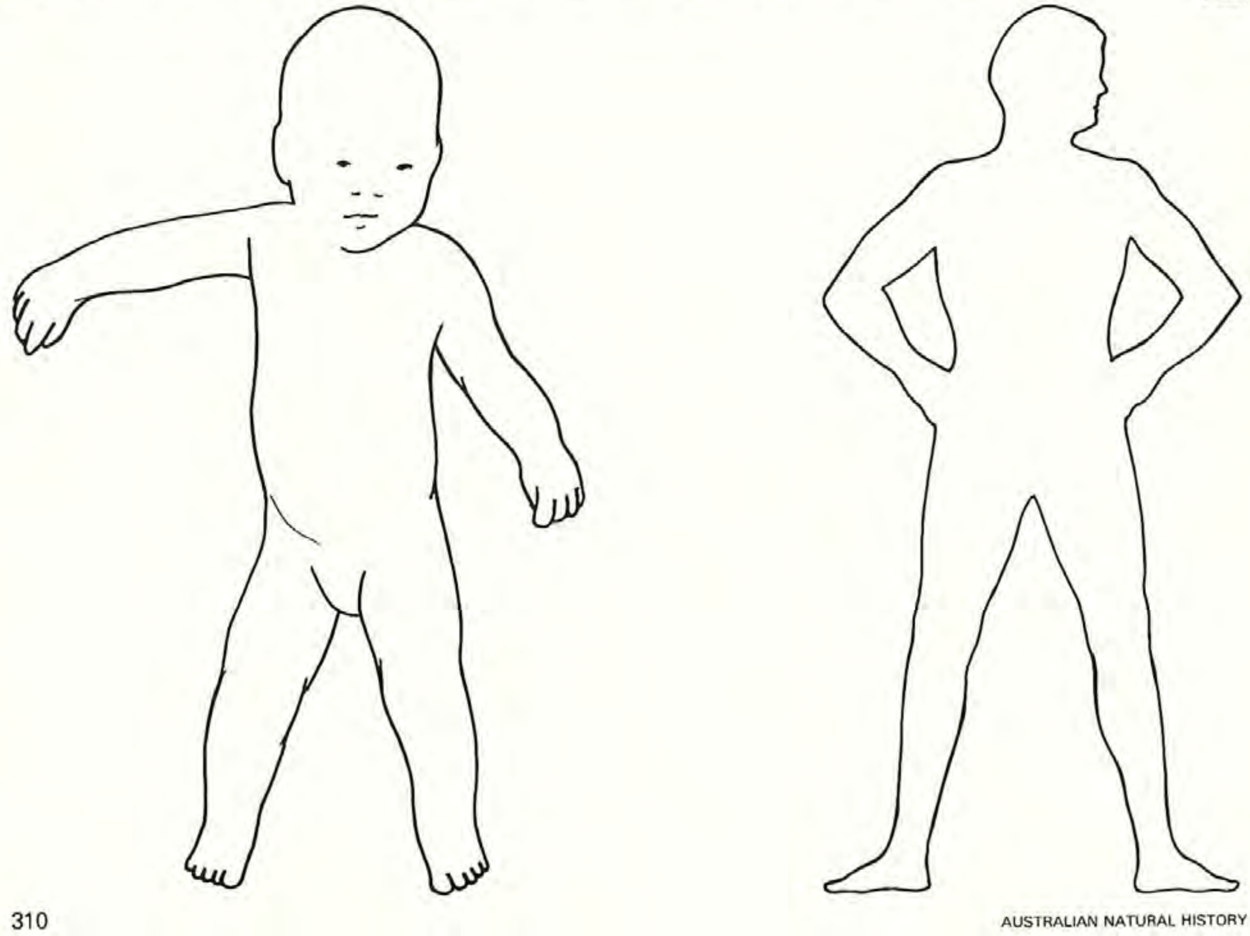

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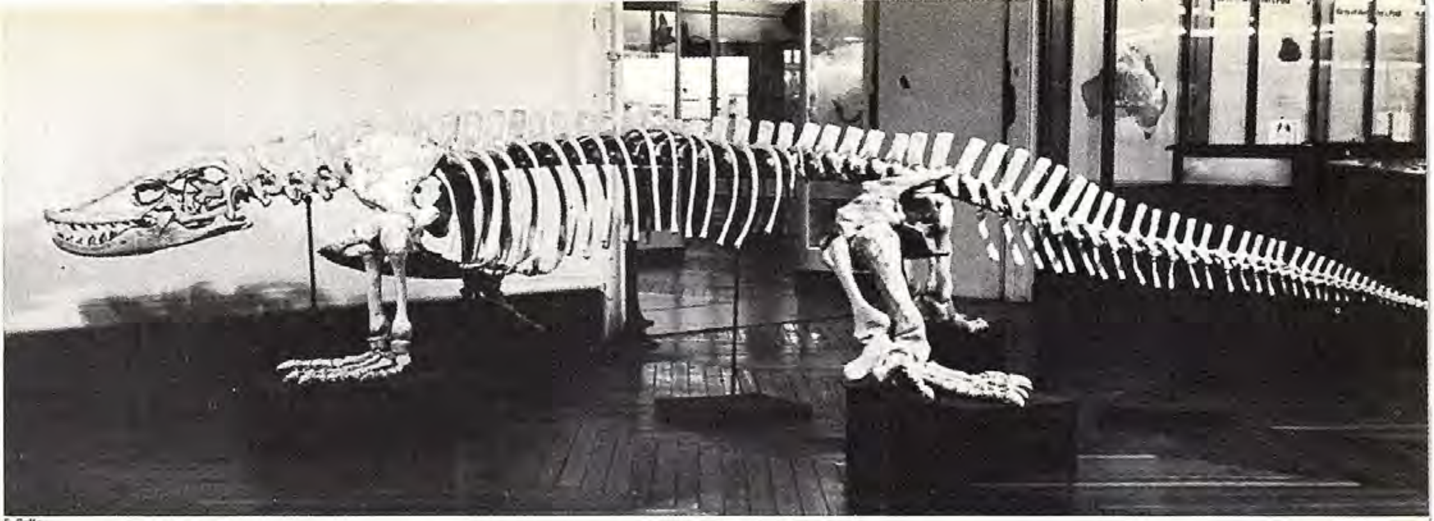
A comparison of the body proportions of an infant and an adult human showing the relative reduction in the size of the head with respect to the trunk as the human grows.


F. Coffa

The reconstruction of the skeleton of *Megalania prisca* Owe[n] 1860. Length: 5.5 metres.

munities. However, *M. prisca* is so rare that there must be some other, unknown factor or factors to explain its extreme scarcity in fossil collections if it actually was a major predator on the large marsupials. Even if the ratio were one predator to one hundred similar-sized prey, more specimens of *Megalania* should have been found. The known material of *M. prisca* consists of one or two partial skeletons (depending on whether the two partial skeletons are actually parts of one individual) and a number of isolated bones, primarily vertebrae from various sites in eastern Australia. The solid black bones in the outline drawing of the skeleton indicate which bones are known from one or more specimens.

In 1974 the National Museum of Victoria decided to reconstruct a full size replica of the skeleton of *Megalania* based on existing material in the Australian and Queensland museums. In order to reconstruct the entire skeleton from the known elements of *Megalania prisca,* it was necessary to infer the dimensions of missing bones from complete specimens of various modern species of *Varanus,* its closest living relative. This could only be done by measuring and analysing the change in proportions of the various skeletal elements relative to one another with increasing size. It is not sufficient simply to double every dimension of a *Varanus komodensis,* the largest living varanid, because increase in size is not necessarily uniform for all dimensions. Just as an adult human is not simply an enlarged version of an infant but differs quite markedly in proportions (with a much smaller head relative to body length for example), a large species of *Varanus* differs from a smaller one in relative proportions as well as overall size. Following such an analysis a reasonable estimate could be made of the principal dimensions of each element in the skeleton of a *M. prisca* of a given length.

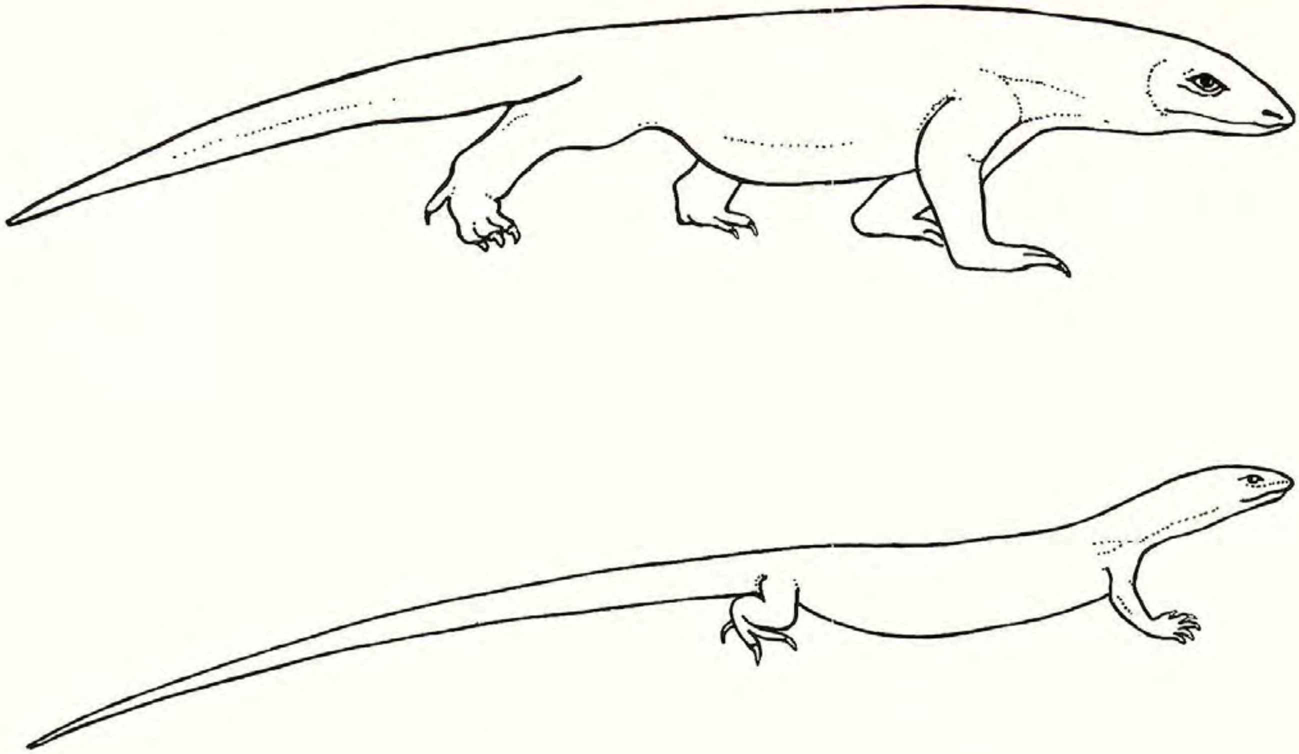
To attempt to account for the changes in proportions with size increase, forty-seven measurements were made on individual skeletons representing various species of *Varanus.* Pairs of measurements were then plotted on ordinary graph paper to see what was the relationship between them. Frequently, a straight line was found to give an excellent fit to the data, indicating that the proportions remained the same or nearly so. However, often a definite curve was seen where the data was plotted on ordinary graph paper and then an attempt was made to see if the points fell in a straight line on log-log graph paper. If a straight line was found to fit the data well on ordinary or log-log graph paper, it was assumed that the relationship would hold in the size range of *Megalania prisca.* For example, when the lengths of the femur and ulna of the same individual are plotted on ordinary graph paper, a reasonable good fit can be made with a straight line drawn through the points. On the other hand, on log-log graph paper, the fit is nearly perfect.

The choice of log-log graph paper as an alternative to ordinary graph paper in such cases is not capricious. Many studies have shown that this kind of relationship is to be expected between different elements of the skeleton as are the ones of constant proportions. (Gould (1966) is an excellent introduction to this area of investigation.) The particular kind of relationship in a given case depends to a large extent on the changes in the pattern of mechanical and physiological demands placed on the skeleton at different sizes.

It was neither practicable nor necessary to plot every possible pair of relationships. With forty-seven measurements taken two at a time, there are 1081 possible combinations. Rather, a net of relationships was worked out as required to specify what each of these forty-seven measurements would be in a specimen of *Megalania prisca* 5.5 metres long. First, head, trunk and tail were estimated by extrapolating their empirically determined relationships with total length. These values in turn were used as bases to estimate other measurements by further extrapolation. At this stage it became possible to check the plausibility of the estimates of skeletal dimensions by extrapolating the relationships of a particular measurement with two or more bases and comparing the answers.

This procedure is far from foolproof. The fact that in many cases, the fit of the data among living species of *Varanus* to a straight line is only a crude approximation at best, is a warning that extrapolating to greater dimensions than have ever been encountered with actual specimens is likely to lead to large errors. As animals change in size, the relationship between two measurements may suddenly be altered at a critical threshold. A set of points may lie along a straight line in one region and then suddenly change direction to form a second straight line over another size range. Thus even where the known range of a pair of measurements plot along a single, straight line there is no certainty that this simple relationship will be maintained in individuals outside the sample size range.

There are undoubtedly minor errors but, whether they



S. Brown

are large or small can be determined only when and if more complete fossil specimens are found. Such a reconstruction is not simply a flight of uncontrolled fancy; the most conservative basis available was used in extrapolating to obtain the required estimates. There is also the very real possibility that someday a skeleton will be

Above: Comparison of the relative trunk and tail length of a small and large species of *Varanus* illustrating the relative reduction in the size of the tail with increased total length. The larger *V. komodensis* above has a total length of 3.0 metres; the smaller *V. eremius* below is 0.4 metres long. Below: Proportions of a wax model of a vertebra are checked with special instruments.

F. Coffa

found complete enough to provide a check.

Once the dimensions of the different bones had been decided upon, the next step was the construction of the individual skeletal elements. Each bone was first modelled in wax. The size specification—guidelines used to reconstruct the skeleton represented only a small fraction of the information actually needed to reconstruct the animal. It was constantly necessary to compare the details of the actual bones with the models being built. In the case of the skull, only the length, width and height were specified in the general plan. All the individual bones had to be fitted into these dimensions. Only small portions of the braincase and upper jaw were known and the remaining dimensions had to be extrapolated from the skull of a Komodo dragon. Once the individual bones of the skull were modelled, they had to be modified until they fitted properly with respect to one another.

When the wax model was completed to our satisfaction, a mould of it was then made and a cast either of epoxy resin or polyurethane foam was poured. The individual elements were then assembled on a steel frame and wooden stand, ready for public display.

Although the primary function of this reconstruction was to have a display specimen of the most plausible reconstruction of *Megalania prisca* currently possible, it will serve another purpose as well. In 1962, Professor T.H. Frazetta published an analysis of the motion of the various elements of the skull of *Varanus* with respect to one another. His original study was carried out using two dimensional paper cutouts of the different skull bones. Using a cast of the skull of *M. prisca* in which the individual elements are able to move with respect to one another, Professor Frazetta will be able to test his ideas with a three dimensional model.

Thus, for the twin purposes of display and scientific study, a reconstruction of the largest known terrestrial predator that lived in Australia during the Pleistocene, *Megalania prisca,* has been made through examining the scanty fossil evidence available and filling in the missing pieces by extrapolating from its nearest living relatives.

F. Colla

An epoxy resin cast of the lower jaw of *Megalania prisca* is removed from its mould.

FURTHER READING

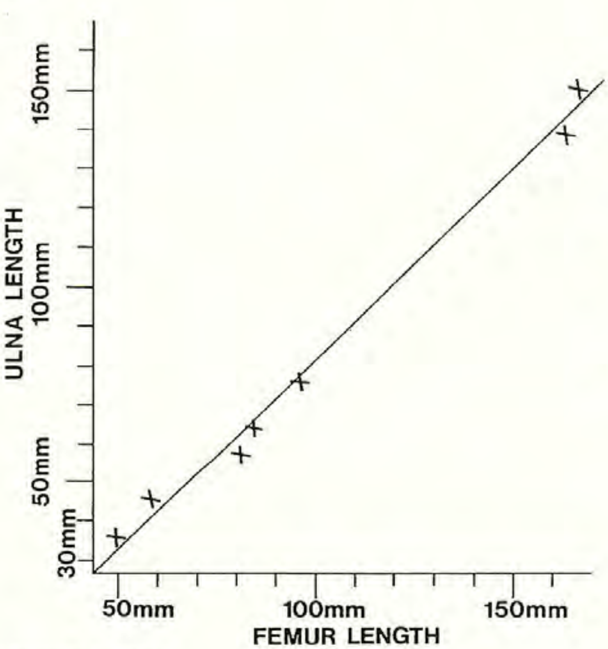
Frazetta, T.H., 1962. A functional consideration of cranial kinesis in lizards. J. Morph. 111:287-319.

Gould, S.J., 1966. Allometry and size in ontogeny and phylogeny. Biol. Rev. 41:587-640.

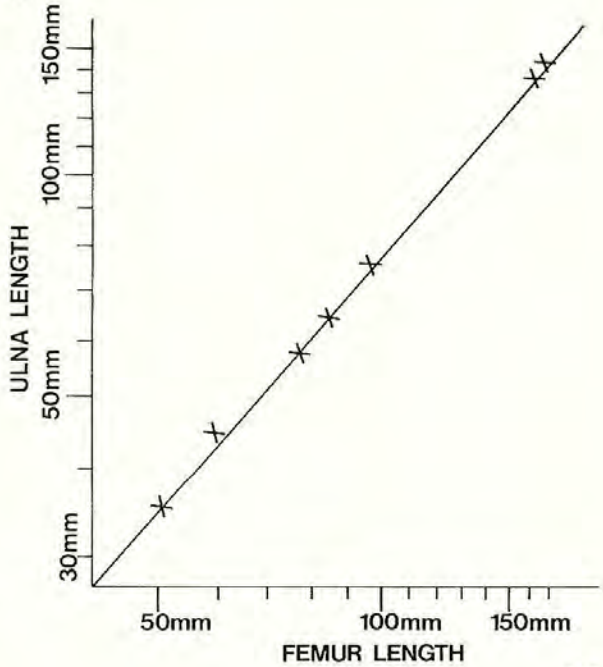
Hecht, M.K., 1975. The morphology and relationships of the largest known terrestrial lizard, *Megalania prisca* Owen, from the Pleistocene of Australia. Proc. R. Soc. Vict. 87:239-250.

Left: Femur length against ulna length in modern species of *Varanus* plotted on ordinary graph paper. Right: The same data plotted on log-log graph paper.

S. Brown



S. Brown



R. Jenkins, ANPWS

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AUSTRALIAN ENDANGERED SPECIES. MAMMALS, BIRDS AND REPTILES, by Derrick Ovington, *Cassell Australia, 1978, 183 pages, illustrated, $19.95.*

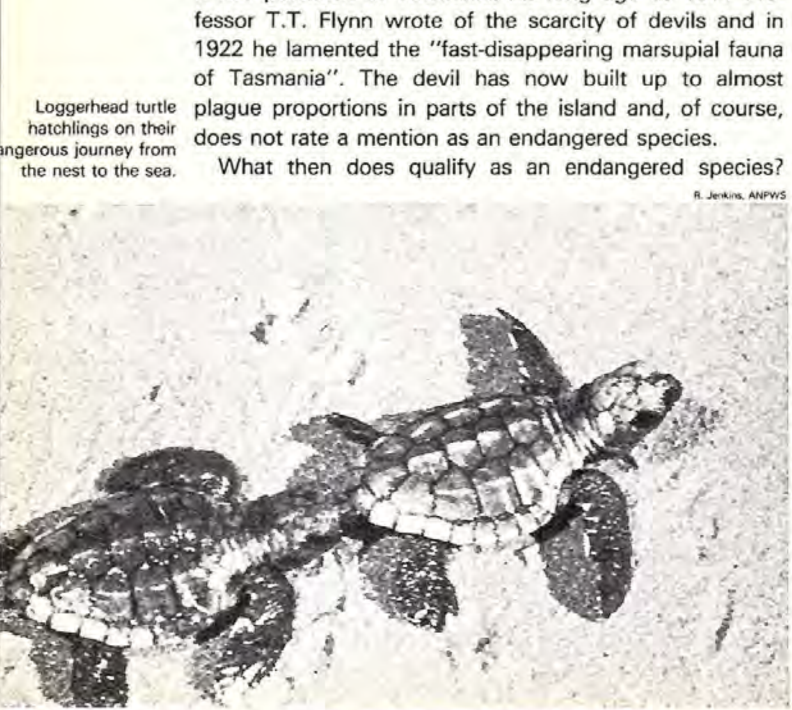
Derrick Ovington is Director of the Australian National Parks and Wildlife Service, an organisation which was established in 1975. Amongst its other duties the Service works with the State and Territorial wildlife services to recommend Australian species to be included in the appendices to the Convention on International Trade in endangered species of Wild Fauna and Flora. However a careful perusal of the descriptions of forty-three forms of mammal, bird or reptile included in the endangered list does not seem to suggest that trading has had much to do with their present rarity. European man must take most of the blame even though some species just pass quietly into limbo without leaving descendant species.

The thylacine was already extinct in New Guinea and on the whole of mainland Australia when European man arrived. Did the Tasmanians do any more than just nudge it a little faster towards an inevitable end? The devil (*Sarcophilus*) disappeared from the mainland a few hundreds of years before the arrival of European man but it has persisted in Tasmania. As long ago as 1911 Professor T.T. Flynn wrote of the scarcity of devils and in 1922 he lamented the "fast-disappearing marsupial fauna of Tasmania". The devil has now built up to almost plague proportions in parts of the island and, of course, does not rate a mention as an endangered species.

What then does qualify as an endangered species?

Loggerhead turtle hatchlings on their ngerous journey from the nest to the sea.

R. Jenkins, ANPWS



Professor Ovington says that not all species regarded as endangered are included because of the difficulty of reaching agreement about the precise meaning of 'endangered'. If the pig-footed bandicoot (not sighted for over fifty years), desert rat kangaroo (missing forty-seven years) and thylacine (last positively identified specimen died in captivity forty-five years ago) are not to be regarded as extinct then why not include toolache and brown hare wallabies on the endangered list? The last authentic record of the toolache was in 1927 about the same time as the last pig-footed bandicoot was seen. It took over fifty years to rediscover Leadbeater's possum after it went 'missing, presumed extinct' and when the parma wallaby was found on Kawau Island (NZ) sundry persons talked of 'reintroducing it to its old haunts' where it had not been seen for above thirty years. Can we be sure that all is well with these last two species—the first living in a fragile habitat and the latter with, at best, a greatly diminished range?

The bilby, or rabbit-eared bandicoot, was moderately abundant at the time of European settlement and its skins were marketed early in the present century so trade may have contributed to its present rarity. It also fell victim to the traps set to catch the vermin which nostalgic colonists imported from Europe. Another species of rabbit-eared bandicoot, the yallara, may be extinct. Grazing practices, competition from rabbits and predation by foxes are thought to have spelled the doom of that interesting example of convergence with ungulates, the pig-footed bandicoot.

Perameles bougainville, one of the barred bandicoots, is now apparently confined to Bernier and Dorre Islands in Shark Bay, Western Australia. These islands are also the last refuge of a banded hare wallaby population which had a wide distribution in Southwestern Australia and may have extended to South Australia. Lesueur's rat kangaroo, which once had an even wider distribution than the banded hare wallaby, also finds refuge on Bernier and Dorre as well as on Barrow Island. The western hare wallaby does persist in the Tanami Desert but it also appears to be secure only on Bernier and Dorre Islands. Other endangered species now found only on islands include the stick nest rat and the Shark Bay mouse.

Islands also provide the only refuges for seven of the

ENDANGERED ANIMALS UPDATED

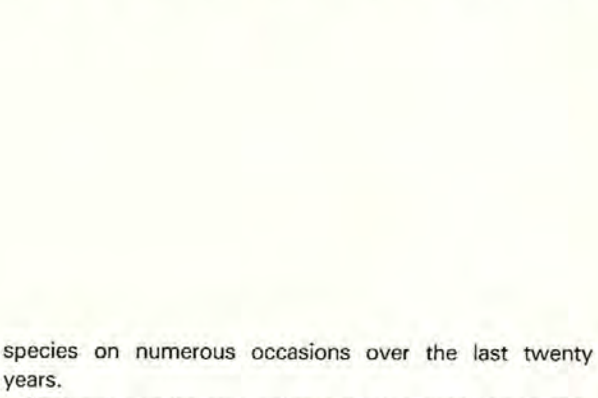
eighteen listed endangered birds although some of these, such as the Lord Howe Island woodhen, are endemic to the island where they occur. Others are subspecies of species not endangered in other places.

The overall lesson seems to be clear (the following is however my viewpoint and not necessarily that of Professor Ovington). Generally speaking those islands which now provide refuges for the remnants of once widespread animals have suffered less from the ravages imposed by European man than have many parts of mainland Australia. A variety of reasons are evident: the islands may be remote, difficult of access, short of water, not suitable for 'development' or may not have attracted the introduction of pest or feral animals. There are numerous other islands which have lost much of their native fauna because of exploitation usually combined with the introduction of rats, rabbits and other vermin.

Australian Endangered Species has chapters on People and Wildlife, History of Extinction and Wildlife Biology and gives a Conservation Chronology detailing significant events affecting wildlife. Professor Ovington is properly cautious about attributing pre-European extinctions to hunting by Aboriginal people but he does think their use of fire could have endangered and possibly exterminated some species. Understandably, he is also cautious about the value of some research which is done in the name of conservation. All practising scientists are aware of the difficulty of finding relevant information amongst the mass of books, journals, reports, etc. which now clutter the libraries and Professor Ovington is no exception. However after saying how difficult it was to compile information on Australian endangered species he is chary about saying where he got the information. The descriptions of endangered species are based on leaflets already issued by the National Parks and Wildlife Service but the references to research publications which accompanied these are not included. A general bibliography is given but the reader will search in vain for the source material on which much of the book is based. Readers of *Australian Natural History* may recognise the essential similarity of Tables 1 and 2 (pp. 42-43) to Tables which appeared in an article by Dr J.H. Calaby in *Australian Natural History,* Vol. 19 No. 2, 1977 but Dr Calaby does not get a mention except as a joint author of a book on kangaroos. He has written about Australian endangered species on numerous occasions over the last twenty years.

No book can be up to date and few avoid some mistakes. This one is no exception. The 'sugar glider' pictured on page 20 is a feathertail. On page 47 it is stated that the reintroduction of parma wallabies may be accompanied by the introduction of a viral disease which affects other marsupials (this is but one of the statements which should have a source reference). However the parma virus is not something they brought from New Zealand because marsupials from all over Australia have antibodies to it, indicating that it has long been endemic. Indeed it was at first thought that the parmas may have lost their resistance to the virus during their century plus of New Zealand residence and hence were susceptible on arrival home but antibodies also occur on Kawau Island. Attempts to keep the bridled nail-tailed wallaby under artificial conditions (p. 68) *have* been successful. None would disagree about the endangered status of *Caloprymnus campestris* (p. 80) but I've not met anybody who seriously thought it represented "the primitive ancestral stock of kangaroos" as is stated.

A. Fox, ANPWS



Egrets used to be killed for their plumes.

The above are but minor criticisms of a book which is well researched, beautifully illustrated and nicely produced. It should be required reading for all students of conservation and especially for those who lament the present 'destruction' of the larger species of kangaroos. None of these are endangered and, as Professor Ovington states, some have had their chances of survival enhanced by current grazing practices.

In his Chapter on Conservation Action Priorities, Professor Ovington courageously undertakes to write on conservation management, research, education, fund raising and national and international legislation. Professionals amongst his readers who have watched shows devoted to wildlife will no doubt find agreement with the following statement (page 158) about Australian media—"At times the accuracy of information is dubious and the treatment of the subject is confused. Often dominated by spectacular or highly emotive viewpoints, media presentation of wildlife is not always conducive to the establishment of sound attitudes. People may feel disappointed that in real life they are unable to see wild animals as readily as skilled naturalists who appear on television and sometimes operate in contrived situations".—*G.B. Sharman, School of Biological Sciences, Macquarie University.*

THE VOYAGING STARS—SECRETS OF THE PACIFIC ISLAND NAVIGATORS, by David Lewis, *Collins, 1978, 208 pages, illustrated, $8.95.*

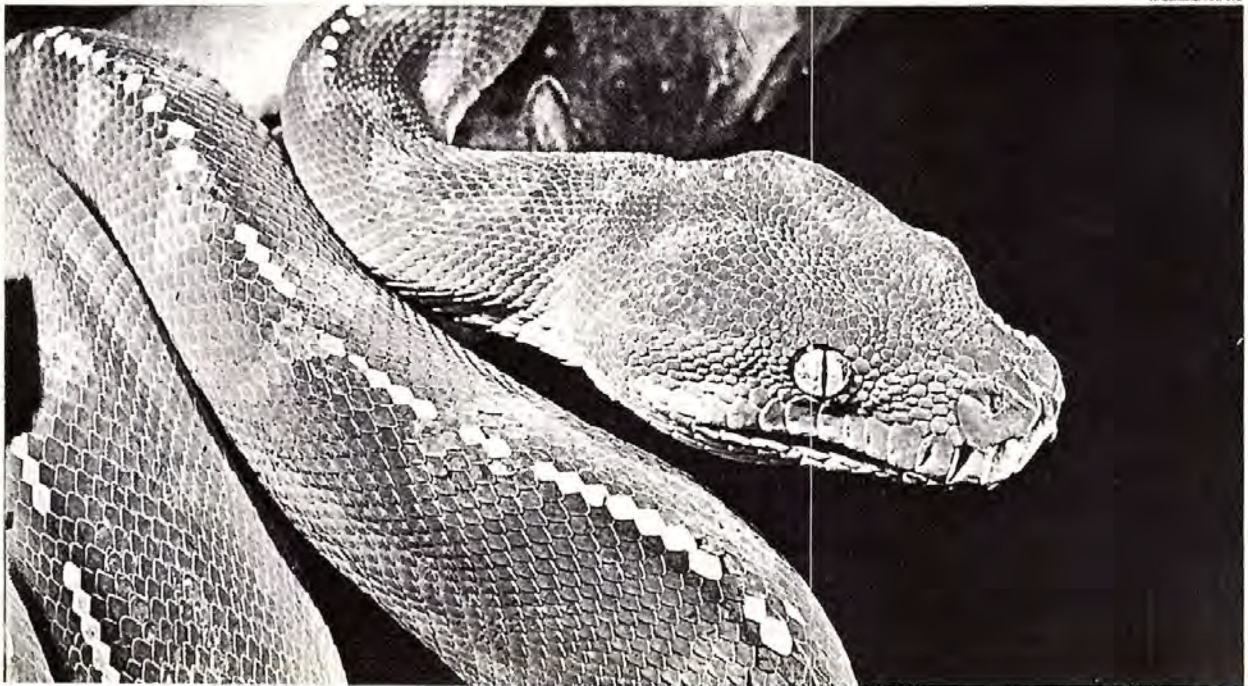
The late Andrew Sharp really set the cat among the pigeons when he challenged perceived wisdom about the abilities of Polynesian navigators. The resulting argument raised many important points and forced all to be less willing to accept statements at face value. Perhaps most significant was the revelation of how little is known of traditional navigational techniques in the Pacific. While others were content to lament the passing of this knowledge, David Lewis decided to discover to what extent this was true. As he revealed in his previous book *We, The Navigators* (ANU Press 1972), the craft of long distance navigation without instruments is far from dead in the Pacific. In some areas colonial administrations banned long sea voyages on safety grounds; elsewhere, motorised vessels replaced sailing canoes. But in almost all of the Pacific areas which Lewis visited, traditional sailing lore is still remembered, though with the passing of time by fewer people. Lewis' writings attempt to record this lore before it vanishes.

In various parts of the Pacific, Lewis asked those recognised as holders of navigational knowledge to undertake instrument-free voyages to known islands either on his own yacht or in sailing canoes. Irrespective of craft or conditions, the success rate was perfect, even in areas where the particular voyage had not been undertaken in the navigator's adulthood. The accuracy with which landfalls were made, even on low-lying islands of tiny size, can only be described as astounding. It is not simply a matter of knowing the stars, but also an ability to 'read' the motion of the sea and the movements of various birds, and to interpret clouds, winds and currents; in fact, the ability to bring together information from many different sources which may be 'invisible' to the average person who knows *only* the land. To many non-sailors, some of the clues may seem incredible, possibly *post hoc* rationalisations. Sceptics there may be, but, as the saying goes, 'once you've seen it, you've got to believe it'. I remember my own amazement in 1977 when I saw for the first time the reflection of an atoll lagoon in the clouds. The reflection really does occur, and must be an invaluable aid to the navigator seeking landfall on islands which, even with coconut palms, do not have elevations exceeding twenty metres.

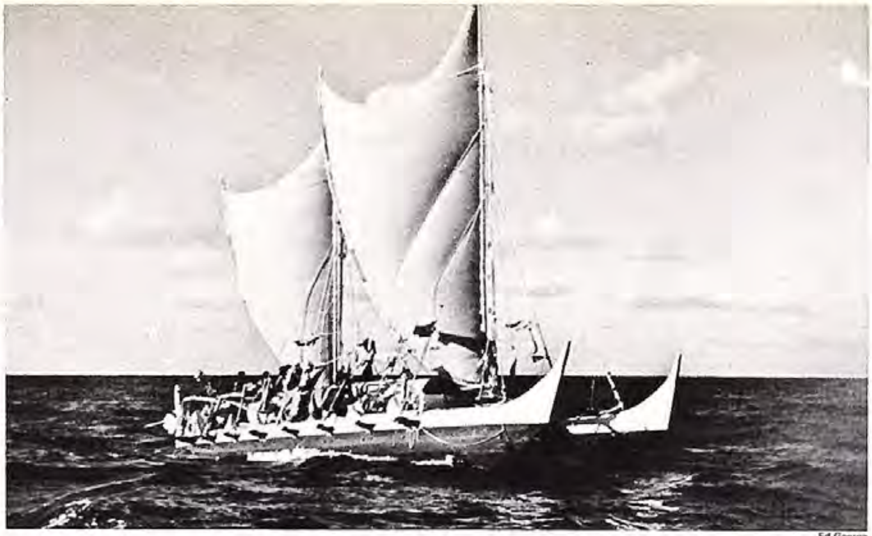
This latest book by Lewis, an unashamedly popular work, is a summation of his Pacific voyaging experiments, and includes new material gained since *We, The Navigators.* The reader 'visits' almost every part of the Pacific where long distance voyaging was formerly common, 'participates' in the voyage of the *Hokule'a* from Hawaii to the Society Islands in 1976, and by the end of the book, can fully appreciate why Te Rangi Hiroa titled his classic book *Vikings of the Pacific.* Lewis has a relaxed, anecdotal style that is easy to read yet informative, with photographs and line drawings to further entertain and inform. I thoroughly recommend this book to those who wish to gain new insights on a general level into one of the truly fascinating aspects of non-Western life in the Pacific.—*Jim Specht, Department of Anthropology, The Australian Museum.*

een Python

R. Jenkins, ANPWS



Right: The 60-foot Polynesian double canoe *Hokule'a* on her 2500-mile voyage from Hawaii to Tahiti; note her typically Polynesian claw-shaped sails which were reconstructed from ancient Hawaiian rock carvings.



Ed George

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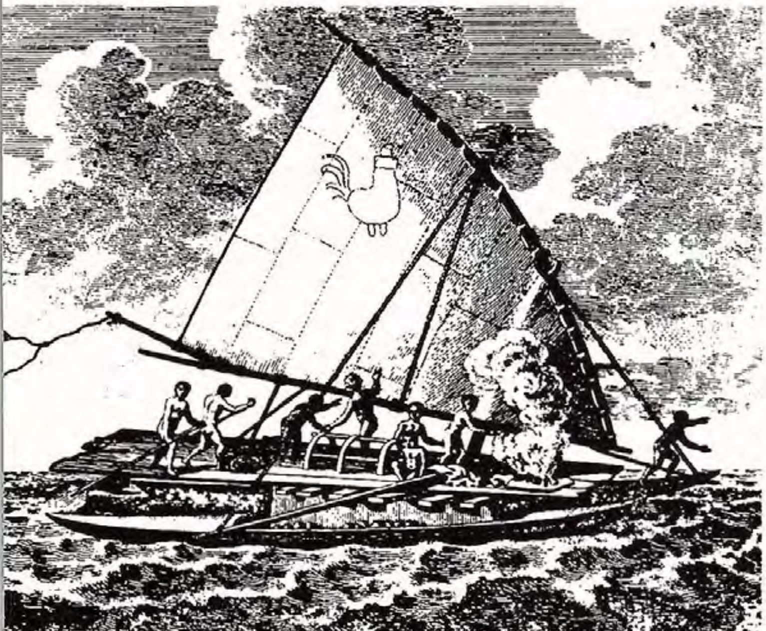
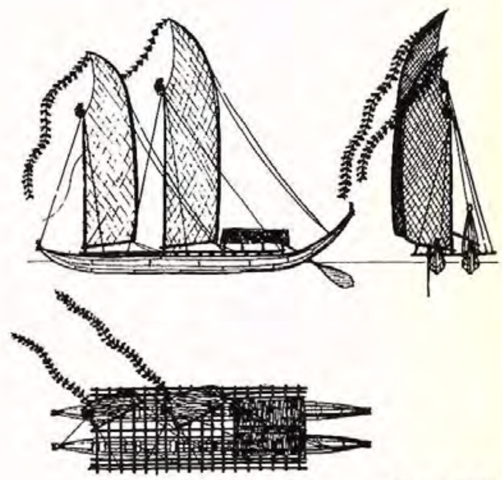
Below: A *tongiaki* encountered off the north Tongan islands by the Dutch explorers and Le Maine in 1616.



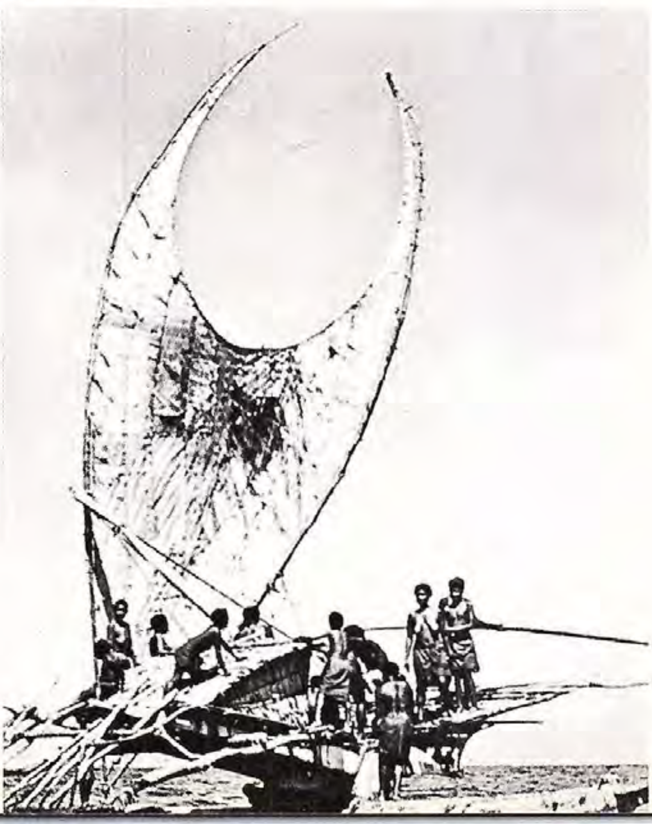
Below: Tahitian *pahi* voyaging canoe.



after J.M. Neyret, 1967

Below Left: A 40-foot Ninigo sailing canoe with pandanus mat canted square sails, an ancient type of sail still used in Indonesia and possibly of ultimate Egyptian origin. Below Right: Tevake's *te puke* trading canoe, Santa Cruz Reef Islands.

Judith Huggins Balfe



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