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AUSTRALIAN NATURAL HISTORY

Sharks — Cicadas
Cyclones — Possums

AUSTRALIAN NATURAL HISTORY

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The characteristic colour pattern of the female Red Back, *Lactrodectus hasselti,* usually makes it an easy spider to recognise. Contrary to what one would expect it is only the bite of the female Red Back Spider which causes envenomation problems. Photo Mike Gray.

The Common Brushtail, *Trichosurus vulpecula,* prefers eucalypt leaves as its main food but because the leaves contain toxic oils and phenols their intake is limited by the ability of the possum's liver to detoxify these substances. So in order to meet their energy needs, possums regularly graze on grasses and herbs, as well as eating fruits and flowers. Photo H. & J. Beste. (NPIAW).

EDITOR
Roland Hughes

CIRCULATION
Cathy Kerr

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COVER

The White Shark, *Carcharodon carcharias,* with its big black eyes, pointed snout, high dorsal fin and razor sharp triangular teeth, is undoubtedly one of the most dangerous marine predators. Photo Ron and Valerie Taylor.

BACKCOVER

A hammerhead caught in one of the meshing nets used off Sydney beaches. Drawing Glenn Ferguson.

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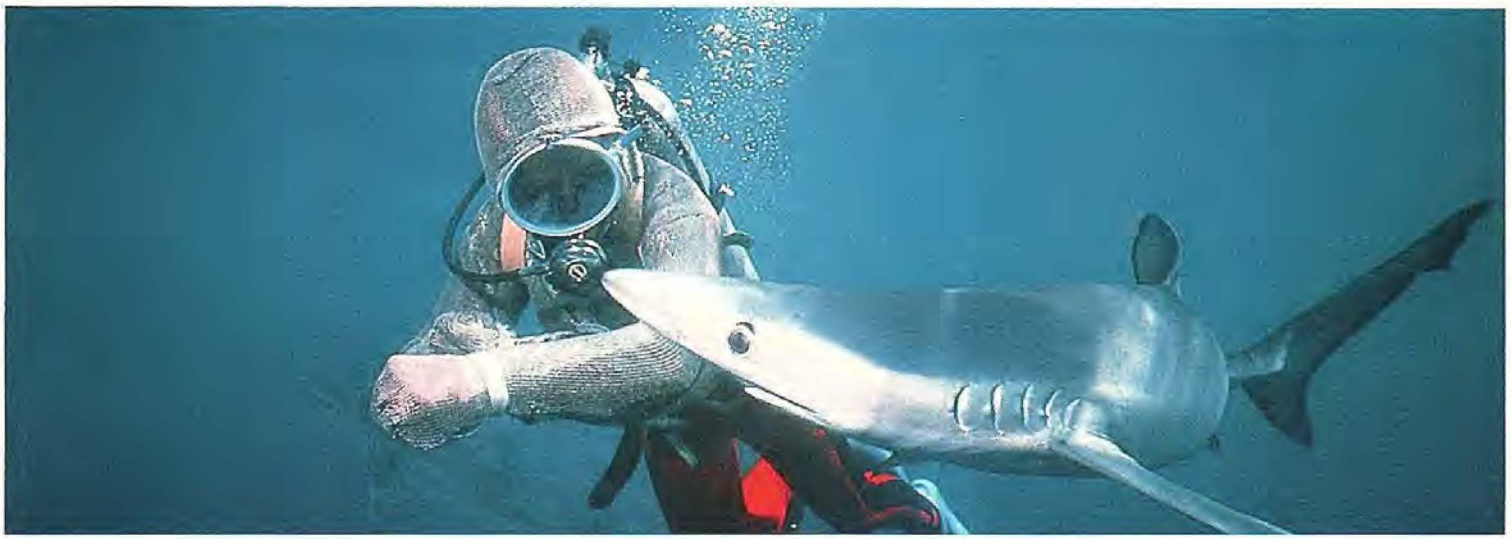
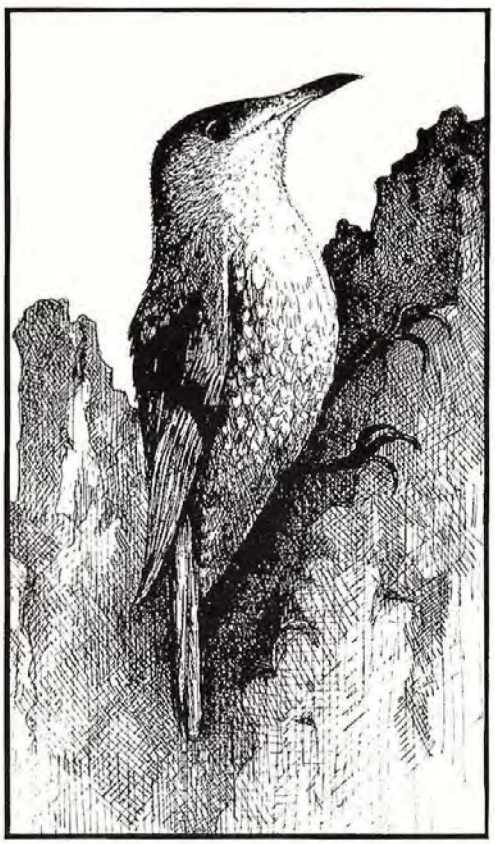




Top, Valerie Taylor fends off a Blue Shark, *Prionace glauca*, in her now famous chain-mail suit. The Blue Shark probably accounts for 90% of the winter population of large sharks off the east coast of Australia. Photo Ron and Valerie Taylor.

The White-throated Treecreeper, *Climacteris leucophaea*, has an extremely energetic pre-copulation display which initially involves the male giving a loud series of crescendo calls from the base of a thick, sloping branch. Drawing Angela Wright.

On the 14th December, 1982 the United Nation's World Heritage Commission placed Tasmania's endangered south-west wilderness area on the World Heritage List and issued a strongly worded statement condemning the damming of the Franklin.

"The committee is seriously concerned at the likely effect of dam construction in the area on these natural and cultural characteristics which make the property of outstanding universal value in particular, and considers that flooding of parts of the river valleys would destroy a number of cultural and natural features of great significance".

"We recommend to the Australian society to take every possible measure to protect the integrity of the site. The committee suggests that the Australian authorities should ask the committee to place the property on the list of World Heritage In Danger until questions of dams construction is resolved".

The Tasmanian Government's response to the committee's statement was a prime example of narrow-mindedness and reflected a complete lack of understanding. The Deputy Premier, Max Bingham, said "it gives us the green light to go ahead with the dam, having due regard to the treatment of the area as one of great beauty".

Already the Government's case for the dam has been squashed and described as misleading by a Senate Select Committee looking into the Gordon-below-Franklin project. They found there was no economic justification to build the dam for at least three years, if ever.

The Senate Select Committee also found that the Tasmanian Government's claims were based on mistaken information and that power demand forecasts by the State's Hydro-Electric Commission were over estimates.

At the time of writing the dam is still underway and the Federal Government has refused to intervene.

By allowing the dam to proceed, both Governments are condemning one of the world's finest areas as well as the largest stand of huon pine and richest archaeological site discovered in recent times.

The Federal Government must accept its responsibilities and prevent the destruction of this priceless wilderness.

Roland Hughes
Editor

STREAMLINED SCAVENGERS OF OUR EAST COAST WATERS

by John Stevens

Despite the presence of large numbers of sharks off the NSW coast and the fact that the area is one of the worst for shark attacks, our knowledge of these predators is almost nonexistent.

John Stevens, a CSIRO Division of Fisheries Research Scientist, collects information on the numbers, type, etc of our potentially more dangerous sharks. From this data, collected in his own time from gamefishing clubs all over the state, he has begun to build up a picture of shark movements off NSW.

Easily the most feared of all sharks the White Shark, *Carcharodon carcharias,* is most common in the Great Australian Bight. According to Valerie Taylor, who along with Ron has probably witnessed more White Shark behaviour than anyone else, they have some interesting habits. "To me, the most fascinating is that they raise their heads from the water to investigate the unusual. It is rather nerve-wracking seeing a 4.5 metre Great White carefully watching one's every move, with its head above water," says Valerie. Biologists believe that this most unsharklike habit may result from its search for seals living along the shore. Many South Australian fishermen claim to have seen White Sharks lift their bodies clear of the water to grab a sleeping seal from rocks.

Opposite, Blue Sharks, *Prionace glauca,* make up ninety percent of the large shark population off the New South Wales coast during winter. All the photos in the article are by Ron and Valerie Taylor.

Prior to the introduction of meshing operations in 1937, the eastern seaboard of Australia, and the coast of New South Wales in particular, had the unenviable reputation of being the worst area in the world for shark attacks.

Despite this dubious honour Australia is well behind other countries in the field of shark research. Shark work carried out in this country concentrates on the various species of commercial importance, particularly the school and gummy sharks which serve a large fishery off the south-east coast. Little attention is given to the larger, potentially more dangerous species. In fact there is still very little information on how many and which sharks occur off New South Wales, let alone knowledge of their life histories.

The presence of sharks mainly depends on water temperature variations caused by changes in the East Australian Current. Surface temperatures just off the continental shelf in the Sydney region reach a minimum of about 19°C in August. By September the East Australian Current has strengthened having its maximum influence in February and March when temperatures rise to approximately 23°C. By the end of May the water temperature has again dropped to about 20°C.

Between October 1979 and May 1982 thirteen species of shark caught during game fishing competitions between Port Stephens and Narooma, NSW were studied. Eight of these were members of the family Carcharhinidae, which forms the most modern group of sharks, including the Blue, tiger and whalers. Other sharks include two species of hammerhead (family Sphyrnidae), the mako and White Shark (family Lamnidae) and one species of thresher (family Alopidae).

September usually marks the start of the fishing season and during this period catches are dominated by and usually restricted to the Blue Shark, *Prionace glauca,* and the Shortfin Mako, *Isurus oxyrinchus.* Both sharks occur off Sydney throughout the winter months, probably accounting for ninety percent of the large shark population.

The Blue Shark is one of the world's most abundant large sharks and occurs in tropical and temperate seas between 50°N and 40°S latitude. While primarily an open ocean species, the Blue Shark is common at particular times of the year in certain continental shelf regions. It makes extensive migrations and studies off south-west England and the north-east of America have shown trans-Atlantic migrations of up to 6,400km, with the shark using current systems to travel right around the North Atlantic. Blue Sharks off the east coast of Australia also make extensive migrations, in this case, into the Pacific.

Blue Sharks, like the majority of Carcharhinids and Sphyrnids, give birth to live young — viviparity. During pregnancy the young obtain nourishment via a placenta, as do mammals. The gestation period is about nine months and, in one litter, up to a hundred young are born, each 50cm in length.

The male shark uses a pair of modified extensions to the pelvic fin, called claspers, to fertilize the female. During copulation the male rotates one of the claspers towards his head, before inserting it in the female, to transmit sperm.

Prior to mating the male bites the female stimulating copulation. These courtship scars, incurred by the female, are often dramatically evident as semi-circular bites and raking cuts. Tissue under the skin of the female Blue Shark is almost twice as thick as that of the male affording her some protection from the mating bites. Even so, some severe wounds are inflicted.

Curiously, this type of bite is often similar to the pattern of wounds made by other sharks on their victims, supporting the theory that many such attacks are not directly related to feeding.

Relatively little work has been reported on shark ageing, although, some success has been achieved with Blue Sharks based on the interpretation of rings on their vertebrae. While results on Australian Blue Sharks are not available, work in England and North America show these sharks reach a length of 150cm in

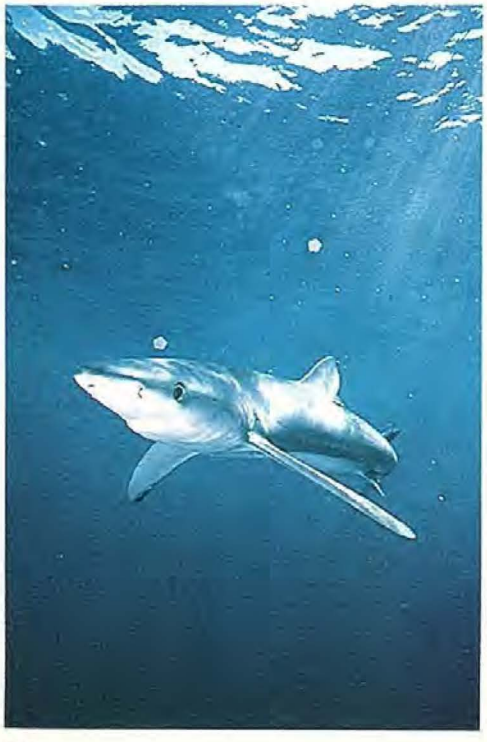
three years and 300cm in ten years, a relatively fast growth rate.

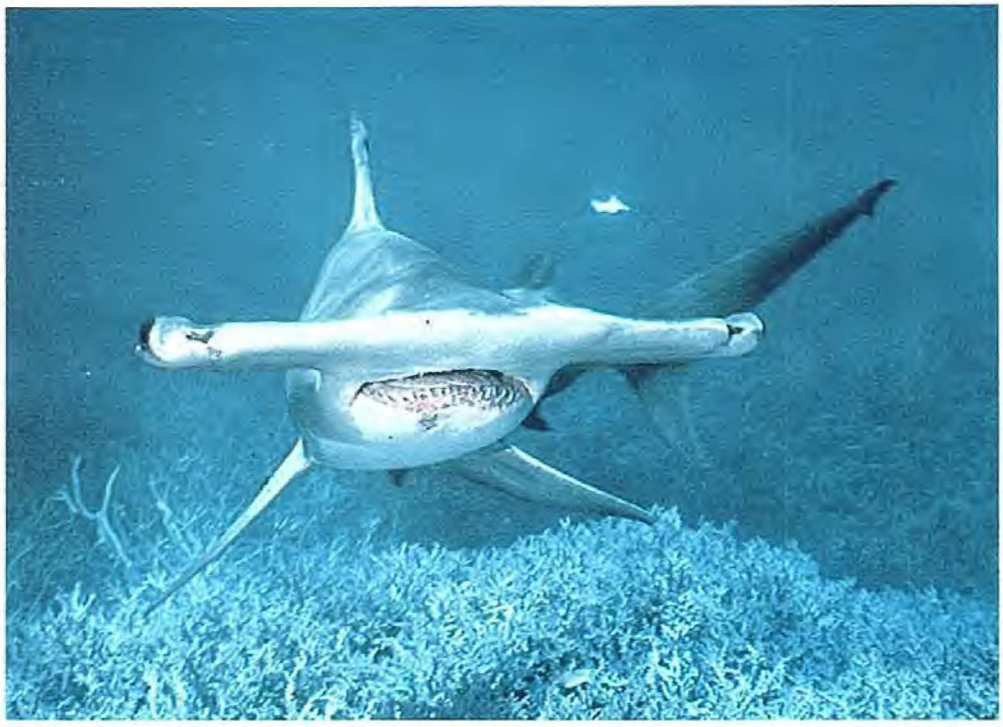
As Blue Sharks are found in the deeper cooler water of the tropics, their presence off the NSW coast during the warmer months is rare. The birth period tends to be between September and November as fishermen often make catches of pregnant females with near-term pups during these months. After November the females tend to leave the coast while the males remain.

The Blue Sharks which occur off the New South Wales coast are relatively large (215—325cm) when compared to their maximum recorded length of 383cm. In contrast to most other sharks where females reach maturity at a larger size than males and attain a greater maximum length, the opposite tends to hold true with Blue Sharks. Sexual and size segregation is common among sharks and may serve to reduce competition for food, restrict aggression between the same species and remove adults from nursery areas.

Whereas sharks are thought to be indiscriminate feeders, most are in fact, selective about their food. Blue Sharks feed mainly on pelagic fish as well as squid, cuttlefish and the occasional octopus. However, when food is scarce they become less selective.

The Shortfin Mako, *Isurus oxyrinchus,* is the fastest and most active of sharks having a body form similar to that of the tunas. The Mako, together with the other Lamnids, has an elevated body temperature which may be up to 10°C above that of the surrounding water. This allows the shark to use its muscles more efficiently.





There is an ongoing debate among biologists on the function of the 'hammer' of hammerhead sharks. It seems most likely that it serves as a wing or hydrofoil enabling the shark to make rapid turns and depth changes.

The Shortfin Mako has a worldwide oceanic distribution similar to the Blue Shark, although it tends to be less common and prefers warmer water.

Makos exhibit a specialised form of reproduction known as oviphagy. The first few pups which develop in the uterus are cannabalistic, feeding on the supply of eggs which the mother continues to ovulate. During pregnancy the embryos develop an enormously distended stomach which is full of egg yolk.

Shortfin Makos give birth off the New South Wales coast during November, having between four and fourteen pups, each about 70cm in length. While the males reach sexual maturity at 200cm, females do not become mature until almost 300cm, a common feature in most sharks. The species feed primarily on small pelagic fish although large Makos have been known to chase active prey such as swordfish. Their diet off Sydney consists mainly of nannygai, *Centroberyx affinis,* indicating Makos spend a considerable amount of time feeding on or near the ocean bed.

Two other species of shark which are present in small numbers during the cooler months are the Bronze Whaler or Copper Shark, *Carcharhinus brachyurus,* and the Black Whaler or Dusky Shark, *C. obscurus.* The term 'whaler' is usually applied to members of the genus *Carcharhinus* many of which are hard to tell apart. Blue and Mako Sharks are easily identified, while the Whalers can often only be told apart by differences in tooth shape and numbers, body dimensions, fin shape and the number of the vertebrae.

The Blue Sharks which occur off New South Wales are all relatively large and usually feed on pelagic fish.

The Bronze Whaler is found in temperate waters of all the world's oceans but is rare or absent in the tropics. Common in the southern waters of Australia, such as the Great Australian Bight, Bronze Whalers seem to only rarely visit the Sydney area.

The Black Whaler, lives in tropical and temperate waters and ranges from the Bight, north to the Arafura Sea. It is the largest Whaler, reaching a length of 360cm, with an average size off the New South Wales coast ranging between 130—340cm.

The White Shark, *Carcharodon carcharias,* needs little introduction. The abundance of this fearsome and well-known predator appears to be linked to the presence of certain marine mammals on which it preys. On a worldwide basis the White Shark is probably most common in the Great Australian Bight, a region which is renowned for its large colonies of marine mammals.

It is truly regrettable that so many large specimens of this shark have been caught in the past by sport and commercial fishermen without any scientific data being collected. While this species is widely recognised its life history remains almost a complete mystery. No reliable record of a pregnant White Shark exists and little is known of its reproduction.

Occurring throughout the year off New South Wales, White Sharks reach maturity at 400cm but can grow to a monsterous 640cm — the size of the largest reliably measured White Shark taken off Cuba.

To complete the list of cool water sharks off New South Wales, two other species must be included — the Thin-tailed Thresher, *Alopias vulpinus,* and the Smooth Hammerhead, *Sphyrna zygaena.*

Biologists believe the enormous upper tail lobe of the Thin-tailed Thresher, a distinctive feature which comprises some 50 percent of body length, is used to herd schools of the small pelagic fish on which it feeds. Another use of the tail may be to stun individual fish. X-rays show that the tail's tip is greatly strengthened by expansion and thickening of the fin supports. Although the Thresher, like the Mako, is known to be oviphagous, little information is available on its reproductive habits.

The Smooth Hammerhead mainly inhabits cool water regions. Near-term pregnant females usually appear off the New South Wales coast sometime during December, outnumbering males by more than two to one. The Smooth Hammerhead's movements earlier in the year are not known although the central Queensland coast appears to be their northern limit.

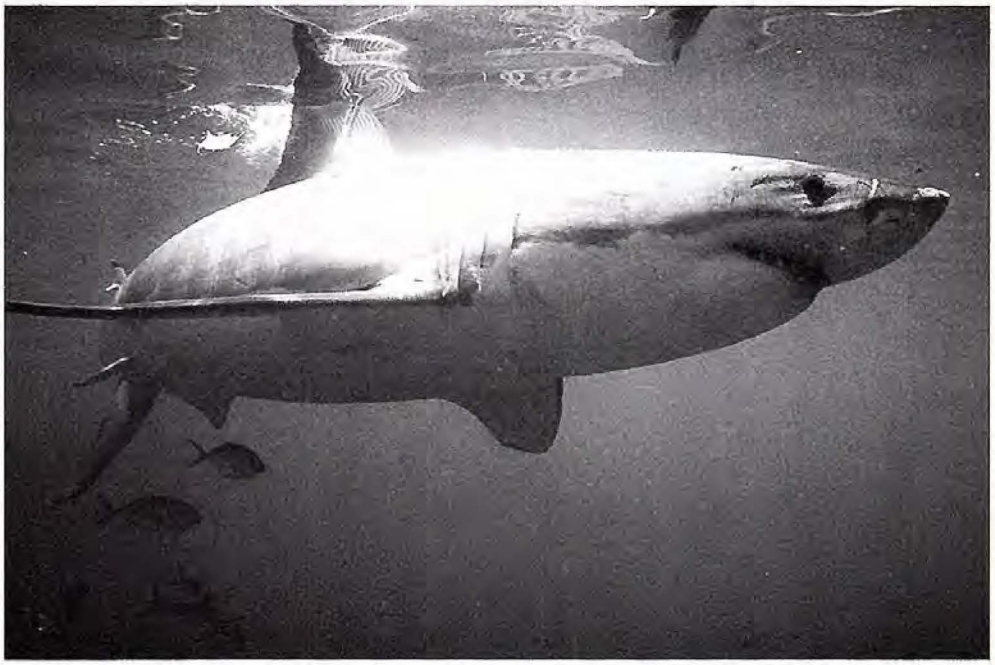
Growing to 400cm in length, female Smooth Hammerheads mature at 260cm and give birth to live young with a litter size between 20—30.

Although the function of the 'hammer' is an on-going debate among biologists, it seems most likely that it serves as a wing or hydrofoil enabling the shark to make rapid turns and depth changes. Coupled with its fast, active nature, this would enable it to feed on highly maneouverable prey such as squid and small pelagic fish. Hammerheads have relatively small mouths, which are not suited to taking large prey.

Warm water sharks begin to appear off Sydney's coast with the arrival of northern tropical water brought down by the East Australian Current. From December to April the Tiger Shark, *Galeocerdo cuvieri,* is the dominant warm water shark present.

The Tiger Shark is known to reach over 500cm in length but usually ranges between 180—370cm off New South Wales. As it breeds in tropical waters, pregnant females and young Tiger Sharks tend to be a rare occurrence in these waters.

From December through to April Tiger Sharks, *Galeocerdo cuvieri,* are the dominant warm water shark present off Sydney. This particular shark is over three metres long and is surrounded by a school of pilot fish.



Tiger Sharks do not reach maturity until they are 350cm and unlike most carcharhinids are ovoviviparous. Young are born live but as there is no placental connection formed during pregnancy, nourishment is obtained from a yolk sac. Litter sizes are large with up to 80 pups being born, each 60—70cm.

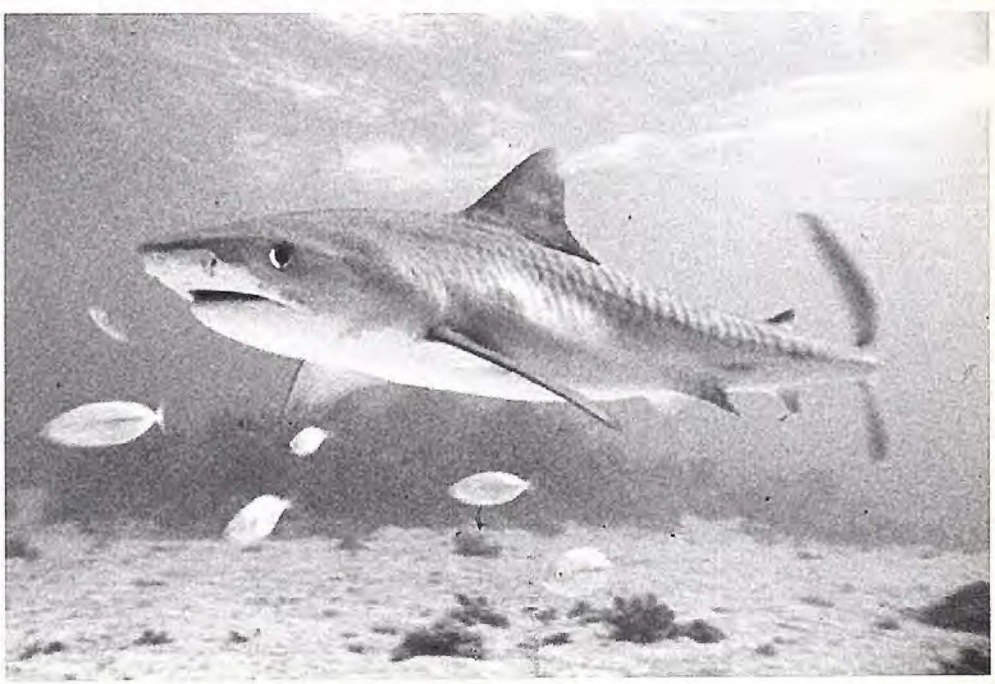
The large number of attacks attributed to the Tiger Shark are due to its size, indiscriminate feeding habits and because it is often found lurking in shallow water, particularly at sunset and night. Several Tiger Sharks captured in the Sydney area have contained mammal remains, most probably pig and sheep, presumably from carcasses thrown off ships. Mutton birds, sunfish and seasnakes in tropical waters have also been found.

White Sharks are present off New South Wales throughout the year and usually average 400cm in length.

Other tropical sharks taken from New South Wales waters during summer include four species of Whaler (genus *Carcharhinus)* and the Scalloped Hammerhead, *Sphyrna lewini.*

One of the whalers, the Long-nosed Grey Shark, *Carcharhinus brevipinna,* can be numerous during the summer in contrast to its cousin, the Blacktip Shark, *C. limbatus,* which occurs far less frequently.

The Blacktip Shark is distinguished by a relatively shorter snout and larger teeth. It is

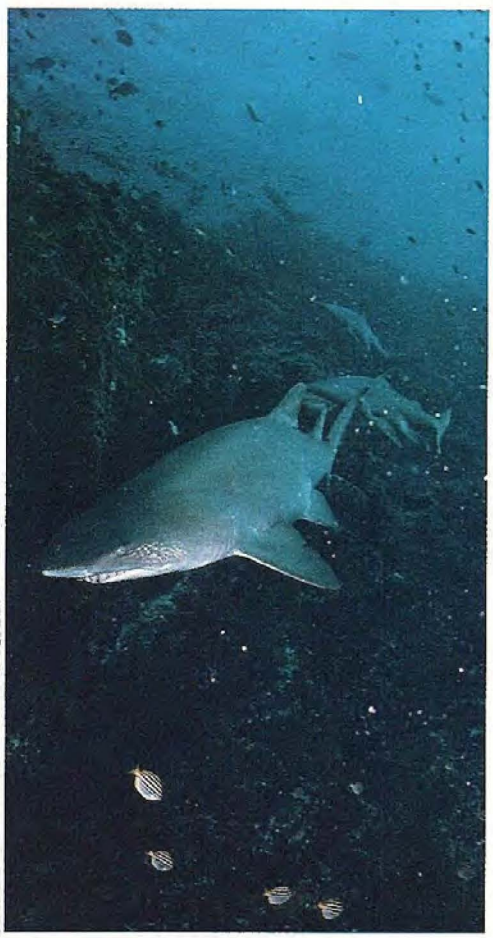



GLENN FERGUSON '82

found in large numbers in the Arafura Sea where it forms the basis of a Taiwanese gillnet fishery. While the Blacktip Shark is capable of making large migrations, most that occur off the New South Wales coast come from a separate north Queensland population.

With its restricted breeding season the Blacktip Shark mates during March and the females ovulate towards the end of April. After a gestation period of eight months the females give birth to their young late November or early December with litter sizes averaging three pups, each 60cm in length.

The large gaps in our knowledge of these and other sharks highlights the urgent need for intensive study programmes on the life history and behaviour of Australia's sharks. Only then will the appropriate authorities be able to frame more effective shark-fishery management policies and obtain a better understanding of the shark-hazard problem.



Above, a Blue Shark on the prowl and top right, taking a lunge at Valerie Taylor.

Right, set against the sun shining on the sea surface, a Blue Shark glides by always on the look-out for its next meal.

Opposite, a White Shark. Drawing Glenn Ferguson.

SHARK ATTACK — FACT vs FICTION

by Roland Hughes

During January, 1982, a 20 year old surfer, Martin Allan Ford, died of wounds he received from an attack by a shark off Tallow Beach, south of Cape Byron, NSW.

Surfing with five other friends, Martin Ford was 200 metres off the beach when the shark struck.

This was the first fatal shark attack in NSW since 1967.

When you consider that there have been only a little more than 100 fatal shark attacks in Australian waters since records were first taken in 1919 and that well over 100 people die on NSW roads every month, shark attack is a rare occurrence. The worldwide annual total of shark attacks only averages 26, of which 30 percent are fatal.

In the case of Martin Ford the shark was not caught and therefore not identified. This is a common problem with shark attacks as positive identification of man-eaters can only be made if tooth fragments are found in the victim.

A comprehensive study of Australian shark attacks by Dr V. M. Coppleson (published in 1958 and still the only detailed study ever undertaken in Australia), showed that most attacks occur between two and six o'clock in the afternoon. Although attacks were more common on lone swimmers, groups of people were not immune.

Coppleson found that the probability of attack was not influenced by the weather, tides or water clarity.

His investigations also confirmed that the majority of Australian attacks are made by lone sharks. Only in a couple of cases were packs of sharks involved.

Often the shark struck the victim a number of times while always ignoring other swimmers nearby.

According to John Stevens, author of the previous article, several popular misconceptions about sharks and shark attack continue to arise in the media. Notably, that all these attacks are an attempt by the shark to eat the victim. Other fallacies include the belief that shark attacks are directly linked to water temperature and are perpetrated "by a creature that is nothing more than a scavenger or vicious eating machine". Another is that sharks are totally unpredictable.

John Stevens points out that an analysis of over 1,000 shark attacks throughout the world over the last 30 years shows that between 50 and 75 percent of attacks have no direct relationship to feeding. "This becomes more understandable when it is realised that only some 30 percent of attacks are fatal and that 75 percent of victims are struck only once or twice," he says.

"The pattern of wounds from survivors of shark attack does not support the view that the shark was trying to remove large portions of flesh from the victim."

Dr Stevens believes that the fact that sharks do not press home their attack after the initial strike, despite large amounts of blood and tissue in the water, is inconsistent with a direct feeding attack.

Two biologists, Richard Johnson and Donald Nelson, while working in the Marshall Islands, studied the response of the Gray Reef Shark to humans.

Gray Reef Sharks compete with one another as well as other species for food and have developed a ritualised threat display.

The two scientists discovered that many of the attacks on divers resulted from the shark being cornered. In every case of shark attack investigated, the shark had exhibited it's threat display prior to attacking.

A Gray Reef Shark's threat display centres on an S-shaped swimming pattern followed by a figure of eight as it moves closer to the threat — in this study's case, a skindiver. While the shark swims it's body twists and turns with its pectoral fins depressed, snout raised, jaws slightly opened and back arched.

The current belief is that this ritualised behaviour also serves as a form of courtship display and territorial defence. Wide-ranging migratory sharks' threat response seems to differ from that of the Gray Reef Shark in being stimulated by an aggressive incursion into the shark's living space as opposed to geographical territory.

Much more research needs to be carried out on this aspect of shark's behaviour, but it seems likely that the majority of shark attacks are aggressive threat reactions by the shark to a person's presence in the water.

John Stevens believes this explanation is supported by the type of wounds found on shark attack victims, which are often similar to the wounds sharks inflict on each other when they fight.

"While they may not be of much consequence to another shark they have far more serious results on an unprotected human," he says.

Biologists believe that of all sharks, only the White Shark may actually include humans in it's diet. This is because it habitually takes large prey, especially marine mammals.

According to John Stevens, sharks are far from being simple eating machines. "Although they have been around for some 250 million years some species have, for example, an advanced and complex reproductive system similar in many ways to our own. They can also do well in learning tests and have extremely sensitive sensory systems."

"Sharks have a very acute olfactory sense and in some cases can detect water-born chemicals at lower concentrations than analytical methods devised by chemists. They are sensitive to low frequency pulsed sounds, have good nocturnal and diurnal vision, biorhythms, and can use bioelectrical cues to guide close range attacks and, possibly, even for navigation."

Different sharks show a range of peculiar behavioural activities, typical postures and in some cases a degree of social organisation. Dominance between sharks of the same and different species, based on size and sex, characterises a number of sharks, including some of the whalers, hammerheads and the White Shark.

By far the most effective method of reducing shark attack is the mesh netting of beaches. Meshing works not by enclosing a beach and excluding the sharks, but by reducing the population to a level where the statistical chances of attack are minute.

Since October, 1937, the surfing beaches of Sydney, Newcastle and Wollongong have been systematically meshed for sharks.

No attacks on swimmers have occurred on these beaches since, although infrequent attacks do occur in estuaries, which are not meshed. The last attack was in Sydney Harbour in 1964.

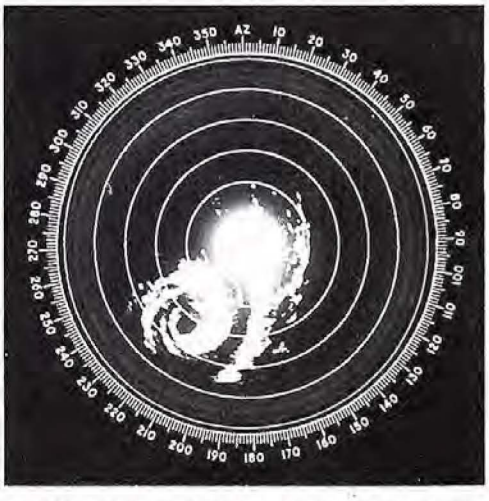
IT'S AN ILL-WIND THAT BLOWS IN THE TROPICS

by J. L. McBride

Tropical cyclones are a fact of life up north. On average five cross or come close to our shores each year and fifteen form off the coast. When cyclone Tracy hit Darwin on Christmas morning 1974, 49 people were killed and another 16 were reported missing, presumed drowned at sea. It was the first time Australians were made aware of the awesome power and destructive potential of tropical cyclones, known elsewhere in the world as hurricanes or typhoons.

Most people can still instantly recall the news reports of the aftermath of cyclone Tracy. Some will remember cyclone Joan on Port Hedland, one year later. Queenslanders still remember the battering of the Gold Coast by a series of cyclones in 1966—67 and the flooding and wind damage in Townsville caused by cyclone Althea in 1971.

In this article John McBride tackles the subject of tropical cyclones explaining what they are, where they occur and the forecasting methods used to predict their path. He also covers the scientific research currently underway to further our understanding of this frightening natural phenomena. John McBride is a specialist in tropical meteorology working at the Australian Numerical Meteorology Research Centre, Melbourne. Over the past seven years he has written a number of research papers on the development of tropical cyclones.



Top, Darwin after cyclone Tracy. Photo courtesy of *The Sydney Morning Herald.*

Below, an image of tropical cyclone Hazel on the screen of the Bureau of Meteorology radar at Learmonth, on the coast of Western Australia, in March 1979. The radar image 'photographs' rainfall. Features include a rain-free circular eye, surrounded by curved bands of rain, with clear air in between. The bright spot in the centre of the screen is ground clutter and is of no meteorological interest. The range rings on the screen are approximately 74 kilometres apart.

The family of cyclones, or large scale low pressure weather systems, can be divided in two. The first is the mid-latitude cyclone. This is the familiar 'low' or low pressure system which appears to the south of Australia on the daily newspaper weather maps, and is responsible for most rain or cold air occurrences in Australia's southern capitals — Perth, Adelaide, Melbourne, Hobart, Canberra and Sydney.

During the winter months residents of these cities experience the effects of a low at an approximate frequency of once per week. These steadily eastward moving systems have typical wind speeds near the ground of between 5km/hr and 50km/hr. The clockwise wind circulation extends over a distance of the order of 2,000km and the main rain activity affecting Australia is usually concentrated into a north-south extending band known as a 'cold front'.

The other member of the cyclone family is the tropical cyclone. In comparison with the mid-latitude low, the tropical cyclone occurs infrequently, with an average of ten occurring near Australia each summer. In addition, they tend to stay within their area of origin, so that only a little more than three per year occur to the west of Australia, three to the north and three to the east. However, there is considerable year to year cyclone variability. The Coral Sea, for example, immediately east of Australia, may last a whole summer with only one tropical cyclone, but then could have as many as eight or more in the following year.

Also in comparison to the mid-latitude weather system, the tropical cyclone's strong winds exist over a relatively small, concentrated area. As a result a particular city or location on Australia's tropical coastline may last ten or more years without experiencing the direct effects of a tropical cyclone.

When the strong winds do come, however, the effect can be devastating, as tropical cyclones in our region typically have wind speeds near the ground in excess of 100 km/hr. Wind gusts in Australia have been measured as high as 246km/hr in tropical cyclone Trixie in 1975, 252km/hr in tropical cyclone Kerry in 1979 and 217km/hr in tropical cyclone Tracy in 1974.

Tropical cyclones have different names in different parts of the world. Many countries officially describe them as 'tropical storms'. In the North West Pacific Ocean they are called **typhoons** once their sustained wind speeds are estimated to exceed 120km/hr. In the American region such systems are called **hurricanes.** In Australia the only official title used is **tropical cyclone** which is given to any large scale tropical weather system with 10 minute mean wind speeds exceeding 63km/hr.

Effect of the earth's rotation

The word 'cyclone' is a generic term used by meteorologists to describe any large scale weather system with low pressure in its central region and high pressure further out. The pressure difference gives rise to a 'pressure gradient force' which causes the air near the ground to attempt to move inwards toward the low pressure region.

The earth is rotating, however, at the rate of one complete revolution per day. The effect of this rotation on the air movement is to cause it to be deflected perpendicular to its direction of motion. The result is a balanced flow situa-

Cyclone Tracy

Photo top left, by Tony Burgess. All photos courtesy of *The Sydney Morning Herald.*

Cyclone Tracy was an ominous cloud formation hovering over the Timor Sea when US weather satellite SR8 first detected it, a week before Christmas Day, 1974.

In the Darwin Tropical Cyclone Warning Centre meteorologists tried to determine whether the formation was a tropical cyclone and if it would pass over Darwin.

At 4.15pm on Sunday, three days before Christmas, meteorologists broadcast the first cyclone warning to the City of Darwin. This was to be the first of twenty warnings. At this stage it was still impossible to accurately predict the cyclone's ferocity, speed or direction.

Although first spotted 200 kilometres north-northwest of Darwin, the cyclone travelled slowly southwest passing the tip of Melville and Bathurst Islands, then turned south-east towards the city.

By the time it reached the outskirts of Darwin the swirl around the eye of the cyclone exceeded 259km/h.

At midday on December 24th the Tropical Cyclone Warning Centre delivered a warning that the eye of the cyclone, with "very destructive winds" exceeding 150km/h, would probably pass close to Darwin.

This was 15 hours before the storm hit the city.

In Darwin at 9pm, on December 24th, the steady breeze that was blowing turned into a gale. Its force increased through the night until just before 1am, when the first strong wind gust struck the city.

The eye of cyclone Tracy passed over Darwin an hour later and by 5am the winds had abated and the city lay in ruins.

Darwin, with a population of 41,000, was immediately declared a national disaster area.

After visiting the devastated city on Boxing Day, the then Deputy Prime Minister, Dr Jim Cairns, said that the rebuilding of Darwin would be Australia's biggest challenge since World War II.

"Darwin is devastated; Darwin is destroyed; there is virtually no building in Darwin that is not seriously damaged".

"Darwin looks like a battlefield or a Hiroshima", he said.

Dr Cairns description was apt. Over 5000 of Darwin's 8000 houses were demolished and under 400 remained habitable. Only after three years of continuous work at a cost of over $500 million was the city returned to order.

Roland Hughes.

tion where the air rotates around the area of low pressure, with the pressure gradient force pushing the air inwards and the rotational force, acting perpendicular to its direction of movement, pushing the air outwards.

The rotational force (its technical name being the Coriolis force) acts at right angles to the motion of the air. The choice between acting to the right of the motion or to the left depends on the direction of rotation of the earth.

Looking down at it from the north pole the earth is spinning in an anticlockwise direction — whereas from the south pole it is spinning in the opposite direction. Accordingly, as the direction of the earth's rotation is opposite between the northern and southern hemispheres, so also is the direction of action of the rotational (or Coriolis) force. In the northern hemisphere it acts to the right of the air's motion while in the southern hemisphere it acts to the left.

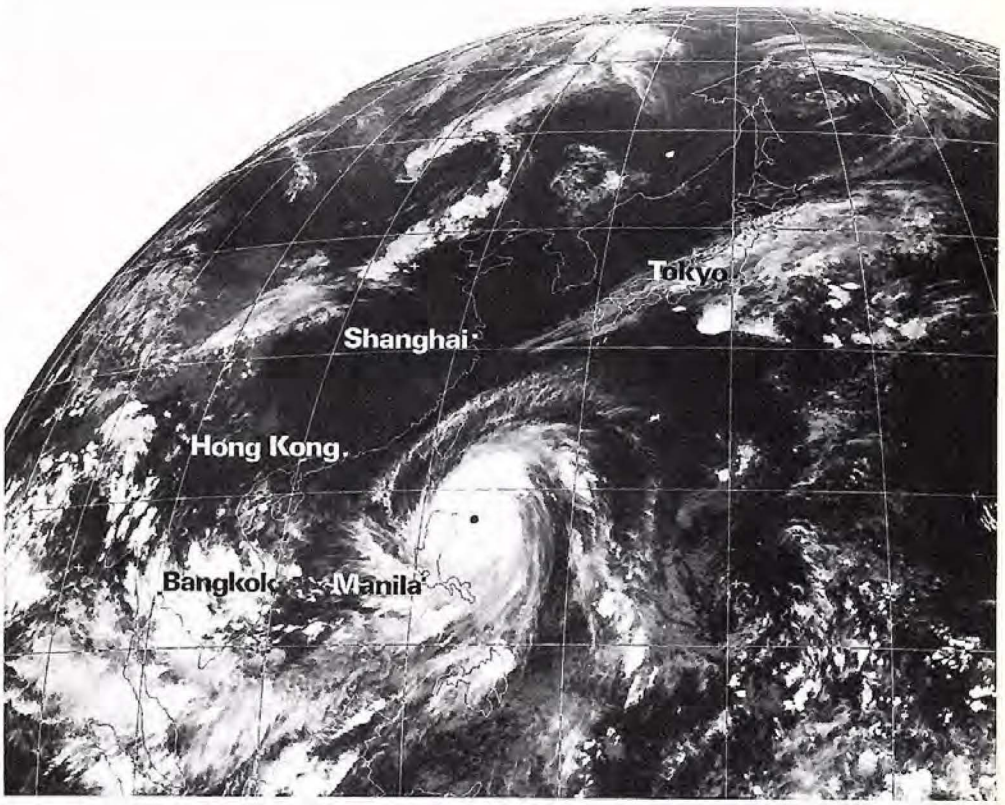
The airflow around a cyclone north of the equator has the rotational force acting to the right of its direction of motion and the inward pressure gradient acting to its left. For this configuration to be possible the air circulation must be in an anticlockwise direction. In the southern hemisphere, on the other hand, the rotational force acts to the left, so the flow around a cyclone is clockwise.

What tropical cyclones are

In a tropical cyclone the region of strong winds forms a funnel stretching from the earth's surface up to a height of approximately 6km. Very strong wind speeds of greater than 120km/hr are typically restricted to a narrow ring extending from about 20km to about 60km from the cyclone centre. The clockwise wind circulation extends much further than this (often as far as 1000km from the centre), and tropical cyclone strength winds occasionally are observed as far as 500km from the centre. Inside the strong wind belt is the famous eye of the cyclone where wind speeds drop to almost calm.

The rainfall from tropical cyclones occurs in 'convective' or thunderstorm clouds, which extend up to heights of 12km or more above the ground. In the belt of strong winds the thunderstorm clouds form a continuous ring known as the 'eye wall'. Further out they occur in curved bands, known as the spiral bands.

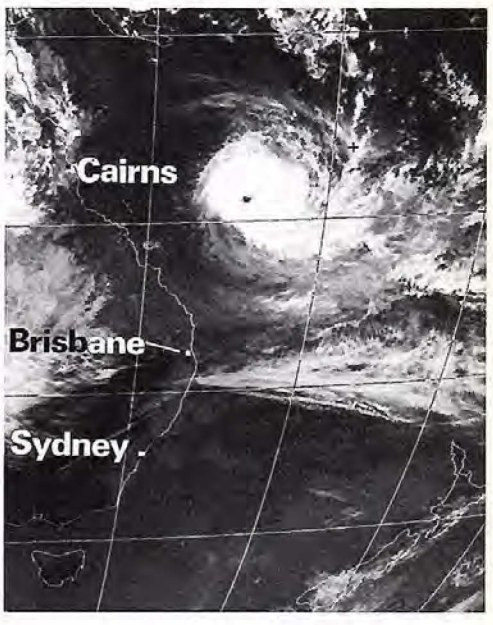
Put simply, tropical cyclones are large scale weather systems with low pressure in the centre surrounded by clockwise rotating wind. The wind circulation extends out large distances, but includes a narrow belt of extremely strong winds in the eye wall region approximately 20km from the system centre. The strength or intensity of a tropical cyclone is measured in terms of either the maximum wind speed or the surface pressure in the centre of the eye — generally the lower the pressure the higher the wind speed.



Infra-red satellite photograph of tropical cyclone Clara approaching the islands of the Philippines in September 1981.

Right, infra-red satellite photograph of tropical cyclone Kerry in February 1979.

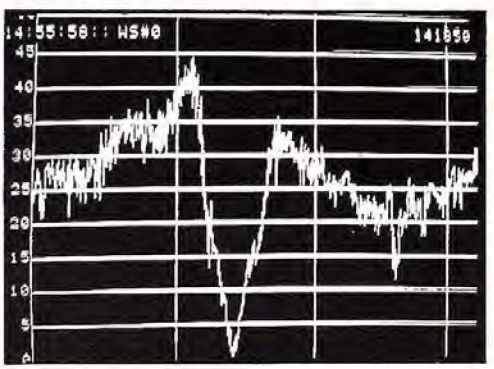
Below right, computer plot of wind speed (vertical axis in metre per sec) versus time (horizontal axis) taken on board a United States Government research aircraft as it flies through the eye of tropical cyclone Anita in the Gulf of Mexico. Photograph courtesy of Dr R. Sheets, National Oceanic and Atmospheric Administration, USA.



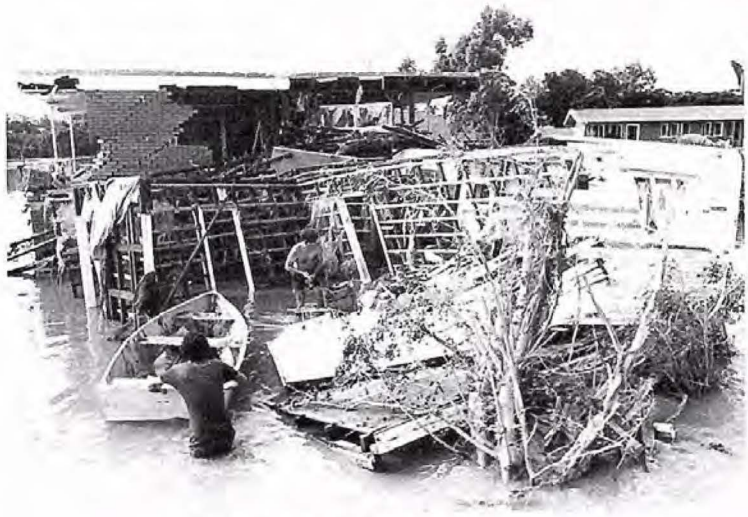
Damage due to cyclones

The tremendous damage associated with tropical cyclones has three major physical causes. The first is direct wind damage to buildings and structures, as in the case of the damage to the city of Darwin due to tropical cyclone Tracy on Christmas Eve 1974.

The most devastating effects of cyclones are due to **storm surge.** This is the name given to the very large coastal tides brought about by the combined effect of the strong winds blowing across the sea surface and the rising of the sea surface due to the very low atmospheric pressure encountered in the eye of the cyclone. The height of the tide experienced when a cyclone hits a coastal town depends on a number of factors including the strength of the cyclone, the level of the normal lunar tide at the time of impact, the shape of the coastal topography and the vertical slope of the continental shelf in the region.



Brisbane Floods



Photos courtesy of *The Courier-Mail*.

On January 25th, 1974 Brisbane faced the most serious flood of its history. Cyclone Wanda was causing heavy rain to lash the city, with more than 300mm falling during a 12 hour period.

Suburb after suburb was blacked out as strong winds and rising floodwaters took their toll.

By midnight on Friday 25th, after continual torrential rain, flood heights were up 1.2 metres on the record experienced the previous noon.

Many people found themselves trapped in their homes, surrounded by flood waters. Other houses were washed away.

On Monday January 28th, the continually rising Brisbane River, reached over the six metre mark. Nine metres was the previous maximum recorded during the 1893 Brisbane flood.

By this stage the flood had crippled the city, leaving thousands homeless, suburbs isolated and essential services disrupted.

On Tuesday January 29th the inevitable happened and the Brisbane River's massive floodwater began its final devastating surge through the whole of the city.

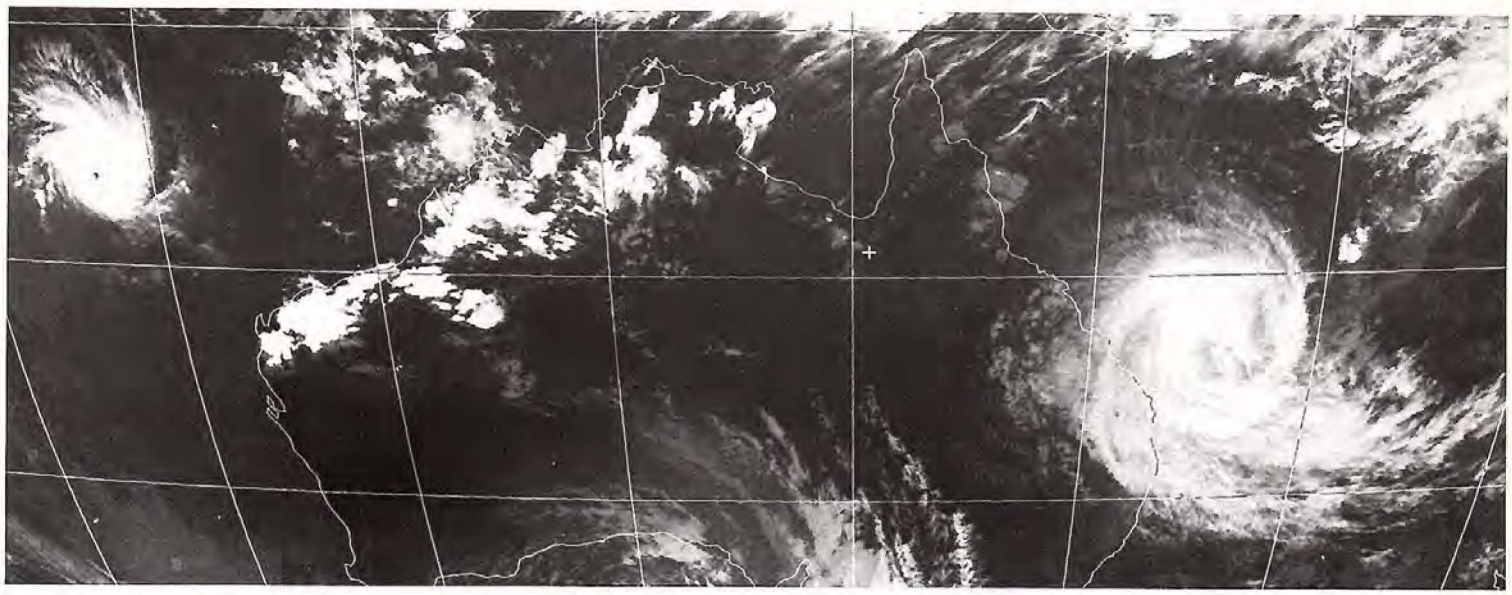
Rescue craft operated continuously day and night to remove hundreds of people trapped in flooded suburbs as the river height reached 6.7 metres — 4.2 metres above normal.

The city was paralysed with the Brisbane River exceeding 3km in width. Houses and buildings disappeared under the murky water as the flood spread.

The then Director of the Brisbane Weather Bureau, A. J. Shields, described the flood as the most disruptive in memory.

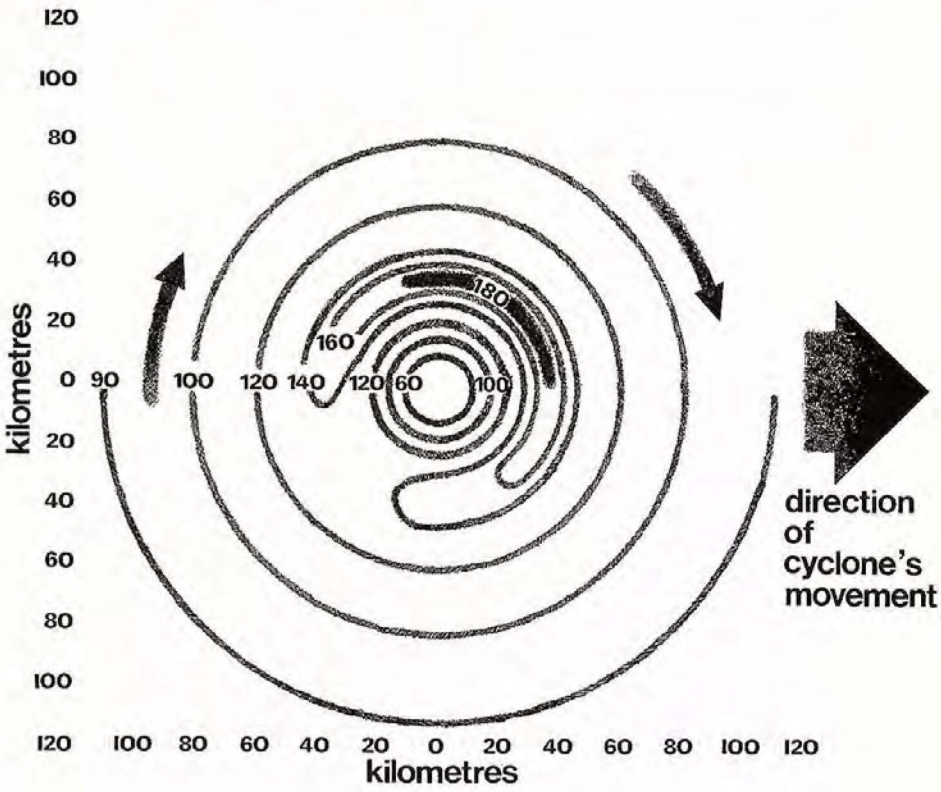
"The rain was so heavy over such a wide area, that flooding occurred in almost every watercourse".

"The flooding was far more severe than the June 1967, or February and April 1972 floods", he said. — **Roland Hughes.**



An infra-red satellite photograph of a pair of tropical cyclones in February 1981. On this image, white colour represents clouds high in the earth's atmosphere. Tropical cyclone Neil, west of Australia in the Indian Ocean, is a small system with a distinct cloud free eye in the centre. In tropical cyclone Freda, east of Queensland, the eye cannot be seen clearly. In comparison to Neil, Freda is much larger with its curved cloud bands extending 800 to 1000 kilometres from the cyclone centre.

Right, schematic illustration of wind direction (arrows) and wind speed (km/hr, extreme wind belt shaded) in a tropical cyclone.



When cyclone Althea visited Townsville in 1971 the storm surge produced a sea level three metres higher than normal, which resulted in sea water from the Ross River covering the main street. One tropical cyclone in 1970 caused an estimated 300,000 deaths when the storm surge swept into the low-laying Ganges delta plain in the country of Bangladesh.

The third major cause of damage (after storm surge and wind) is flooding due to the cyclone rains. Cyclone Wanda provided the initial rain that saturated the Brisbane River immediately prior to the major floods in Brisbane in January 1974.

Conditions under which they form

The major sources of energy for tropical cyclones are the heat energy and the energy of condensation of water vapour, both tapped from the underlying ocean. Tropical cyclones always form over the tropical oceans where the sea surface temperatures are warm, and they occur in all the world's oceans except the South Atlantic.

The maintenance of the low pressure — strong wind structure of the tropical cyclone is dependent on continuous access to the underlying oceanic energy source. Accordingly tropical cyclones occur only over the sea, and they usually decay rapidly once they move over land. They form only in the tropics, but once formed can move into higher latitudes. For this reason cities as far away from the equator as Perth, New York or Wellington can occasionally experience the effects of tropical cyclones, which have weakened as they have moved over colder seas.

In the northwest Pacific Ocean very warm sea surface temperatures extend well north, so that tropical cyclones frequently retain their strength as they make landfall in Japan and Northern China. Tropical cyclones have played an important part in influencing the history of that region. For example in the 13th Century the Mongol army of Kublai Khan carried out two successive invasions of Japan. In both instances the invaders had the upper hand, but were ultimately defeated when a tropical cyclone suddenly arose and destroyed their fleet of 200 ships.

In all parts of the world tropical cyclones follow marked seasonal cycles. In Australia they occur only in the summer and autumn, with a maximum frequency in January, February and March.

Forecasting

In Australia the Bureau of Meteorology has responsibility for all forecasting and warnings related to tropical cyclones. Forecasting depends on many skilled techniques which have evolved as a result of scientific research over recent decades. These include a combination of a number of sophisticated methods such as the skilled interpretation of satellite and radar imagery and a number of more simple techniques such as extrapolation of the current path of movement.

A major ingredient of the skill of a tropical cyclone forecaster is the ability to evaluate the applicability of the various available forecast techniques to the current situation and to issue a forecast which integrates the results of the different techniques.

An important component of the process is the monitoring of the cyclone's current location and intensity and the structure and change with time of the larger scale atmospheric flow in which it is embedded. This is done by continuous data collection and data analysis procedures designed to statistically and numerically combine observations from a number of different sources.

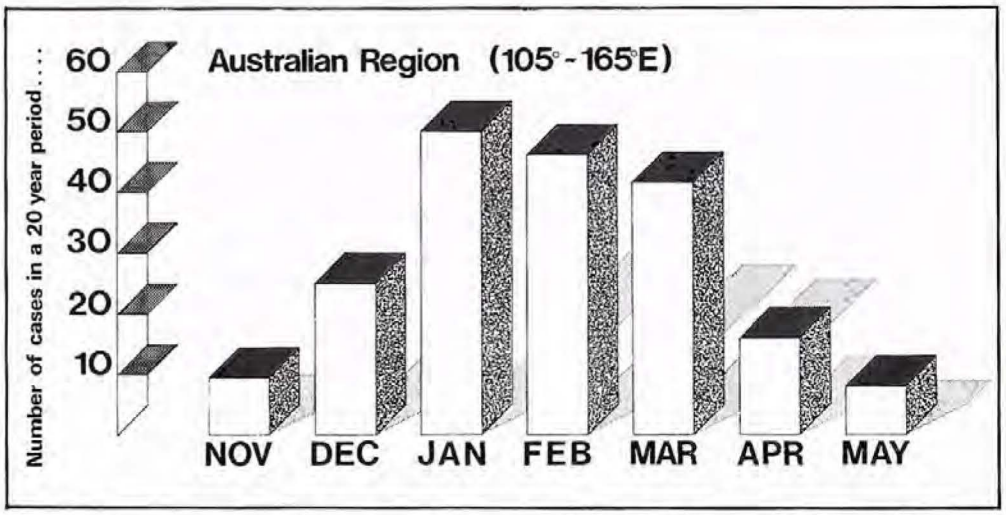
Data platforms include the World Weather Watch network of surface and upper air meteorological observations, information from the United States polar orbiting meteorological satellites and the Japanese geostationary meteorological satellite, and radar information from the Australian coastal radar network.

Research

Tropical cyclones have been the subject of much active scientific research in recent decades. The research has two main aims:
1. to improve forecasting, and
2. to gain a better physical understanding of cyclones.

Research techniques include observational data gathering and statistical analysis, the derivation of mathematical models, laboratory modelling using devices such as rotating water tanks or gases of different densities, and numerical or computer simulations of the structure and life-cycle of a tropical cyclone.

Much of the current detailed knowledge of the structure of the tropical cyclone's inner core region stems from the work of the National Hurricane Research Laboratory of the United States of America. Since its establishment in the middle 1950's this research facility has almost continuously monitored tropical cyclones in the north west Atlantic Ocean by means of aircraft specifically instrumented to take meteorological and other scientific observations. This facility visited Australia briefly in 1979, and during that mission flew into the region of the eye of tropical cyclone Kerry in the Coral Sea and tropical cyclone Rosa in the Gulf of Carpentaria.

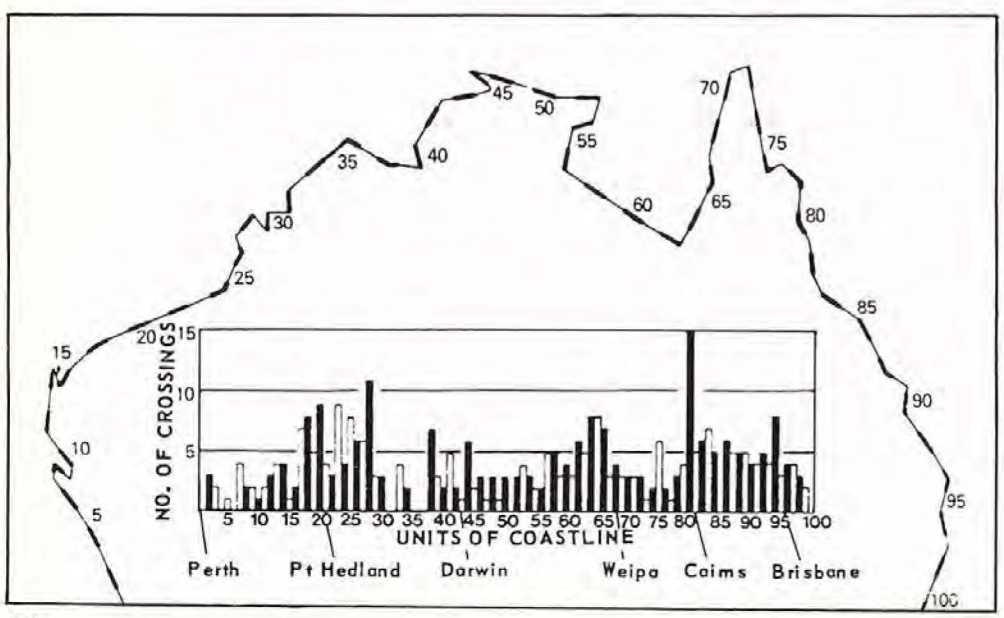


Distribution by month of tropical cyclone development events near Australia between 1959 and 1979. The cyclone season lasts from November to May. The most frequent occurrence (71 per cent) is during the three month period January to March.

As a result of the current high level of research activity, rapid advances are being made in man's knowledge and understanding of tropical cyclones. The currently accepted theory explaining the maintenance and supply of kinetic energy to generate the winds in a tropical cyclone hinges on the concept of a co-operation between two distinct scales of motion.

The first is the scale of the individual convective clouds making up the eye-wall and the spiral rain bands. The existence of these clouds, each 20km or so in diameter, depends on a continuous supply of moisture in the form of water vapour. This is collected by evaporation from the surrounding and underlying ocean and carried into the cloud region by the large scale (or cyclone scale) movement of air spiralling inwards towards low pressure.

The laws of thermodynamics state that the cyclone scale area of low pressure corresponds to one of warm temperatures through the depth of the atmosphere. The large scale warming of the atmosphere required to maintain this structure is due to the collective effects of the condensation energy released in all the individual clouds. The release of energy takes place continuously as the atmospheric water vapour is converted to rainfall. Consequently a co-operative situation exists whereby the clouds provide the heat energy to drive the large scale cyclonic air flow and the cyclone scale movements of air pro-



This figure, supplied by the Bureau of Meteorology is a histogram of the frequency of tropical cyclones crossing 100km idealised segments of the Australian coastline in the period 1909—1975. It reveals that very few segments of the 10,000km stretch of coastline have not experienced at least one tropical cyclone landfall.

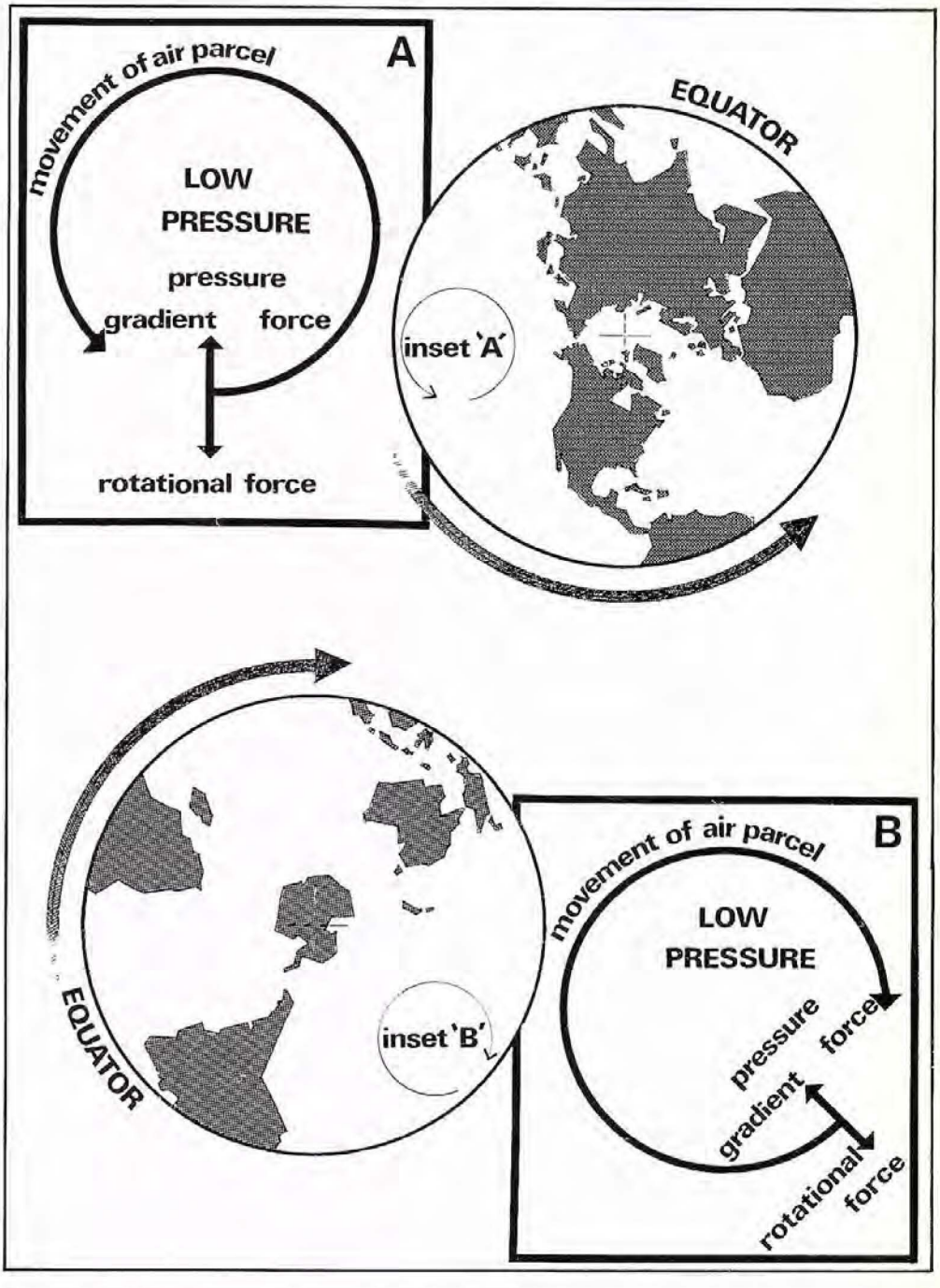
vide the moisture inflow necessary for the clouds to feed on.

Computer simulations are used to duplicate most of the main features of the structure of the fully developed tropical cyclone. The simulations have less success, however, at duplicating the development or growth of a tropical cyclone from a weak system. Most rainfall over the tropical oceans occurs in very weak low pressure weather systems known as cloud clusters. Most cloud clusters have a life cycle of a day or so, but occasionally one develops into a tropical cyclone.

Research has revealed a number of important features of the large-scale atmospheric flow surrounding a pre-tropical cyclone cloud cluster. As a result some of the characteristics of the state of the atmosphere during the development of a tropical cyclone have been identified. These characteristics in turn should provide a clue as to the physical mechanisms and causes for the development of the cyclone.

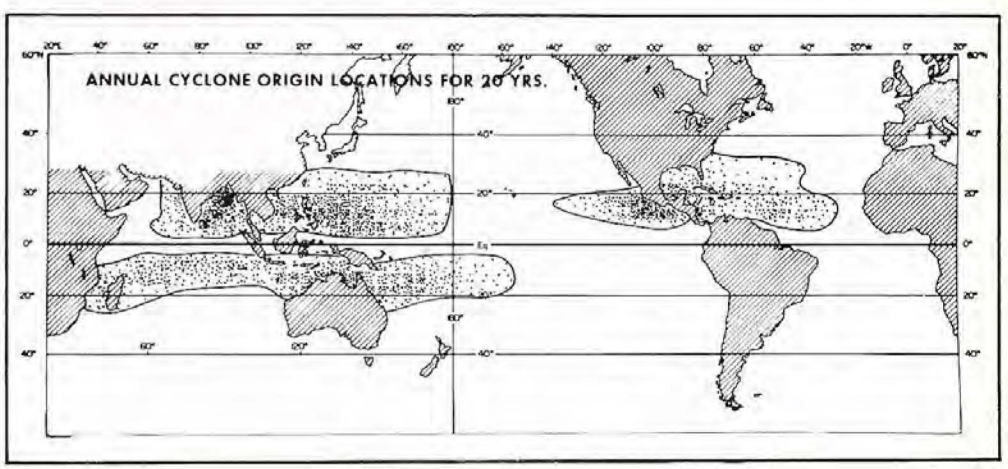
Australian studies have shown that 85% of cyclones near Australia originate from tropical weather systems which first appear in a large scale line of change in wind direction known as the 'monsoon shear line'. This and other recent research indicates a close interrelation, at least in the Australian region, between tropical cyclones and the southern hemisphere monsoon.

Research along these lines is currently being carried out at the Australian Numerical Meteorology Research Centre (ANMRC). The ultimate aim of the ANMRC tropical research programme is to formulate computer models designed to simulate the behaviour of both the monsoon and tropical cyclones and then to improve our ability to predict these two major sources of tropical weather. Close co-operation exists between ANMRC and other Australian institutions studying tropical cyclones. These include the Bureau of Meteorology, the CSIRO Division of Atmospheric Physics and several universities.



Schematic representation of the direction of air circulation in cyclones in the northern and southern hemispheres. North of the equator the sense of rotation of the earth's surface is anti-clockwise, the corresponding rotational force acts to the right of the air particle's movement, and the resultant balance of forces is such that the air rotates around a cyclone in an anti-clockwise direction.

South of the equator the earth rotates clockwise, the rotational force acts to the left, and a cyclone has a clockwise air circulation.



Right, points of origin of all tropical cyclones during the period 1952—1971. Figure from an article by W. M. Gray in the book, *Meteorology Over the Tropical Oceans,* published by the Royal Meteorological Society, Berkshire, U.K., 1979.

WHISPERS, SCREECHES, GURGLES, SCREAMS ....

Possums of Australia Part 1 — The South

by Meredith Smith

The Common Brushtail, *Trichosurus vulpecula*, of all Australia's mammals has probably made the most successful adaptation to urbanisation in Australia. Photo R. & D. Keller, National Photographic Index of Australian Wildlife (NPIAW).

Opposite, the Western Pygmy-possum, *Cercartetus concinnus*, like the Honey Possum also feeds on pollen and nectar, as well as, moths, beetles, cicadas, spiders, termites and other invertebrates. Photo H. & J. Beste (NPIAW).

For many of us it is impossible to remember the number of times we've been woken from a blissful nights sleep by the raucous antics of attention-grabbing possums. Probably the most adaptable of all our native mammals, the 24 species of Australian possums, live in four separate families and range in size from cute little balls of fur weighing no more than 10—12gm to the more robust solidly built Spotted Cuscus which weighs over 4kg.

Meredith Smith, a scientist at the Laboratory Animal Services, South Australian Department of Agriculture, is presently working on the breeding and husbandry of Sugar Gliders. While an expert on Australia's possums, Meredith is also a specialist in mammal reproduction biology having gained her PhD studying this aspect of kangaroos.

Possums are arboreal marsupials with hand-like feet, clawless big toes which are opposable to the other toes and often a long, prehensile tail. In common with kangaroos, wombats and the koala, they have two large incisor teeth in the lower jaw, and the second and third toes are joined together with the claws separate. This is known as syndactyly.

Possums are found in Australia and New Guinea, on islands as far west as Sulawesi and as far east as San Cristobal in the Solomon Islands. Of the 42 species currently recognised, 24 occur in Australia and five of these also occur in New Guinea. They range in size from the Feathertailed Glider, *Acrobates pygmaeus*, weighing 10—12gm to the Spotted Cuscus, *Phalanger maculatus*, weighing over 4kg.

Study of the external form, internal anatomy and of the biochemistry of the blood proteins shows that the possums can be classified into four groups, differing sufficiently for each group to be given the taxonomic rank of family. On this ranking, each possum group is regarded as differing from the others as much as it differs from the kangaroos. One family, containing only the Honey Possum, differs widely from the other three.

While all possums are dependent on trees or shrubs, diversity of form, function and behaviour enables them to occupy a variety of habitats. They occur from coastal heath in southern Australia to above the treeline in the Snowy Mountains and from the seldom-flowing water courses of central Australia to the dripping cloud-forest of mountain tops in tropical Queensland and New Guinea.

The most familiar possum is the Common Brushtail, *Trichosurus vulpecula*, which many home-gardeners know as the nocturnal raider of fruit trees and rosebuds. Mesmerised by the beam of a torch, the pink-nosed, round-eared possum seems unwilling to move, and gives the impression of being sluggish, even when it turns away and merges into the darkness. But sluggish it is not, and released from the intruding torch beam it can move with speed and agility. Its strong claws hold securely in the bark as it scales a tree trunk. It scampers along the top of a branch then, as the branch narrows, swings underneath it, gripping with its hands and feet, the big toe opposing the other toes just as the human thumb opposes the fingers. Reaching the end of the branch, it anchors itself with a turn of its tail around a twig, the naked skin on the underside

Leadbeater's Possum, *Gymnobelideus leadbeateri*, has a precarious existence as its survival depends on the maintenance of forest areas containing eucalypts old enough to develop hollow trunks. Photo Andrew Smith (NPIAW).

of the tail serving to increase friction. Still holding with its feet as well as its tail, the possum reaches out with its hands and body to investigate an adjacent branch. It takes hold, lets go with its feet and tail, and drops a little way as the branch sags beneath the weight. Momentarily off-balance, the possum immediately regains a firm foot-hold and scampers off. It is generally unsociable and encounters between individuals are marked by raucous screeching, uttered repeatedly by each individual as it sits upright on its haunches with arms outspread.

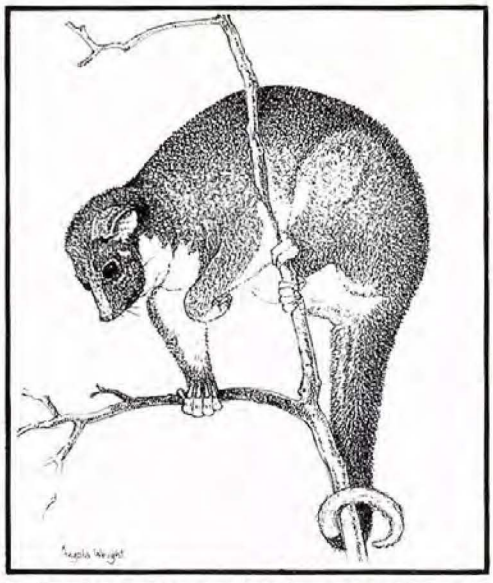
The Common Brushtail lives in open forest, eucalypt woodland and in the gum trees along watercourses in open plains country. In Tasmania it is as abundant in wet sclerophyll forest as in dry sclerophyll forest but in mainland Australia it is generally absent from wet sclerophyll forest and closed forest. However, a subspecies, the Coppery Brushtail of northern Queensland, lives only in closed forest.

Eucalypt leaves are the preferred food but, because these contain toxic oils and phenols their intake is limited by the ability of the possum's liver to detoxify these substances. In order to meet their energy needs, possums regularly graze on grasses and herbs and also eat fruits and flowers. Strictly nocturnal, they retreat at dawn to a tree hollow, emerging again at dusk.

The Common Brushtail has successfully adapted to land development and urbanisation and readily uses man-made structures for its daytime retreat. In New Zealand, where the Common Brushtail was released several times between 1858 and 1920, it has spread over about two-thirds of both islands and causes severe damage to the native forests.

The Common Ringtail *Pseudocheirus peregrinus*, also utilises suburban gardens as a food source, at least in south-eastern Australia. However, it usually shuns buildings and retreats to a round, enclosed nest, sometimes called a drey, built in thick shrubs. Its natural environment is forest or scrub where there are shrubs having dense, tangled foliage. The drey is built in the branches of shrubs, in mistletoe clumps or sometimes in a tree hollow. Bundles of twigs are carried in the coiled tail and woven tightly together into a spherical structure, about 30cm across, lined with bark, fern, grass or moss. Although several ringtails may share a nest they do not allow individuals from other nest-groups to enter.

The natural environment of the Common Ringtail, *Pseudocheirus peregrinus*, is forest or scrub where there are shrubs with dense, tangled foliage. Drawing Angela Wright.



In the wild, the Common Ringtail is strictly herbivorous, eating the leaves of gum trees and shrubs and also some seeds. Dependence on dense shrubs renders the ringtail population susceptible even to partial clearing of its habitat.

Gliding possums, or gliders are specialised for life in open forests. The most widespread of these is the Sugar Glider, *Petaurus breviceps*, which extends from Tasmania throughout forested eastern Australia and coastal Northern Territory to the Kimberley region and in New Guinea below 2,000m altitude, wherever there are trees. It is a small possum, weighing about 120gm, with head-and-body about 170mm long and a fluffy tail about the same length. In northern Australia and Papua New Guinea they are smaller.

The gliding membrane is a fold of skin stretching from the outside of the fifth finger to the ankle covered with dark grey fur above and pale grey below, like the body, and conspicuously fringed with white. A Sugar Glider can glide 40—45m from tree top to tree trunk.

Sugar Glider, *Petaurus breviceps*, has a fold of skin which stretches from the outside of the fifth finger to the ankle. On preparing to glide, the glider lowers its head and leaps, immediately spreading the lower-limbs out widely so that, from below, it appears to be square, with a fluffy tail straight out behind. Photo G. Suckling (NPIAW).

Preparing to glide, it lowers its head and leaps, immediately spreading the four limbs out widely so that, from below, it appears to be square, with the fluffy tail straight out behind. About 3m from its landing place it draws the hindlegs into the body and swoops upwards slightly to land gently. It can swerve, manoeuvre and even turn right around during the glide by movements of the tail and forelimbs. When an animal is not airborne the gliding membrane retracts against the body, its position being marked by the wavy white line of the fringe.

The larger gliders such as the Yellow-bellied Glider, *Petaurus australis*, can travel as far as 100m in one glide. Gliding interspersed with quick scampers up tree trunks to gain height allows the glider to move speedily through open forest or woodland but this technique cannot be used in closed forest. Except for the Sugar Glider, gliders are absent from closed forest. The Sugar Glider does penetrate closed forest, where it borders open forest.

The Sugar Glider is a gregarious animal and groups of two to six or even more share a nest of gum leaves in a tree hollow. Individuals of a group recognise each other by odours produced from scent glands in the skin of the head, chest and cloaca and are smeared with secretion from those glands by the dominant male of the group.

Sugar Gliders from other groups are vigorously attacked with bites to the neck, cheeks and ears, the attack being accompanied by the anger call which is a loud, rapidly gurgling drone that runs down to faint grunts. The alarm call given, for example, when an owl is nearby, is quite different, an intermittent, loud but not harsh yapping. The short muzzle, big eyes and fluffy ear bases give the Sugar Glider a timid, anxious facial expression that belies its pugnacity. Undaunted by animals much larger than themselves, they may oust even a Brushtailed Possum should it attempt to encroach on their food source.

Insects are important in the diet of the Sugar Glider and when moths and beetles are abundant they provide most of the food. At other times the gliders seek the oozing sap of eucalypts, the gum of wattles, nectar and, almost certainly, fruits and seeds. They do not eat gum leaves nor, apparently, any other leaves.

In winter in southeastern Australia when food is scarce and low air temperatures increase the gliders' need to maintain body temperature, their habit of huddling together in a nest enables them to share the heat loss and spare their energy. Moreover when food is scarce a glider may become torpid during the day, its body temperature dropping to 10° or more below that of an active animal (about 36°C), and so reduce the energy expended on body heat. Torpor lasts for less than 16 hours at a time and arousal is spontaneous.

Found only in the rugged sandstone boulder country and dissected plateaux of the Kimberley Region, the Scalytailed Possum, *Wyulda squamicaudata*, is strictly nocturnal. Photo A. G. Wells (NPIAW).

Huddling during severely cold weather may be helpful to the Sugar Glider, but, it is probably essential to the survival of the Leadbeater's Possum, *Gymnobelideus leadbeateri*. This possum is about the same size and has the same proportions as the Sugar Glider but is distinguished from it by the absence of a gliding membrane by having the tail short-haired for the basal third (in contrast to the continuously fluffy tail of the gliders), and in having very short claws on the fingers and toes. It lives in wet and misty eucalypt forest, all the known populations occurring at altitudes between 500m and 1500m. A group of two to eight individuals occupies a deep tree-hollow where they build a nest up to 30cm across from shredded strands of bark from mountain ash trees.

In winter when the ground is snow-covered for many weeks and food is extremely scarce the warm, insulated, shared nest is essential to their survival. Because of their dependence on deep hollows which do not develop in mountain ash trees younger than about 100 years, Leadbeater's Possums cannot survive in forests that do not contain over-mature trees.

The Mountain Pygmy-possum, *Burramys parvus*, a much smaller possum, weighs only about 50gm and survives in a severely cold winter climate by entirely different means. Its habitat is boulder strewn terrain in the subalpine to alpine zone of the Snowy Mountains, at altitudes from 1370m to the highest possible, 2,432m. It lives in deep tunnels formed by the rock scree and the big granite boulders. The surrounding vegetation is of dwarfed alpine herbs and shrubs and, at slightly lower altitudes, snow gums. Strong winds are common, frosts are frequent and the ground is snow-covered for at least three months each year. However, the ground does not freeze and the vegetation holds up the winter snow so that small animals can forage beneath it. The food of the Mountain Pygmy-possum includes plants, worms, beetles, grasshoppers and spiders.

The Leadbeater's Possum is about the same size as the Sugar Glider but is distinguished from it by the absence of a gliding membrane. Drawing Angela Wright.

The Four Pos

Phalangeridae

The Common Brushtail Possum, *Trichosurus vulpecula*, communicates by sound and scent. During the breeding season, the possum uses deep guttural coughs and sharp hisses to mark its home ground. It secretes a reddish substance from glands under the chin, on the chest and near the anus which also serves to establish den ownership. Major predators of the Common Brushtail are the Dingo, Carpet Snake and Lace Monitor.

The Scaly-tailed Possum *Wyulda squamicaudata*, is the only member of its genus. Its natural habitat is very rugged, rocky country where it lives in rock piles during the day, venturing out only at night to feed in the trees. The possum feeds on blossoms though, in captivity, it will eat insects, nuts and leaves.

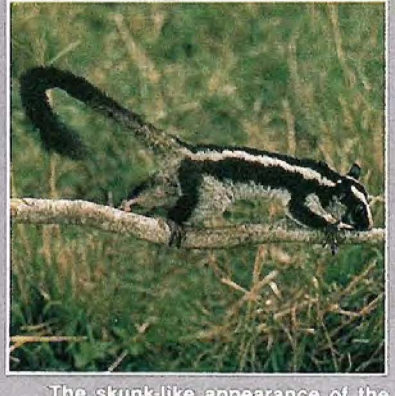
Cuscuses are very different in their behaviour to Brushtails. A Brushtail moves quickly from tree to tree, but a Cuscus is a deliberate climber and, even on the move, continues to grip with three feet with its tail coiled around a branch. The large canine teeth of the common Spotted Cuscus, *Phalanger maculatus*, indicate that its diet is partly carnivorous but, in the wild, it has only been observed to feed on fruit, flowers and leaves.

Petauridae

You will often first detect the presence of the Common Ringtail Possum, *Pseudocheirus peregrinus*, in scrub by its soft, high-pitched twittering call.

The Yellow-bellied Glider, *Petaurus australis*, is the largest and most raucous of the three Australian gliders.

For the Sugar Glider, *Petaurus breviceps*, gliding is an efficient way of exploiting patchy resources.



The skunk-like appearance of the Striped Possum, *Dactylopsila trivirgata*, makes it a conspicuous animal, but its small numbers and shyness cause it to be one of the least known of Australian possums.

sum Families

Burramyidae

The tail of the Feathertail Glider, *Acrobates pygmaeus*, makes it easily distinguishable from any other genus of this family. As a specialised aerodynamic structure, it helps the animal to steer, brake, volplane and anchor itself. The tail is flattened with a fringe of long, stiff hairs along each edge and very short fur on the upper and lower surfaces. The Feathertail Glider is arboreal but it is not restricted to the forest canopy. It forages through the shrub layer and hunts almost to ground level, feeding on insects, nectar and sugary tree sap.

The minute size of the Eastern Pygmy-possum, *Cercartetus nanus*, allows it to nest in very small tree holes. Built of shredded bark, its nests are spherical and of about 6cm in diameter. Abandoned birds' nests and shredded bark in the forks of tea-trees are also used by the possum as nest sites. It breeds from spring to autumn and carries four or sometimes five, young in its pouch for up to six weeks after birth.

With tiny claws on the upper surface of its fingers, the forefoot of the Western Pygmy-possum, *Cercartetus concinnus*, resembles a human hand. The possum grasps its food while it eats, discarding the inedible portions such as wings and hard parts of insects. Its daytime shelter is a gum-leaf nest in a tree hollow where it sleeps immobile until dark.

Tarsipedidae

The Honey Possum, *Tarsipes rostrata*, is the only known species of this highly specialised family. It has fewer teeth than any other marsupial and microanatomical and biological characteristics indicate that it is no more closely related to possums than to quolls or bandicoots. The Honey Possum is thought to be the survivor of an extinct marsupial group that now only exists due to its specialised way of life.

With its long pointed snout and brush-tipped tongue, the Honey Possum is well adapted to an exclusive diet of nectar and pollen. When feeding, it pushes its snout into a flower and licks pollen from the anthers by protruding its tongue through a funnel formed by the upper and lower lips. The possum is only common on coastal sandplain heath where nectar-producing plants can provide it with food throughout the year.

Text adapted from the forthcoming book, The Mammals of Australia, *by Ronald Strahan (ed.); Angus & Robertson, Sydney. This book includes an account of every species of Australian mammal and will be illustrated with colour photographs from the National Photographic Index of Australian Wildlife.*

At the other extreme of climate two tropical possums, the Scalytailed Possum, *Wyulda squamicaudata,* and the Rock-haunting Ringtail, *Petropseudes dahli,* shelter in dens among rocks. The former is found only in the rugged sandstone boulder country and dissected plateaux of the Kimberley region, while the latter is also found throughout the rocky central plateau of Arnhem Land. Both are nocturnal, leaving their rock shelters at night to feed on the leaves, blossoms and fruit of eucalypts and other trees.

The most specialised of the possums is the tiny Honey Possum or Noolbenger, *Tarsipes rostratus,* found in the sandplain heaths and shrub lands of south-western Western Australia. It feeds on pollen and nectar from the flowers of numerous species of *Banksia, Lambertia, Dryandra, Callistemon* and *Hakea.* It has a long snout, about two-thirds the length of the head. Its teeth are rudimentary while its tongue is highly developed. Relaxed, the tongue is about 2 cm long, but it can be extended to at least 4cm in a downward curve. The upper surface bears dense bristles, increasing in length from the base of the tongue and forming a brush at the tip. The curvature of the tongue causes these bristles to be held stiffly erect. At each flower the Honey Possum first rapidly licks the pollen from the stamens and then inserts the tongue rapidly and repetitively, deep into the flower to collect the nectar.

Pygmy-possums of the genus *Cercartetus* do not show any of the Honey Possum's specialisations for flower feeding but also feed on pollen and nectar. However, their diet also includes moths, beetles, cicadas, spiders, termites and other invertebrates. Three of the four species live in forests of south-eastern Australia, where food shortage occurs at the same time as severe cold. All undergo daily torpor, with body temperature falling sometimes to as low as air temperature. Torpor is more profound than in the Sugar Glider and may last for several days at a time. Feathertail gliders are closely related to pygmy-possums, whereas the other gliders are related to ringtails.

No species of possum known to be living at the end of the Pleistocene Epoch has since become extinct. The survival of several of them, such as the adaptable Common Brushtail and the widespread Sugar Glider, seems assured, and many others are in no danger at present. However, all possums are dependent on trees or shrubs and their habitat is destroyed by clearing — for many of them it is destroyed simply by a reduction in the density of undergrowth. Leadbeater's Possum has the most precarious existence, since it's survival depends on the maintenance of forest areas containing eucalypts old enough to develop hollow trunks.

The Honey Possum, *Tarsipes rostrata,* lives in the sandplain heaths and shrublands of south-western Western Australia. Photo A. G. Wells (NPIAW).

This nocturnal raider of fruit trees and rosebuds, the Common Brushtail Possum, *Trichosurus vulpecula,* is notorious with home-gardeners. Photo H. & J. Beste (NPIAW).

THE PRIVATE LIVES OF TREECREEPERS

Australia's treecreepers are not our most conspicious birds but they are quite unusual. Small and brown with short tails, long bills and large, strong legs and feet treecreepers hunt for food on tree trunks and branches.

Richard Noske studied the behaviour and ecology of the three species of treecreepers that inhabit south-eastern Australia over four years, as part of his post-graduate research. In this article he describes many aspects of the natural history of these three birds — the White-throated, Red-browed and Brown Treecreeper — for the first time.

by Richard Noske

A colour-banded male Brown Treecreeper, *Climacteris picumnus*, about to feed its nestlings. The male is distinguished by black flecks on the feathers of the chest. These are replaced by rufous stripes on the female. Photo Richard Noske.

In a country where woodpeckers are conspicuously absent, it is somewhat ironical that the Australian treecreepers are known to many Australians as 'woodpeckers'. Once grouped with the treecreepers of the northern hemisphere (Certhiidae), the Australian treecreepers (Climacteridae) are now regarded as a distinct family which evolved from a large, ancient collection of birds from the Australasian region. Like their northern counterparts, the Australian treecreepers typically forage by climbing up tree-trunks and along branches, though some species also feed on the ground. There are six species in Australia and one in New Guinea.

Three species of treecreepers are found in south-eastern Australia. They are the familiar White-throated Treecreeper, *Climacteris leucophaea,* which inhabits all types of rainforest, sclerophyll forests and wetter woodlands, the Red-browed Treecreeper, *C. erythrops,* which inhabits wet sclerophyll forests (particularly along the Great Dividing Range) and lastly the larger Brown Treecreeper, *C. picumnus,* which mainly occurs in open woodlands but is also found in sclerophyll forests. The last two species rarely occur together, but each occurs commonly with the White-Throated.

The Brown Treecreeper forages extensively on the ground and rarely encounters the smaller more arboreal White-throated Treecreeper where their ranges overlap. The Red-browed Treecreeper, however, is very similar in both size and foraging behaviour to the White-throated and these two species often co-exist. Despite these similarities, scientific evidence indicates that the Red-browed is more closely related to the Brown Treecreeper than either is to the White-throated. These relationships are best shown by contrasting the life styles of these three birds.

The White-throated Treecreeper lives in territories as small as five hectares which are occupied and defended year-round by one pair of birds. The male and female partners rarely forage together during the non-breeding season keeping mostly to their own corner of the territory. This reflects the characteristically anti-social nature of this species.

White-throated Treecreepers maintain their territories through displays and a complex repertoire of calls some of which are sexually diagnostic. Even disputes between mated pairs involve one bird chasing the other to the accompaniment of loud calls. However, neither sex is consistently dominant over the other.

Non-aggressive encounters frequently occur between members of different pairs along the borders of territories. These encounters are characterised by a repeated clicking noise, as the tail and wings of the birds are rapidly flicked open. The participants otherwise remain silent and stay separated by about five metres. At the other extreme, when one or both members of two (occasionally three) neighbouring pairs meet, physical scuffles may ensue. The duellists spar as they scamper up the tree-trunks, clashing furiously in the air and tumbling towards the ground with feathers flying, until the loser flees. Bills are gaped, tails fanned and wings spread during these battles, which usually last less than five minutes. One skirmish between two unmated males competing for a lone, previously mated female and her territory lasted continuously for over an hour.

At the onset of breeding,the male becomes extremely vocal giving loud tremulous, crescendo calls. He flies to the female with food, announcing his arrival with a fast trill, which causes his body to vibrate and the feathers of his forehead to stand erect. After the female accepts the food, he flies off, minimising the period of close contact.

The pre-copulation display of the White-throated Treecreeper is no less exciting than a territorial dispute. Initially, the male gives a series of loud crescendo calls from a selected site at the base of a thick, sloping branch, where he waits for the female. With each call, he lowers the top of his body and shivers his slightly-spread wings vigorously, tilting his tail gradually upward until it is vertical.

As the female approaches, his display intensifies. His convulsions become more protracted and his wings spread horizontally. On her arrival, the female perches behind the male and he approaches (sometimes backwards) with one or both wings stretched skyward. After a minute or two, the apparently unimpressed female usually flies away leaving her mate to 'cool off' — sometimes he may chase her uttering buzzing and squealing notes, while his wings shake feverishly. If she stays, the pair move to the trunk, and copulation takes place.

Another example of the intolerance of members of this species towards each other is the ostracism of young by the parents. Less than three weeks after leaving the nest, young White-throated Treecreepers are harrassed by their parents and most are evicted by late December, only 30 to 45 days after fledging. During the first three months of the year, the young search widely for a new 'home' which may be either an established territory with a vacancy, or an unoccupied area which might be less favourable.

The social organisation of both the Red-browed and Brown Treecreepers is quite different to that of the White-throated as the offspring of the two former are often allowed to remain with their parents for two years or more. Because these young usually aid their parents in subsequent breeding efforts, they are known as auxiliaries or helpers. Groups rarely contain more than one female, so helpers are invariably males. Since this uneven sex ratio favouring males is not evident in nestlings, it is presumed that young females disperse, or are expelled by their parents, mostly to perish.

A major difference between the three species lies in the length of time between laying and hatching of the last egg. In the Red-browed Treecreeper, *Climacteris erythrops*, this time, known as the incubation period, is about 18 days. Photo J. Purnell (NPIAW).

Brown Treecreepers live in territories which stay fairly constant in size and shape from year to year, regardless of the number of inhabitants. Photo K. B. Richards (NPIAW).

Red-browed and Brown Treecreepers form territories much larger than those of the White-throated Treecreepers. These territories change little in size and shape from year to year, regardless of the number of inhabitants. Occasionally quarrels erupt within groups, but there is a strict dominance hierarchy in which females are always subordinate — even to younger males!

Territories are defended less rigorously than in the case of the White-throated Treecreeper, and there is some peripheral overlap of ranges between groups. Fights rarely occur due to the frequent employment of an appeasement display, in which the trespassing or subordinate bird crouches submissively before the advancing bird, and flutters its wings over its back.

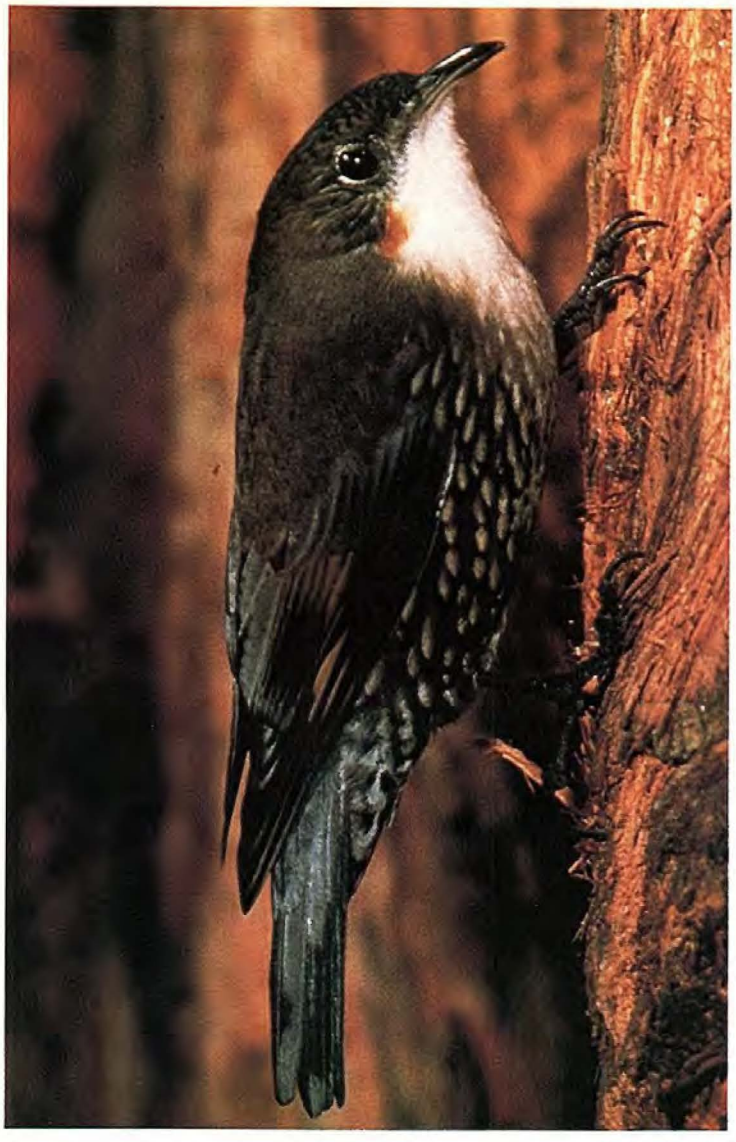
Though the calls of Red-browed and Brown Treecreepers differ greatly, neither have more than five distinct calls and none of these is sexually diagnostic. In both species, 'conversations' occur between group members by simultaneous or alternate calling, involving two or more distinct calls. The pre-copulation displays of these species are relatively simple, subdued affairs compared to those of the White-throated Treecreepers and there is a more active participation by the female. Prior to copulation, the female crouches low, with raised tail and quivering wings, while the male hops around her, often with an insect in his bill.

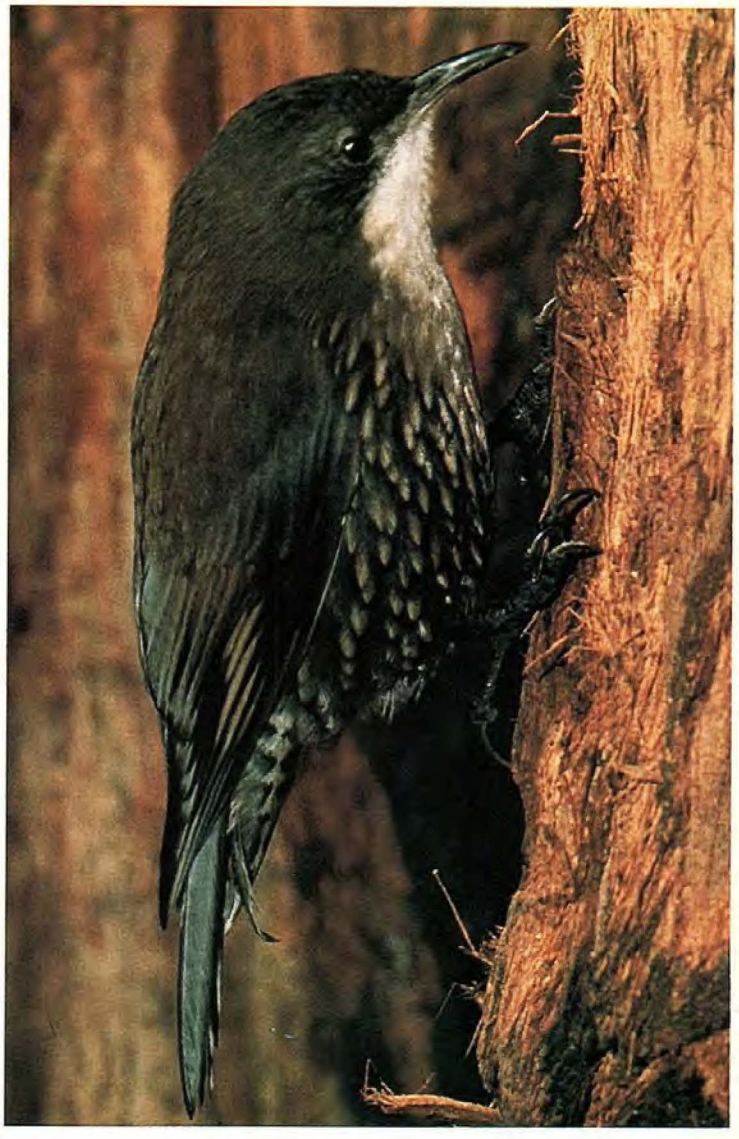
As all males in the group feed the female during breeding, it is possible that promiscuous matings may occur, but in most cases there is probably only one breeding male per group.

At night, all species roost singly but there is a striking difference between the roost-sites of the three species. White-throated Treecreepers prefer fissures or cavities on the surface of tree-trunks, or shallow depressions at the junction of two limbs (sometimes only one or two metres above the ground). Red-browed and Brown Treecreepers on the other hand, sleep inside hollow dead branches or trunks of trees — sometimes at great heights. Old nest sites are sometimes used. Possibly because of the exposed nature of their roost sites, White-throated Treecreepers go to roost later than the other species.

All treecreepers breed in spring and early summer, but the Brown and Red-browed Treecreepers both begin earlier than the White-throated. The nest of each species, built inside a tree-hole is composed of bark and grass and lined with fur and feathers. Each species differs somewhat in their nest-sites. White-throated Treecreepers prefer holes going directly into trunks or thick limbs of live trees, while Red-browed and Brown Treecreepers usually choose hollow dead branches or 'spouts' often in dead trees. In semi-cleared woodlands, the Brown Treecreeper typically nests in hollow fenceposts or tree-stumps.

Nest-building is exclusively the task of the female White-throated Treecreeper, although the male sometimes accompanies her to the nest entrance. In the other two species, however, males (including helpers) also par-





The White-throated Treecreeper, *Climacteris leucophaea*, lives in territories as small as five hectares, which are occupied and defended year-round by one pair of birds. During the non-breeding season the male (right) and female (left) mostly keep to their own corner of the territory. Photos T. & P. Gardner (NPIAW).

ticipate in the construction of the nest though much of the initial work is done by the female.

'Sweeping' is a common, yet hitherto undescribed habit of treecreepers which like building, is performed only by the female White-throated Treecreeper and by both sexes in the other two species. The bird holds material in its bill and wipes it back and forth sideways for up to half an hour over the bark surface in and around the nest-hole, and on adjacent branches. The material is usually a clear translucent substance like snake-skin, insect wings, or (in settled areas) fragments of plastic bags. The abrasive action of sweeping, or the chemical properties of the material used, may serve to disrupt scent marks on the bark left by possums or other animals, which compete with treecreepers for tree hollows occasionally causing nest losses.

Two or three eggs are laid with equal frequency by both the White-throated and Brown Treecreepers while the Red-browed lays only two eggs. White-throated Treecreepers take five to six days to lay three eggs, while Brown Treecreepers may lay this number in three days. Incubation of eggs generally begins with the completion of the clutch, so that the eggs all hatch on the same day. In some broods, however, one nestling is significantly larger or smaller than its siblings and eventually fledges a day earlier, or later.

In all species, incubation is the sole responsibility of the female, who spends 50 to 80 percent of each 'working' day sitting on the nest. Incubation sessions vary in length from two minutes to over an hour, but most often they are less than 30 minutes. Males feed the female both on and off the nest.

As the female White-throated Treecreeper emerges from her nest after sitting, she often utters a single sharp note, apparently to inform her mate that she is no longer confined and requires refreshments. The pair then forage together, the male being more active than the female. During this time, she frequently gives a soft twitter, somewhat similar to the food-begging calls of juveniles of this species. By contrast, the incubating females of the other species lack distinctive food-soliciting calls and are often fed by more than one male.

A major difference between the three species lies in the length of time between laying and hatching of the last egg, (the incubation period). White-throated Treecreepers have a period of 22 to 23 days — probably one of the longest incubation periods among passerines (songbirds) of Australia, or for that matter, anywhere. The larger Brown Treecreeper incubates for 16 to 17 days and the Red-browed about 18 days.

Despite this variation the White-throated Treecreeper spends at least as much time

each day sitting as other treecreeper species. Moreover, the eggs of the White-throated Treecreeper differ markedly in colour and pattern, being white, sparingly dotted with dark-brown, whereas the Brown and Red-browed Treecreepers lay pink or pinkish-white eggs, thickly marked with brown and dull purple. These disparities are certainly much greater than one might expect of birds of the same type.

Unlike the incubation period, the nestling period (from hatching to fledging of the young) is the same for all species — 25 to 26 days. This again is an exceptionally long period for such small birds, but like most hole-nesting birds throughout the world, young treecreepers leave the nest at a more advanced stage than birds in open cup nests. The mother broods the young for at least 14 days after hatching in all species, though the time she spends on the nest decreases as the young grow.

When they hatch, baby treecreepers are blind and naked, except for tufts of grey down on the head and back. Five days after hatching, the nestling has tiny blue quills along its arm. Tail quills do not appear until later. By the ninth day, the tail and primary wing feathers have burst from their quills and the eyes are almost fully open. Between the 14th and 15th days, the nestling attains adult body weight although its wing feathers are only about half-grown and its tail less than half grown.

When it fledges, another 10 or 11 days later, the young bird's wings are nearly fully developed but its tail is considerably shorter than in adults. From 18 days, however, the young are capable of weak flight, and premature departures undoubtedly occur through natural disturbances.

Sexual dimorphism in all three species is apparent before the young leave the nest. It is possible to sex nestling White-throated Treecreepers as early as eight days after hatching, by the same criterion as adults. In addition the feathers emerging from the quills above the tail of females are usually bright chestnut-orange, and on males they are usually grey. The spectacular rump patch of juvenile females probably disappears in the first year, but some retain traces of orange for over three years. Juvenile White-throated Treecreepers also possess creamy-white streaks around the

Tree-holes are favourite nest-sites of the White-throated Treecreepers (top), whereas hollow dead spots (middle, a Red-browed Treecreeper by its nest and bottom, a Brown Treecreeper at its nest) are more commonly used by both the Red-browed and Brown Treecreepers. There is much overlap in sites, however, depending on the availability of holes of suitable depth and width. Middle photo J. Purnell, bottom photo L. G. Chandler (both NPIAW).

White-throated Treecreeper

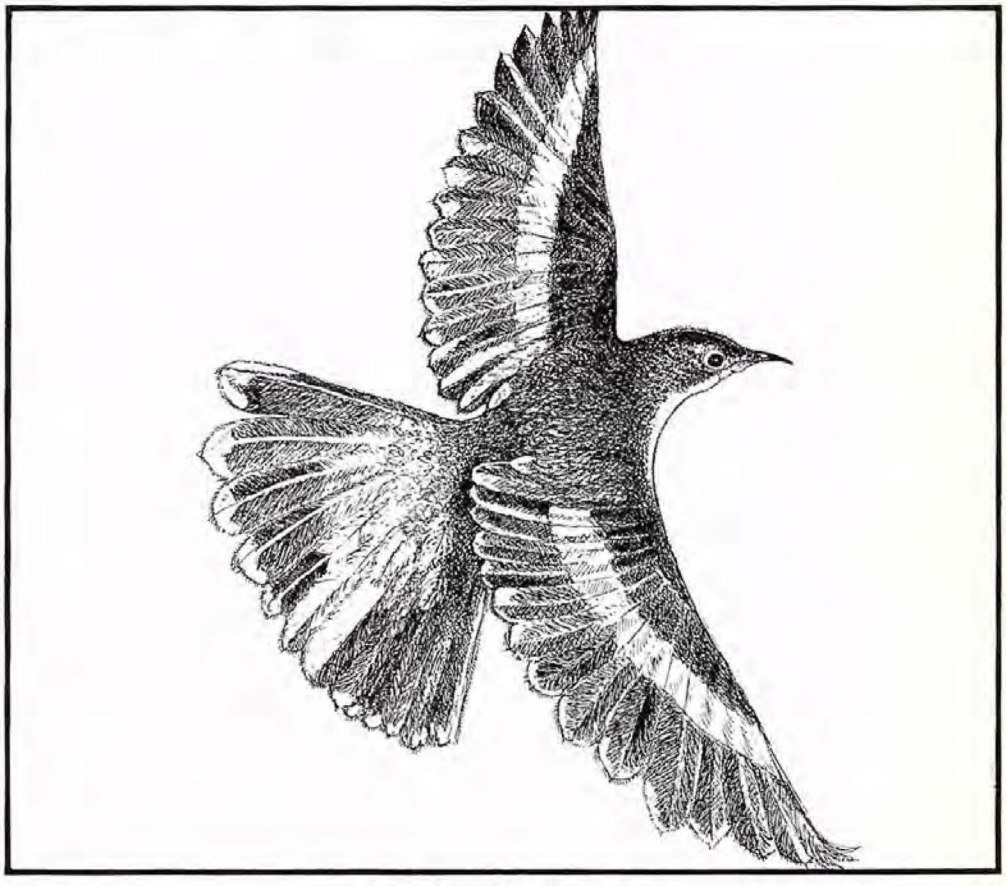
The White-throated Treecreeper while most common in rain and wet sclerophyll forest also occurs in open woodland. The bird is less common west of the Dividing Range and casual visitors have been sighted in Tasmania.

Red-browed Treecreeper

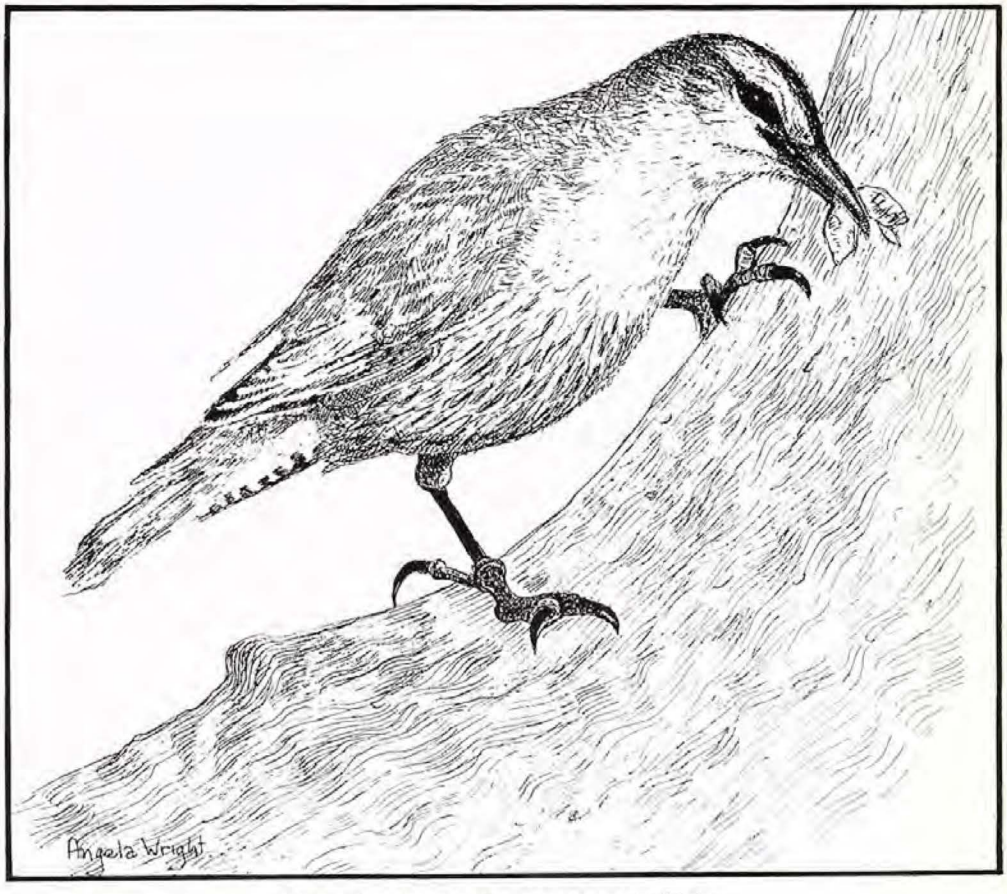
Common in some localities of heavy mountain forest but rare in coastal rainforest.

Brown Treecreeper

Common to abundant in open eucalypt woodland, the Brown Treecreeper is also a straggler on Flinders Island. The Black Treecreeper, the same species as the Brown Treecreeper, occurs north of Cardwell in Queensland, with intermediates living north of Townsville. Dark-crowned Brown Treecreepers live through much of eastern Queensland.



White-throated Treecreeper



Brown Treecreeper Drawings Angela Wright.

back and shoulder, but apart from this variable character, young males are almost indistinguishable from adult males. This situation contrasts with the distinctive juvenile plumages of both Red-browed and Brown Treecreepers.

Young Brown Treecreepers have a darker, more contrasting plumage than adults, and young Red-browed Treecreepers have grey faces and plain buff underparts which superficially resemble the Brown Treecreepers.

The black markings on the lower throat of the male Brown Treecreeper emerge about the 16th day, while the rufous throat markings of the female appear on the 20th day in both the Brown and Red-browed Treecreepers.

On the first day or two out of the nest, young Red-browed and Brown Treecreepers usually remain in hollow dead branches or trunks of trees. White-throated Treecreepers on the other hand, perch or climb in the open immediately after they fledge. The food begging call of Brown Treecreeper nestlings is very similar to the main adult call of their species but young White-throated Treecreepers give a distinctive, 'explosive' chatter, unlike any common adult call.

Juvenile White-throated Treecreepers are fed by their parents until they are expelled from the territory. Juveniles of the other two species are fed for at least a month after fledging, though young Red-browed Treecreepers are occasionally fed until they are three months old, a fact probably related to the slow plumage development in this species.

The early nesting, short periods of laying and incubation and participation of both sexes in nest bulding in the Brown and Red-browed Treecreepers are characteristics which enable second broods to be raised in the same season. This is made easier by the fact that helpers can do most of the caring of the first brood, which allows the parents to re-nest. Lacking these time and work savings, the White-throated Treecreeper is normally single-brooded.

In the social Red-browed and Brown Treecreepers, all group members share in feeding and defending the nestlings and fledglings. Helpers can provide up to 70 percent of the food brought to nestlings, greatly easing the burden of the parents.

Communal breeding is well-developed in the Brown Treecreeper, where as many as six birds feed the young at one nest. For most of the year, related breeding birds defend their territories against each other but during the nestling and fledgling periods, territoriality is somewhat relaxed and the breeder will accept help from any surviving male relatives. Therefore a breeding male may attend his own young as well as his parent's young, simultaneously. Non-breeders also commonly attend young at two nests — a rare phenomena among communal breeders.

Communal breeding is well-developed in the Brown Treecreeper, where as many as six birds feed the young at one nest. Photo W. J. Labbett (NPIAW).

Despite the high degree of social tolerance exhibited by these treecreepers, they do not seek physical contact like many other group-living species of birds. They do not preen each other, or cluster together at any time.

Most aspects of the social organisation and breeding biology of these three treecreepers argue strongly that the White-throated diverged from the other species long ago. Although it occurs in many other habitats, the White-throated is the only species to be found in rainforests — indeed, an isolated population in northern Queensland (sometimes considered a separate species) is confined to rainforests.

The preferred nest-holes and external roost-sites of the White-throated Treecreeper possibly indicate that this species is primarily adapted to the softwoods characteristic of rainforests, where dead limbs are scarce owing to rapid decomposition. In contrast, such limbs are abundant on the hardwood eucalypts of sclerophyll forests and woodlands, where they are used for roosting, nesting and fledging by Red-browed and Brown Treecreepers.

The reduced visual contact in dense rainforests may also explain the evolution of a diverse vocal repertoire in White-throated Treecreepers. Moreover, long incubation periods, such as that found in this species, are more typical of rainforest birds, though the reasons for this are not clear.

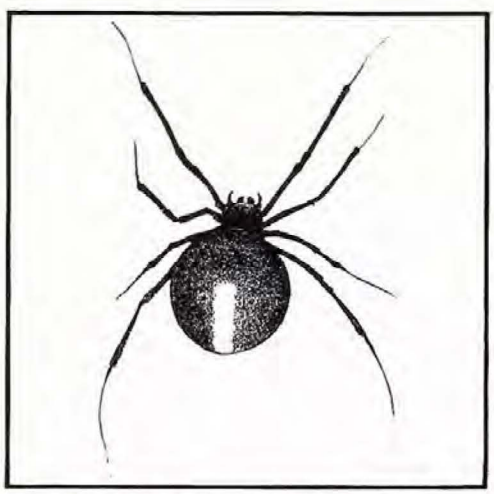
RED BACKS — WHAT EVERY OUTHOUSE NEEDS

Red Backs, one of our more well-known venomous spiders, live particularly well in any man-made structures or debris and as a result caused 13 deaths before the introduction of an antivenom 26 years ago.

In this article Mike Gray, and Arachnologist (spider expert) at the Australian Museum has provided a bit of background on this spider covering its life history, behaviour and the effects of bites on humans.

by Mike Gray

Female Red Back Spider with egg sacs in the upper retreat area of the web. Photo Mike Gray.



The Red Back Spider, *L. Hasselti*, is closely related to the Black Widow Spider and they were previously placed together as a single species. Recent studies suggest, however, that they are in fact distinct species. Other common widow spiders include the red splashed Malmignatte ('evil blood-sucker') of the Mediterranean region and its darker form, the Karakurt (Black Wolf) of southern Russia; the Knoppespinnekop or Shoebutton Spider of southern Africa, black with white spots; and the Brown Widow Spider of South America, brownish with red and yellow mottling. Drawing Angela Wright.

At some time or other most people will have come across that ubiquitous Australian, the Red Back Spider. This widely distributed, spectacularly coloured animal is probably the best known of our dangerously venomous spiders. Its notoriety has even extended as far as having a popular song, 'The Red Back on the Toilet Seat', devoted to it. This notable piece of Australiana graphically refers to one of the perils faced by earlier generations of Australians. Bites from Red Back Spiders remain a common occurrence today but most do not result in serious symptoms. No deaths have been recorded since the introduction of an antivenom in 1956.

The Red Back Spiders belong to a group of some twenty species called the Widow Spiders, genus *Latrodectus (*Greek, Robber-biter). These spiders are widely distributed in the warmer regions of the world. Most of the Widow Spiders appear to have venom which is toxic to humans. The most famous representative is the Black Widow Spider, *L. mactans,* of south eastern North America, Mexico and the West Indies.

Besides Australia, the Red Back occurs in Papua New Guinea and some Pacific islands, South East Asia and probably India. In New Zealand a very similar spider *(L. katipo)* goes under the name of the Katipo or Night Stinger. The habits of this spider differ from its Australian relative in that its webs are found only in coastal regions, in dry river beds and near beaches, often at the base of vegetation or under detritus.

In Australia the Red Back is found in most regions that are not climatically very arid or cold. They are common in open sclerophyll forest habitats and can be found in dry logs, stumps, soil banks, under bark and rocks and in thick shrub foliage. On the Nullarbor Plain they are very common in cave entrances.

Red Back Spiders have adapted particularly well to man-made structures and detritus. They are likely to be found in any dry, dark, undisturbed areas such as rubbish dumps and storage areas, among rafters, under floorboards, in garages, outdoor toilets and laundries. Sometimes they are found in vegetable patches among broad leafed plants such as cabbages and melons.

Undoubtedly the wide distribution of Red Back Spiders has been partly brought about by their association with humans — passive transport of spiders in vehicles and goods was going on for much of the European occupation of Australia. It has also been suggested that the Red Back may have entered Australia from the north with the original Aboriginal and Polynesian immigrants — however this remains conjectural.

Female Red Backs build characteristic webs, though the size varies depending on where they are built (usually in the restricted spaces under rocks or extending from the roof to the floor of sheds). The silk is strong and often rather coarse. The upper part of the web forms a funnel-like retreat and this merges below with an irregular labyrinth of threads from which vertical prey capture lines run down to the ground. These lines are under some tension and will retract upwards if broken. They are also the only parts of the web which have sticky silk globules for entangling prey.

The web is designed to capture walking prey — mainly insects such as beetles, slaters, spiders and many other ground dwelling invertebrates. When a prey animal walks into the forest of catching lines its frantic struggle to escape from the sticky trap may break some lines. These then retract upwards, partially lifting smaller prey, so reducing leg purchase on the ground and the chances of escape.

The female Red Back is quickly attracted down to the struggling victim and proceeds to throw out swathes of silk from her spinnerets, further entangling it. The spider uses a row of barbed bristles on the last segment of the fourth leg in comb-like fashion to rapidly draw out the bands of swathing silk.

Eventually the spider descends to the immobilised prey and bites it, usually on a leg. Once subdued the prey is hoisted about halfway up the web where the spider feeds upon it. Feeding may continue over several days depending on the prey's size. It is not unusual for prey the size of male Trapdoor Spiders to be caught and eaten — occasionally even small vertebrates such as skink lizards fall victim.

The characteristic colour pattern of the female Red Back usually makes it an easy spider to recognise. The colour of the red dorsal stripe and the red ventral hour glass mark on the glossy black to brown abdomen can vary from bright red to orange. The dorsal stripe may be broken into one or two spots in front and occasionally one or two pairs of thin white lateral lines may be present. Spiders lacking obvious red markings almost always prove to belong to a common related genus, *Steatoda,* whose members are not dangerously venomous.

Prior to maturity the juvenile spiders go through a series of striking colour pattern phases linked to successive moults. The young emerge from the egg sac as tiny spiderlings with white abdomens spotted with black markings. In subsequent stages brown-black abdominal colouration increases, red dorsal and ventral markings gradually develop and the white colouration is reduced to lateral stripes.

The typical black and red colour pattern of the female spider is reached with the final moult to adulthood. By contrast, male spiders take fewer moults to mature and retain a juvenile colour pattern. The males are also much smaller than the females measuring some 2-4mm in body length compared to 7-12mm for females.

Female spiders may be found at most times of the year but they and males are most abundant during the spring and summer months when mating and egg laying activity is highest. A female will make between two and six egg sacs in a season, each containing 50-300 eggs. Egg laying can continue into autumn. After 3-10 weeks of development (this variation may be largely temperature dependent) the spiderlings emerge and cluster in the mother's web. Most of the female population dies off during winter and the mother's body sometimes provides a source of food for the young.

It is only the bite of the female Red Back Spider that causes envenomation problems. The fangs of the smaller males are too weak and short to effectively penetrate human skin. The venom glands are relatively large, extending from the jaw bases back into the cephalothorax.

Little is known of the biochemistry of Red Back venom, though its main toxic component is no doubt very similar to that of the American Black Widow spider — an acidic protein, latrotoxin.

The major action of the venom is to interfere with nervous transmission at neuromuscular junctions resulting in paralysis of voluntary muscles. It is probably this action that makes the venom such an effective immobilising agent against the invertebrate prey of these spiders.

Female Red Back Spider, Photo Heather Mclennan.

In humans the venom is relatively slow in its action and consequently it is not necessary to take first aid measures prior to receiving medical advice. The application of a constrictive bandage may increase the severity of local pain. The latter can be reduced to some extent by cooling with ice packs.

Many people are bitten each year by Red Back Spiders but only a minority develop symptoms requiring treatment. Nowadays the usual site of bites is on upper or lower limb, a contrast to earlier times when pan toilets were widely used and bites to the buttocks and genitalia were common.

The symptoms of Red Back Spider bite are fairly characteristic — local pain which spreads and intensifies, nausea and/or vomiting, sweating and general muscular weakness. The bitten area may be marked by a skin weal and local sweating and swelling.

Death from Red Back bites has been eliminated since the introduction of an antivenom 25 years ago. In the period before this 13 deaths were recorded. Treatment with antivenom has proved effective up to 80 hours after being bitten.

Red Back Spiders can be controlled by eliminating potential nesting sites wherever possible. In areas where this is impractical individual webs can be searched for and either physically destroyed (with their occupant) or sprayed with household insecticide, with particular attention to the upper retreat area.

IN REVIEW

CARNIVOROUS MARSUPIALS

CARNIVOROUS MARSUPIALS

Carnivorous Marsupials **edited by Michael Archer. Royal Zoological Society of New South Wales, 1982, 2 volumes, 804 pages, $33.00.**

From *Kangaroos and men* and *Monotreme Biology* we have learned to expect excellence in the Symposia of the Royal Zoological Society of NSW. These two volumes, the proceedings of a symposium held in May, 1980. surpass even that expectation. The intended readership is the professional biologist and research student, but the general reader should find many of the articles, particularly in volume 1, useful.

The 64 articles, written mainly in the standard format of scientific journal papers, are arranged in six sections following an introduction by the editor. Five of these sections contain at least one article which gives a broad review of the entire topic. A total of 18 of the articles serve at least in part as reviews of particular subjects. Topics covered in the six sections are reproduction and life histories, ecology, physiology, behaviour, palaeontology and phylogeny.

The main subjects of these studies are the Australian carnivorous marsupials, the Dasyurids and their allies. Only three of the articles deal in any depth with the American marsupials. There are, however, five papers on Australia's fossil marsupial 'lions', the Thylacoleonidae, including two studies showing there is now little doubt these aberrant 'possums' were indeed carnivores.

The first section is headed by an excellent review of life history strategies in dasyurids by Lee, Woolley and Braithwaite in which they describe six combinations of oestrus pattern, duration and timing of breeding and longevity of males. The unique phenomenon of total adult male mortality after a single breeding season is now known for 18 of the 28 species they reviewed. The remaining eight papers in this section describe various aspects of reproduction, including the description of reproductive patterns in three genera not previously studied.

The 13 papers in the ecology section deal with a variety of approaches to the study of animals in relation to their habitats, food sources and relationships to other species in the community, with the two major reviews by Fox and Morton setting the tone for an overview of dasyurid ecology. Fox presents a detailed synthesis of the pattern of animal species in a community and Morton reviews the adaptations to life in the arid interior of Australia.

The section on physiology is disappointingly short and lacks any attempt at synthesis or overall view. The behaviour section is also quite short, no doubt reflecting the scarcity of studies in this field, but is preceded by a thorough review of communicatory behaviour by Croft.

Volume 2 is devoted to the palaeontology and phylogeny of the carnivorous marsupials with 12 and 16 contributions, respectively. There is considerable overlap in content between these two sections, and Archer's review in the first paper of this volume really serves as an introduction to the entire volume. Indeed the first two papers of the palaeontology section appear to group more naturally with the three leading reviews in the final section.

The remaining palaeontological papers deal with revisions of fossil genera, descriptions of fossil faunas and with the analysis of the thylacoleonids as carnivores.

The final section contains almost the whole range of diverse methods now being used to assess the phylogenetic relatonships of animals. Many of these techniques are comparatively new and more, newer ones are presently being developed.

The range of topics covered in these two volumes is sufficiently broad, and the depth to which most of the topics are covered sufficiently deep, that it should stand as the major source of information on dasyurid biology up to 1980. The inclusion of reviews written after symposium to give unity to the various sections is welcomed, particularly as the reviewers have all obviously approached their tasks conscientiously.

In producing such a thorough and valuable contribution to marsupial biology at a price that will barely cover production costs, the society and particularly the editor are to be highly commended. More such alternative publishing should be encouraged if we are to reverse the trend where only the richest libraries can afford the latest books. — *George M. McKay, School of Biological Sciences, Macquarie University.*

A Million Wild Acres **by Eric Rolls, Nelson, Melbourne. 1981, 465 pages**

From the first settlement of NSW, Rolls takes us step by step to the present conditions of the Pilliga scrub — a vast area on the northwest slopes of NSW. In this well-written and lively account of the early settlement, there are no dusty recitation of facts but personalities — rogues, adventurers, squatters, capitalists and ordinary people. Rolls has succeeded in blending traditional narrative, folk history, social history and astute observations into a coherent and engaging story.

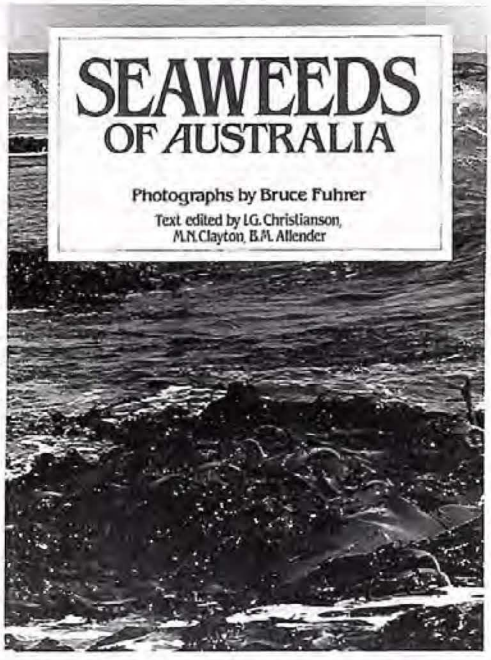
The historical aspects are well researched and Rolls has used an impressive list of primary source documents. But interpretation of descriptions in early documents is fraught with danger. Field ecologists and naturalists should be aware of the difficulties of trying to assess early imprecise en passant descriptions of vegetation. How do we interpret 'impenetrable', 'low scrub', 'dense forest', 'well-clothed hills', 'spaces clear of trees may be imaginary islands'? Each evokes a varied scene to different people yet this is what we must use.

Rolls has unconsciously opened a Pandora's box of doubts and confusion because he tries to fill one of the largest gaps in our knowledge of Australian vegetation: what happened after white settlement? Two hundred years of settlement has wrought enormous changes on the vegetation. Some communities have virtually disappeared; others such as the Ironbark, *E. crebra*, and White Pine, *Callitris columellaris*, forests in the Pilliga have changed more subtly. Density of both canopy trees and shrubs has apparently increased. Relying mainly on anecdotal evidence, Rolls argues this convincingly.

However, when he goes beyond his beloved Pilliga his arguments are no longer as enthusiastic nor as convincing. His ultimate folly is to tell us (on page 250) that the karri and jarrah forests of south-west Western Australia "were the only big areas of thick eucalypts in Australia at the time of settlement"! He summarises these extreme views in the introduction (on page 1), and the publisher repeats it on the dustjacket. "Australia's dense forests are not the remnants of two hundred years of energetic clearing, they are the product of one hundred years of energetic growth". Given that his geographic area of interest is a broad corridor between Sydney and the Pilliga, his continental extrapolation is rash to say the least.

Rolls occasionally makes serious factual errors. On page 251 he states that only Australian plants are adapted to fire. What about Africa, North America and South America? Of more local concern is his definite statement (on page 251) that plants around Sydney have evolved under a regime of regular and frequent winter fire.

This is part of the Pandora's box. For too long, professional ecologists have published papers which are unintelligible to the public. Ecological arguments are complex, they need to be, as the systems are complex. But when are we, as a profession, going to acknowledge our obligation to inform the public with reliable and digestible science. A diet of pap is unnecessary and demeaning, but so are the distortions and half truths so often espoused by the conservation movement, some government bodies and some individual private groups. Rolls had no need to go beyond the Pilliga, nor to use simplistic assertions in place of reasoned arguments.



Buy the book read and enjoy it, — you will certainly learn from it provided you separate the wheat from the chaff. — *John Pickard, School of Biological Sciences, Macquarie University.*

Seaweeds of Australia, **photographs by Bruce Fuhrer, text edited by I. G. Christianson, M. N. Clayton, B. M. Allender, Reed, NZ, 1981, 110 pages, 186 illustrations in colour, $17.95.**

'A picture is worth a thousand words' and this thesis is no dubt the basis of the flood of 'coffee-table' books which have appeared on the market of late. However, in this conglomeration, there has been a noticeable absence of books about underwater plants.

There has been an increasing awareness of seaweeds and of their importance since the World War II, when the absence of Japanese-produced agar stimulated many countries to scour their own coastlines for possible substitute agar sources. Since then growing world concern with additional sources of food from the sea, and with environmental effects of pollution, have led to increasing studies of the marine flora. There is now both academic and general interest in local marine floras.

As a result the timing is perfect to produce a book on the Seaweeds of Australia, lavishly illustrated with excellent colour photographs. The book will enable the budding student to see what a specific alga looks like, avoiding the need to study descriptive texts which often depend on microscopic details only available in specialised journals.

The species illustrated do not seem to be selected for use, for frequency, or range of occurrence or on any other particular basis. More detail should have been given about the distribution of the species chosen. For instance two illustrations are allotted to *Gigartina wehliae,* known only from a limited area in South Australia, while *Gracilaria verrucosa,* the species on which an agar industry in Australia thrived for some years, is omitted.

Despite these comments there is no doubt this welcome book provides a beautifully illustrated record of nearly 150 Australian seaweeds. The detail given is accurate and up-to-date and the publication fills a niche in our Australian literature. — *Valerie May, National Herbarium of New South Wales, Royal Botanic Gardens.*

Australian Aborigines: The Languages and Customs of Several Tribes of Aborigines in the Western District of Victoria, Australia **by James Dawson, Australian Institute of Aboriginal Studies, 1981, 215 pages (including the Appendix), $14.95.**

This book is a must for collectors of Australiana. Produced exactly 100 years after the original version in 1881, *Australian Aborigines* is a beautifully executed facsimile of James Dawson's account of Aboriginal life in western Victoria. The facsimile version has an introduction by J. Critchett, devoted largely to biographical notes on Dawson, which helps the reader to interpret the book within its late nineteenth century social context, and to identify passages in which Dawson has misunderstood some aspects of Aboriginal life.

The account is comprehensive in aim, covering such varied topics as social structure, language, material culture, amusements, methods of disposal of the dead, and Aboriginal cosmology.

With such a wide range of subject matter it is inevitable that James Dawson did not understand all aspects of Aboriginal life. His descriptions of weapons and dress are described accurately and comprehensively but when he moves onto abstract qualities, such as social organisation, he appears at times to have widely inaccurate descriptions.

Dawson uses Aboriginal testimony and his findings at archaeological excavations to correctly deduce that certain earth mounds on river flats are artificial structures formed from the debris of successive phases of Aboriginal habitation on one spot.

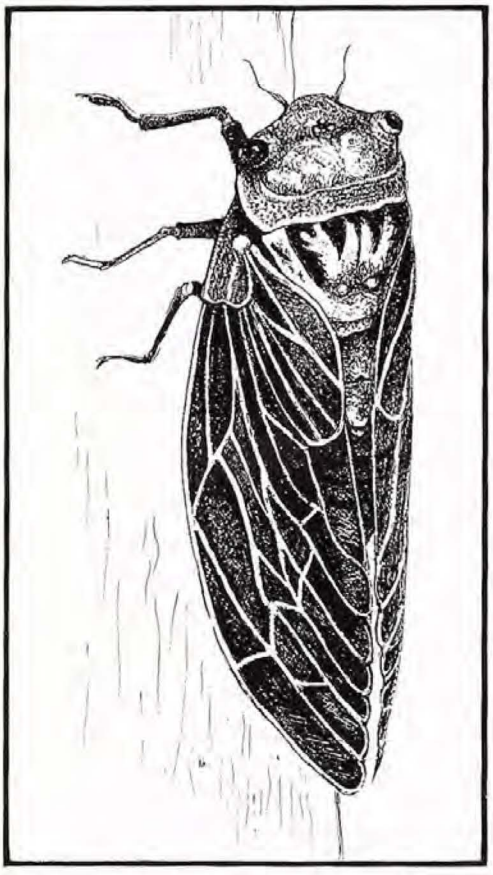
Despite a few misconceptions, the book is one of the few sympathetic accounts of Aboriginal life written by an early settler in a frontier situation. *R. J. Lampert, Curator of Anthropology, the Autralian Museum.*

SUMMERTIME IS CICADA TIME

Nothing jolts the consciousness of the average Australian to the arrival of summer torpor, than the serenade of thousands of cicadas. Australia contains over 200 species of these unusual insects, some of which are the world's most outstanding examples.

by Max Moulds

Max Moulds, a Museum Research Associate and Editor of the *Australian Entomological Magazine,* is an authority on cicadas and has just finished writing a book entitled, *A Guide to Australian Cicadas,* which will be available late 1983.



The Greengrocer and Yellow Monday, *Cyclochila australasiae,* are actually different colour forms of the same species. Drawing Angela Wright.

Eggs within two egg slits are exposed after removal of portion of the branch. Usually several eggs are placed in each slit. Most eggs are white or whitish in colour and are very soft and delicate. The size of eggs varies considerably according to the species with the largest measureing approximately 2mm. Photo J. Frazier.

Australia contains some of the world's most interesting examples of cicadas and they inhabit almost every part of the continent. Most of the 200 or so species are endemic and several are quite remarkable in their appearance and behaviour. One of Australia's most unusual cicadas is the Bladder Cicada, *Cystosoma saundersii,* so called because of the male's greatly inflated abdomen. This large hollow chamber acts as a resonant sound radiator and the song has a remarkable capacity to carry great distances with little apparent loss of volume.

Another remarkable cicada found only in Australia is the Hairy Cicada, *Tettigarcta crinita,* which usually inhabits alpine areas where snow gums grow. Both sexes have their bodies covered with long, downy hair which gives the species its name. Adults closely resemble pieces of dead snow gum bark and often hide during the day under the peeling bark of these trees. Until recent years this species, and the only other known Hairy Cicada, *T. tomentosa,* from Tasmania, were thought to be incapable of sound production. Now it is believed both species possess calls but that these are inaudible to human ears. The nearest relatives of Hairy Cicadas are fossil cicadas from the Permian period.

Cicadas have many different common names, especially among schoolchildren. Perhaps the most famous and sought after is the illusive Black Prince. Amazingly, the association of this name with a particular species has persisted in a somewhat vague and mysterious fashion. There is a virtual folklore surrounding this cicada and it is not difficult to find a city child who will tell you that a chemist will pay $1.00 for the wings alone. Just what the chemist is supposed to do with the wings is unclear! The name Black Prince should, in fact, be applied to *Psaltoda plaga.*

The Greengrocer and Yellow Monday are those most frequently captured by children and are actually different colour forms of the same species, *Cyclochila australasiae.* Sometimes these names become mixed and Green Mondays eventuate. The origin of these names is unclear but both were certainly in popular use by 1896 as was the name Double Drummer for *Thopha saccata.* Other common names widely accepted today include Cherry Nose for *Macrotristria angularis,* Floury Baker for *Abricta curvicosta* and Red Eye for *Psaltoda moerens.* Variations of these have appeared in the past but today these names have stabilised.

The persistent serenade

Cicadas are notorious singers. No other insects have developed such an effective and specialised means of producing sound. Some large species such as the Greengrocer and Yellow Monday, and the Double Drummer produce a noise intensity in excess of 120dB at close range (this is approaching the pain threshold of the human ear). In contrast, some small species have songs so high in pitch that the noise is beyond the range of our hearing.

The song is a mating call produced by the males only. Each species has its own distinctive call and only attracts females of their own kind even though rather similar species may co-exist.

The apparatus used by cicadas for singing is complex and research is still continuing on the mechanisms involved. The organs of sound production are the tymbals, a pair of ribbed membranes at the base of the abdomen. Contraction of internal tymbal muscles cause the tymbals to buckle inwards, and relaxation of these muscles allows the tymbals to pop back to their original position. A pulse of sound is produced as the tymbals buckle inwards, and in some species also as they pop back.

Factors determining the unique character of each species' song are a combination of the sound frequency (natural period of vibration of the tymbals), the pulse repetition frequency (rate at which the sound pulses are produced), the structure of the pulses, variation in pulse amplitude (loudness) and the pattern of grouping of the pulses. Variations within these factors are achieved in several ways. The actual structure of the tymbals differs in size and shape and in the number and length of the ribs between species. Many species alternate the contractions of the right and left tymbal muscles, whereas others such as the Bladder Cicada and *Arunta perulata* (no common name), contract both simultaneously. The ab-

Bladder Cicada

The Bladder Cicada, *Cystosoma saundersii*, is a species that is particularly plentiful in south-eastern Queensland, on the New England Tableland and coastal New South Wales as far south as the Gosford district. It is a species often found in garden hedges and shrubs and in lantana clumps in grazing districts.

Adults are usually green in colour with remarkable fore wings that resemble green leaves. Sometimes, however, they are orange-yellow instead of green. There is no doubt that the cryptic colouring of the green form and the leaf-like fore wings are effective camouflage mechanisms. Adults are mostly found hidden among green leaves at a height of between 1—2m.

Males commence singing at dusk and continue until a little after dark. It is a soft call completely unlike that of nearly all other species and resembles a deep gutteral 'r' continued incessantly. Once the call has been recognised it is not difficult to find them. Nymphal food plants include a wide range of exotic shrubs and trees some of which are privet, mango, loquat, jacaranda and weeping willow. There is no known native food plant. Photo Max Moulds.

Hairy Cicada

The Hairy Cicada, *Tettigarcta crinita*, is a common and widespread species usually found in alpine areas of New South Wales, Australian Capital Territory and Victoria at an altitude above 1,300m.

Adults resemble pieces of dead bark in appearance and hide during the day, often under the peeling bark of snow gums. They can be extremely difficult to locate.

At dusk, however, they become active and fly about rapidly but little is known of their precise behaviour during this time. They are readily attracted to light and are easily caught this way.

It is not a midsummer species as one would expect of an alpine insect but instead is abundant in late summer and early autumn. The hairy nature of the insects' body no doubt provides protection from the cold nights often occurring in alpine areas at this time of year. Unlike most cicadas the female is considerably larger than the male. Photo Max Moulds.

domen often has a marked effect on both the quality of the sound emitted and the pattern of the sound groupings. Most of the abdomen is a large air chamber and often the organs of digestion, excretion and reproduction are confined to just a small portion. The song is often substantially altered by expanding or flexing this abdominal air chamber.

Many species sing during the heat of the day but some do so only at dusk. Often those species that sing at dusk are weak fliers (as in the case of the Bladder Cicada) and gain a degree of protection from predatory birds by confining their activity to dusk.

The loud noise produced by some day-singing cicadas actually repels birds, probably because the noise is painful to the birds' ears and interfers with their normal communication. The males of many species, including the Greengrocer and Yellow Monday, and the Double Drummer, tend to group together when calling which increases the total volume of noise and reduces the chances of bird predation.

Both sexes have organs for hearing. Sound is received by a pair of large, mirror-like membranes, the tympana, which are often concealed below the opercula. The tympana are connected to an auditory organ by a short tendon. When a male is singing it creases the tympana so that it is not deafened by its own noise.

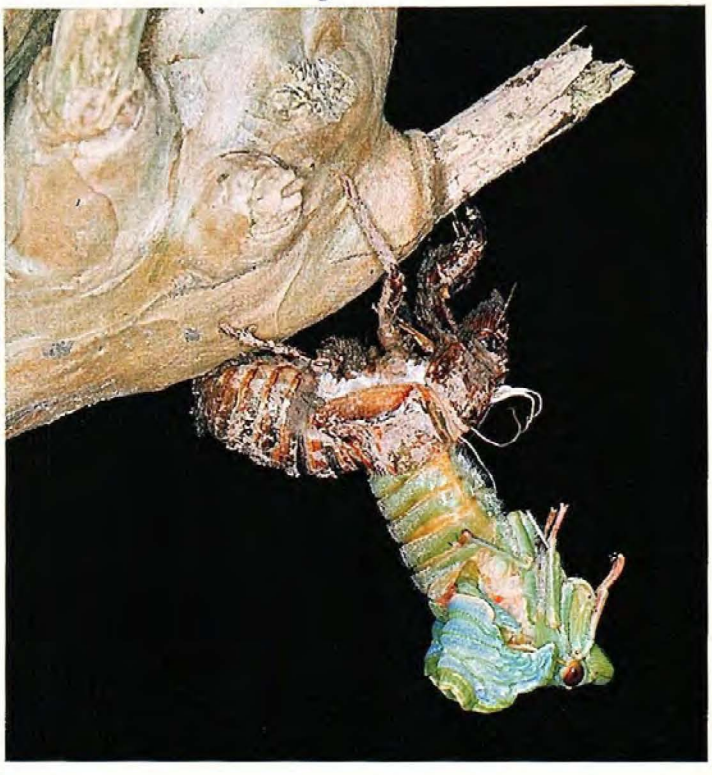
In addition to the calling song many species, including the Greengrocer and Yellow Monday, the Red Eye, and Razor Grinder, *Henicopsaltria eydouxii*, also possess a distress call. This is usually a broken, erratic noise emitted when the cicada is captured. A number of species also have a courtship song which is normally a quiet call only produced after a female has been attracted by the calling song.

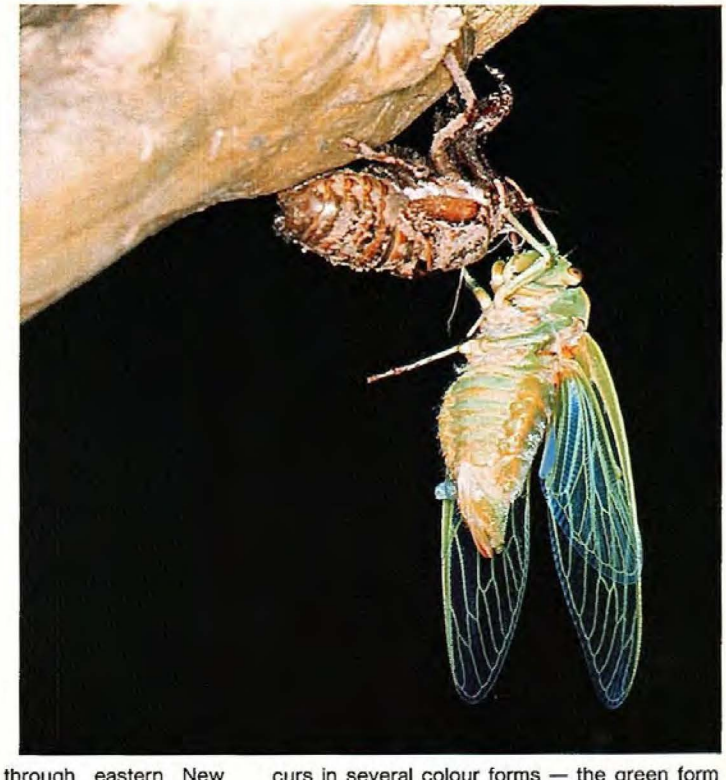
Greengrocer and Yellow Monday males even produce a death call during their last few hours of life, usually as they lie on their back with legs crossed inwards. It is a distinct call consisting of a succession of clicks resembling the sound of a geiger counter.

Eggs are laid in twigs and branches of the nymphal food plant in small slits cut in the bark by the female's spear-like ovipositor. The number of eggs laid in each slit varies both between species and individuals. The egg slits of the Floury Baker usually average 16 eggs each while those of the Double Drummer number about 12, although the number laid per slit by a single female can range from three or less to more than 20.

A female makes many egg slits and often distributes her eggs on two or three branches (not necessarily those of the same tree). A batch of eggs can number 300 or more. Some species such as the Bladder Cicada, Floury

Greengrocer and Yellow Monday





An adult is seen here emerging from its last nymphal skin, a laborious task taking an hour or more.

The Greengrocer and Yellow Monday, *Cyclochila australasiae*, so familiar to residents of Sydney and Melbourne, sometimes occurs in countless thousands in these cities. It is, however, widely distributed ranging from south-eastern Queensland, through eastern New South Wales to southern Victoria and south-eastern South Australia.

Its natural habitat is sclerophyll forest where populations tend to be locally common but the species has adapted remarkably well to suburban situations where it is now probably more common than in bushland. A large cicada, it occurs in several colour forms — the green form (Greengrocer) is by far the most common and occurs throughout the species' range, the yellow form (Yellow Monday) is less common but is also widespread. Other colour forms include one with black markings, another is dark tan in colour and, although rare, a bright turquoise form also exists. Nymphal food plants include Brush Box, Sydney Blue Gum, Poplar and Weeping Willow. Photos Densy Clyne.

Baker and Double Drummer select only living branches for oviposition while others including the Greengrocer and Yellow Monday, the Red Eye and Cherry Nose choose only dead or dying tissue. Many days pass before the eggs hatch (the Greengrocer and Yellow Monday require approximately 120 days, the Floury Baker about 70 days).

Out of sight, out of mind

Nymphs about a millimetre in length hatch from the eggs and are essentially miniature versions of the familiar nymphs often seen on tree trunks from which the adults emerge. Most nymphs are white or creamish in colour when they hatch but others are characteristically pigmented. Young nymphs of the Greengrocer and Yellow Monday are white with black eyes, while those of *Cicadetta marginata* (no common name) are bright pink. The young nymphs fall to the ground after hatching and burrow beneath the surface in search of a root from which to feed by suckling sap.

The length of time that nymphs spend underground feeding and growing is unknown for Australian cicadas. There is no doubt that most species spend at least two years as nymphs and circumstantial evidence strongly suggests that the Greengrocer and Yellow Monday may have a life cycle spanning seven years.

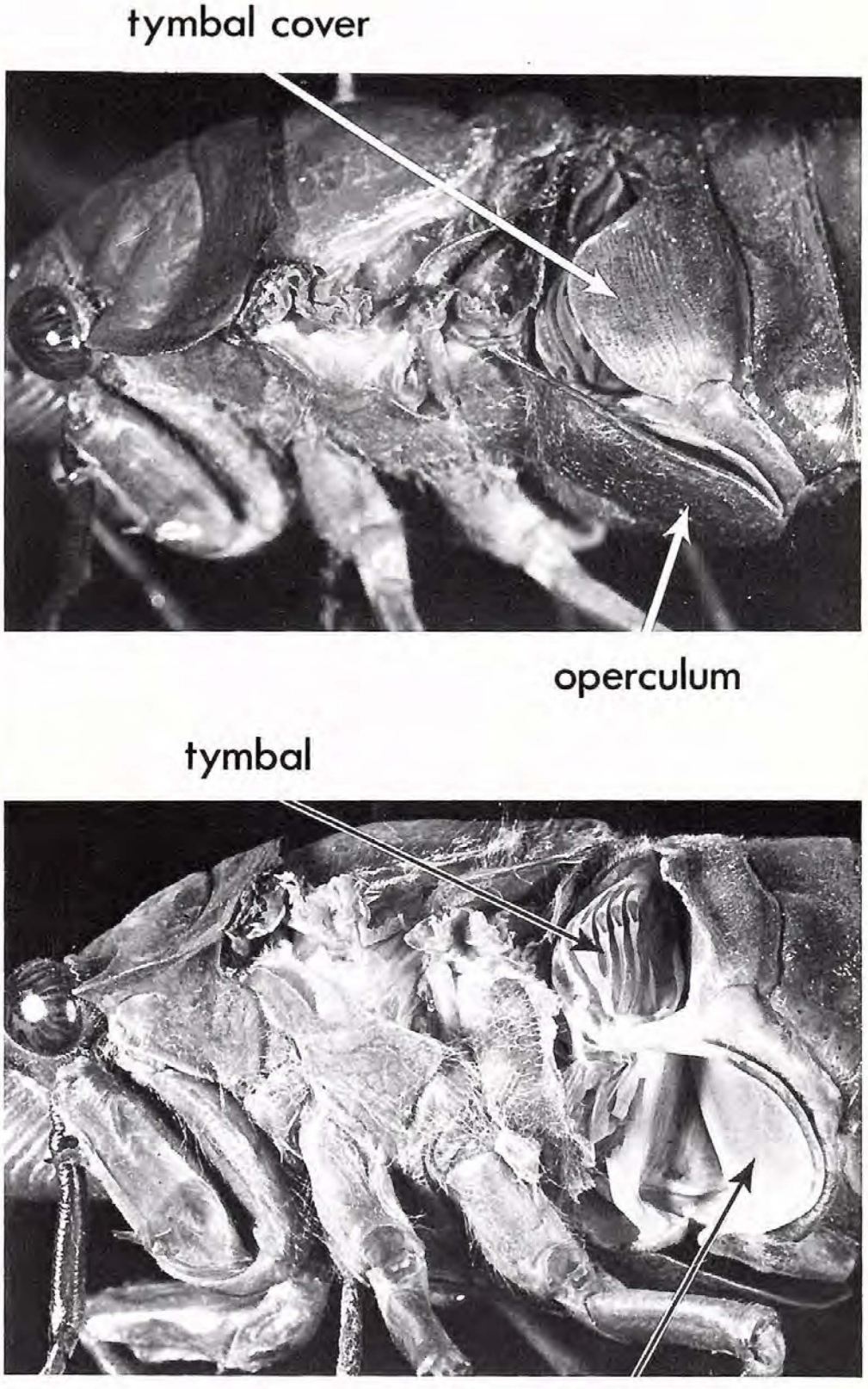
During their subterranean life the nymphs spend a lot of time feeding and as they grow they shed their skin at intervals until maturity is reached. Nymphs are sedentary but do sometimes move short distances if their situation becomes unfavourable. The nymphs of larger species such as the Double Drummer and the Greengrocer and Yellow Monday sometimes dig to a depth of a metre or more but those of many species are usually found no deeper than 40cm.

Mature nymphs work their way to the soil surface where they often rest for several days just below the crust, apparently waiting for favourable weather conditions. If the soil is exceptionally waterlogged, Greengrocer and Yellow Monday nymphs build remarkable tower-like domes of damp mud, often 10cm or more tall (similar to miniature termite mounds in appearance) where they shelter before emerging from the ground.

Fun in the sun shortlived

In most species emergence from the final nymphal skin occurs during the first few hours after dark, and is a laborious process which can last an hour or more. Warm evenings, a day or so after good rains, are especially favoured.

The length of adult life varies but usually a span of between two and three weeks can be expected under favourable conditions. An im-



Side view of a male Greengrocer with wings removed to show the sound organs. Both photos are of the same cicada but in the lower one the tymbal cover and operculum have been cut away to expose the delicate membranes beneath — the sound-producing tymbal and sound receiving tympanum.

Razor Grinder

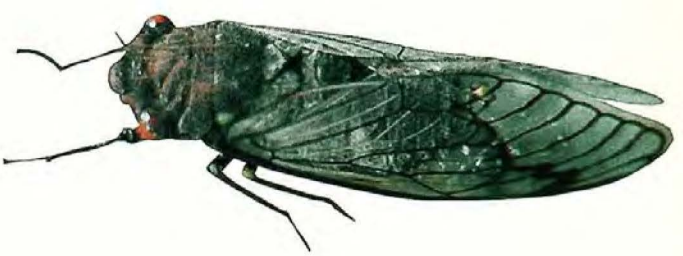
The Razor Grinder, *Henicopsaltria eydouxii,* is often plentiful in south-eastern Queensland and eastern New South Wales. Essentially a lowland species it does not extend inland beyond the foothills of the Great Dividing Range. Adults are usually found in dry and wet sclerophyll forests where large gum trees grow close together but in some areas rain forest margins are inhabited. Populations are highest during December and January. The song is a loud, coarse call resembling the grinding of metal from which the species takes its common name. Although singing can occur at any time of the day, dusk is the time most favoured. Singing often occurs in waves which sweep around hillsides, one group of individuals beginning the chorus and fading as the adjoining individuals begin, and so on. Photo G. May.

Arunta perulata

Arunta perulata is an unusual cicada which never occurs far from the sea and is usually found in or near Coastal Banksias, *Banksia integrifolia,* or in mangroves. It ranges along much of the Queensland and New South Wales coastline and is often common in Sydney. Nymphal food plants include Coastal Banksia and Mangroves. Photo Max Moulds.

Red Eye

The Red Eye, *Psaltoda moerens,* is well known for its bright red eyes which, unfortunately, turn brown or blackish after death. It has a wide distribution from the Granite Belt of south-eastern Queensland, through much of eastern New South Wales, Victoria and South Australia as far as Adelaide and Tasmania. Adults are usually most numerous in December and sometimes occur in huge numbers. Smooth-barked eucalypts in open bushland are often preferred but such trees in suburban situations are also frequented. The Manna or Ribbon Gum, *Eucalyptus viminalis,* is perhaps the tree most widely chosen. The song is very distinctive and once heard is not easily forgotten. It consists of a continuous note interspersed with periods of yodel-like revving. Singing can occur at any time through the day, often with little break on hot summer days when populations are high. Photo Max Moulds.

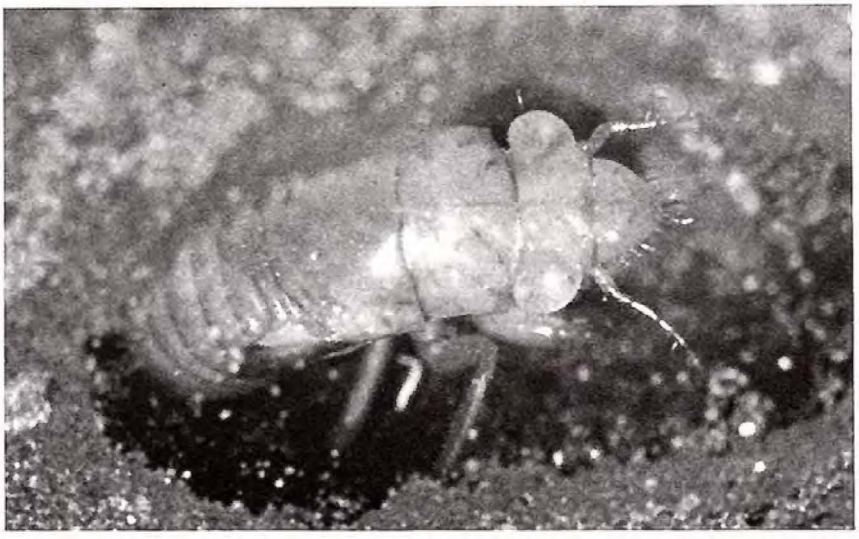


Floury Baker

The Floury Baker, *Abricta curvicosta*, has the body of both sexes appearing as though dusted with flour. It is a common species in south-eastern Queensland and coastal New South Wales and is often found in suburban gardens and sea-side bushland. The song has a hiss-like tone which is distinctive and unlikely to be mistaken for the song of other cicadas. Adults usually sit facing downwards on limbs of shrubs and small trees.

Northern Cherry Nose

The beautiful Northern Cherry Nose, *Macrotristria sylvara*, shown here mating, is found only in north-eastern Queensland between the Torres Strait Islands and Cairns. It is a lowland species and is abundant, especially along the coast between Port Douglas and Cairns city. The first Northern Cherry Nose emerges in December but it becomes most common during January and February. Adults frequent cocky apple and other trees.

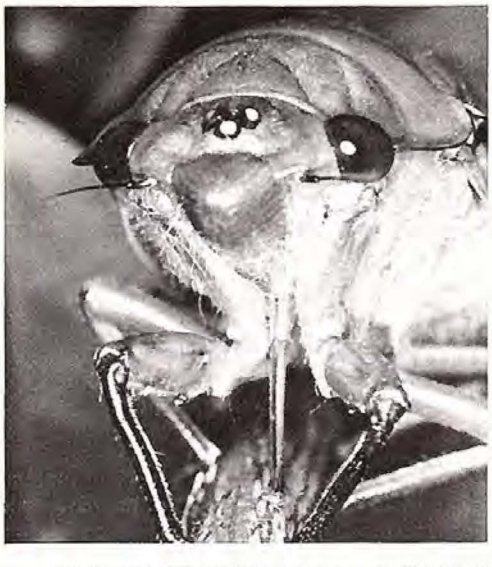


Nymphs remain underground for their entire growing life feeding on root sap. This photograph of an immature nymph was taken through the glass side of an observation tank especially constructed for observing nymphal activity. All photos Max Moulds.

portant factor influencing adult survival is an adequate food supply. (Specimens retained in captivity should, if possible, be housed on a suitable potted plant).

Singing males attract females that fly to them, and after a brief courtship mating usually follows. Courtship behaviour is variable according to species. In the Bladder Cicada, an attracted female produces a pheremone which is dispersed by wing-flicking. The male responds with a courtship song, resembling a succession of quiet, short chirps. The female moves about and continues wing-flicking, usually during periods when the male is silent. After as much as 10 minutes of such behaviour the male finally moves towards the female for mating which then continues for about 90 minutes. Bladder Cicada females and those of some other species often mate two or three times, with a day or two between matings during which egg laying occurs.

There is still a great deal to be discovered concerning Australian cicadas. The distribution of many species is still poorly known and not a single Australian life history has been the subject of detailed research. Adult behaviour and acoustical biology are two other areas where a lot remains to be studied.

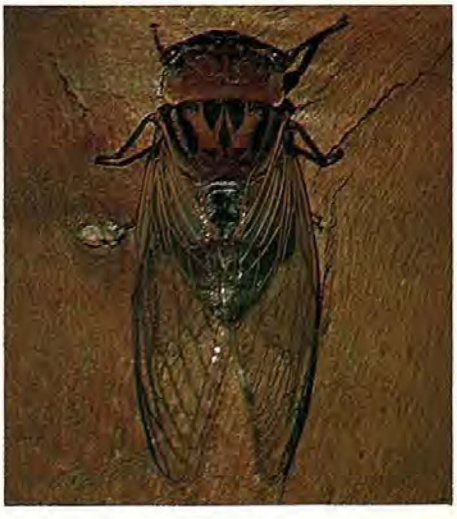


Adults of many species spend a great deal of time feeding and can be so occupied for three hours or more each day during hot weather. They suck up sap through a long, straw-like, feeding tube known as a proboscis. Nutrients are extracted from the sap and the clear, water-like waste is squirted at frequent intervals from the end of the body. Some species, including the Greengrocer, can consume large volumes of sap and the 'rain' which showers down from their trees on a hot summer's day is, no doubt, well known to most of us. Despite the common belief that only the females create this unpleasant phenomenon, both sexes are responsible. Photo Densy Clyne.

Black Prince

The Black Prince, *Psaltoda plaga*, is often found in she-oaks, especially the river She-oak, *Casuarina cunninghamiana*. It occurs abundantly along the New South Wales coast and is locally common around Sydney. In some years populations can be immense with many hundreds inhabiting just a single tree. Adults are black or blackish in appearance with a patch of silver pubescence on each side of the abdomen. It is readily distinguished from the closely allied *P. harrisi* by its larger size and the presence of a blackish Z-shaped infuscation near the apex of the fore wings (absent from *P. harrisi)*. The song begins with a regular succession of sound pulses before changing to a continuous call which often lasts several minutes without interruption. Photo Max Moulds.

Double Drummer



The Double Drummer, *Thopha saccata*, is one of Australia's largest species. The males possess greatly expanded opercula, which are rounded in shape and prominently protrude. It is from these structures that the cicada takes its common name. The Double Drummer is a widespread cicada and occurs abundantly in south-eastern Queensland and eastern New South Wales. In some years it can be exceedingly common in some districts but may be almost totally absent in others. The song is particularly loud and resembles a constant whine. When populations are high the noise is almost unbearable to be near. Unlike many other species of cicada, adults usually emerge from their last nymphal skin during the day. Photo Max Moulds.

Cherry Nose

The Cherry Nose, *Macrotristria angularis*, ranges from north-eastern Queensland, through inland central to south-eastern Queensland, throughout much of the eastern half of New South Wales and around the Mildura district on the NSW/Victorian border. At times it is a very common species but populations fluctuate considerably from year to year. Adults are usually the most common during December and are mostly found in dry sclerophyll forest clinging to the trunks and larger branches of tall eucalypts. The pigmentation of adults varies noticeably between regions. Cicadas from northern and central Queensland are often brownish with yellowish markings while those from further south are usually black with orange markings. Photo B. L. Brunet.

THE TOAD THAT DOESN'T TOE THE LINE

by Roland Hughes

The all-conquering march of what is commonly regarded as Australia's most ugly resident, the Giant Cane Toad, *Bufo marinus*, is intensifying.

Cane toads have already arrived in Coffs Harbour, NSW, and earlier in the year were reported on the Northern Territory-Queensland border.

Alarmed by the spread of toads up the Cape York Peninsula, the Australian Museum, with the financial assistance of the bauxite mining company, Comalco Aluminium, began to research the problem.

During 1977, the Museum sent a research team to Weipa, which was then free from cane toads. All the reptiles and frogs occurring naturally in the district were surveyed.

Working in conjunction with researchers from the Queensland National Parks and Wildlife Service, Museum scientists were able to form a picture of the diversity and structure of the native fauna before and after the arrival of the noxious toads.

After the initial survey was completed annual monitoring surveys were undertaken. At that stage, no cane toads had ever been seen in Weipa.

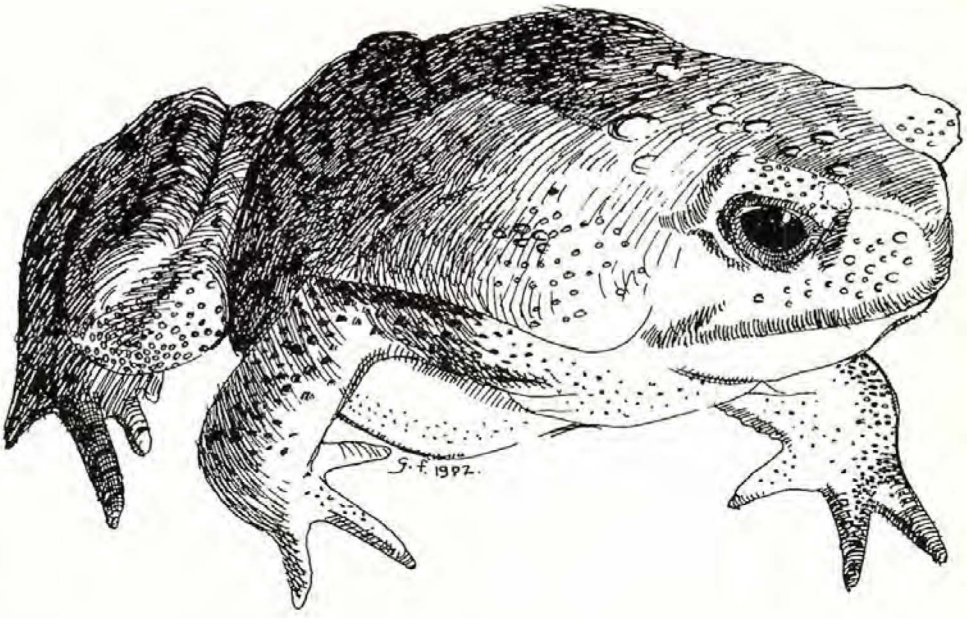
Then during the 1980 wet season the first cane toads appeared in the town's residential area. By the next wet season (1981-82) their numbers had increased dramatically.

Dr Harold Cogger, Deputy Director of the Museum and head of the research programme since its inception, is extremely concerned at the spread of the cane toad.

"Cane toads are in plague proportions in many parts of Queensland and there is a great deal of evidence indicating that they are having a serious effect on the environment.

"The initial survey allowed us to gain a picture of the natural inhabitants of Weipa and succeeding surveys will provide the basis of what is probably the first comprehensive study on the effect of the cane toads on the environment.

"When we started the survey cane toads were not even close to Weipa. Then they gradually moved into the locality and began to breed", Dr Cogger said.



The Queensland Cane Toad originated in North and South America between Texas and central Argentina and was brought to Australia from Hawaii during the 1930s to control insects in cane fields. Drawing Glenn Ferguson.

Dr Cogger is particularly worried about the effect the toad will eventually have on the area's diverse wildlife. Already preliminary results indicate the cane toad is having a devastating effect on other frogs and reptiles as well as mammals and birds.

With a current expansion rate of eight per cent in Queensland, these thick skinned, khaki-coloured frogs, eat anything that fits into their mouths.

The deadly oval paratoid glands on the toads' shoulders contain enough poison to kill most would-be predators including snakes, dogs, cats, pigs and many native mammals. Under threat the toad can deter attackers by squirting a creamy, virulent venom up to a metre in length.

They can live anywhere between 10 and 16 years and whereas native frogs breed only once a year laying up to 4,000 eggs, cane toads may breed twice a year laying anywhere between 10,000 and 21,000 eggs at a time.

The wet season signals their spread as the female needs either ponds or slowly moving water and a plentiful supply of plant material and other organic matter for breeding and nourishment.

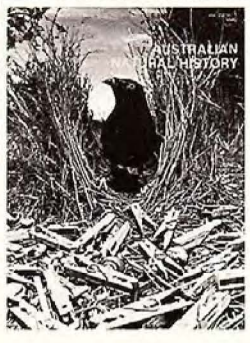
Native fauna, facing such a formidable array of talents, doesn't stand a chance in the competition for food and habitat.

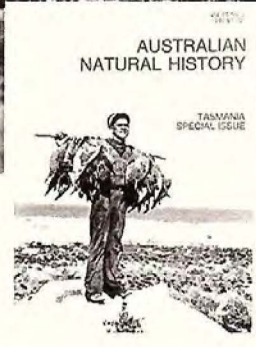
Nor does man's environment limit the toad's spread. Lawns, gardens, roads, footpaths are all favoured.

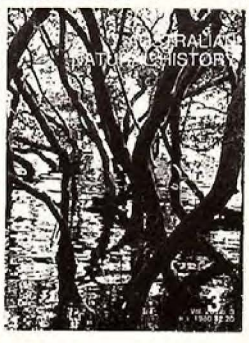
As yet nothing is known that can successfully control cane toads. With very few natural predators, its adaptability, resilience and high breeding potential, ensure the toad's spread into new habitats.

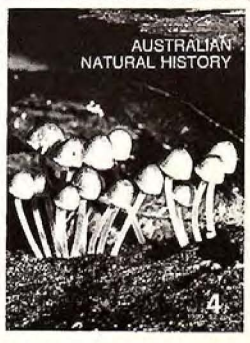
Only with intensive scientific research can a weakness of the cane toad be found.

But by that time it may be too late.









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