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AUSTRALIAN NATURAL HISTORY

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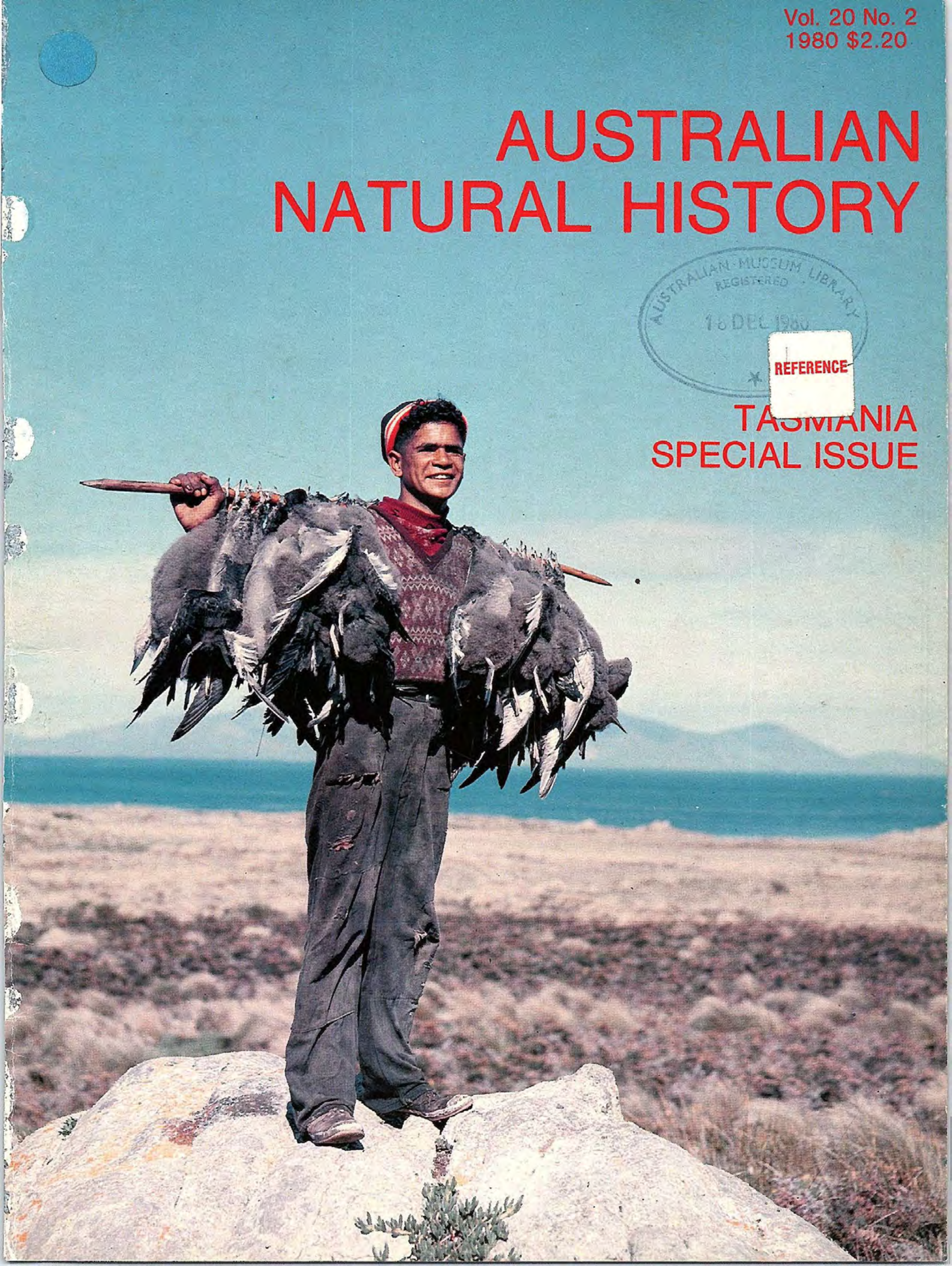
TASMANIA SPECIAL ISSUE



AUSTRALIAN NATURAL HISTORY

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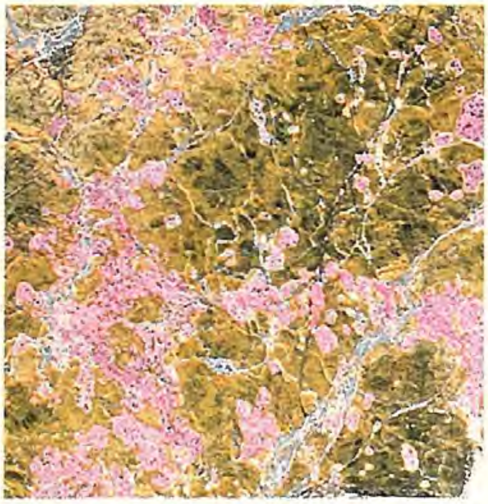

Dispersed within serpentine (green) from the Dundas area of W. Tasmania is the chromite alteration mineral stichtite (lilac). Stichtite was first described from Tasmania and named after Robert Sticht, then manager at Mt Lyell Mine. Illustration about twice normal size. Photo by Greg Millen/The Australian Museum.

Although once distributed throughout a major part of mainland Australia, the Tasmanian devil, *Sarcophilus harrisii*, is now found only in Tasmania. This scavenging, carnivorous marsupial is equipped with very powerful jaws and consumes bones, skin, fur and feathers, usually leaving little trace of its victim. Photo by J. E. Wapstra.

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COVER: Athol Burgess, of Cape Barren Island in Bass Strait, holds a spit of fledgling short-tailed shearwaters, *Puffinus tenuirostris*. Although once one of the main commercial ventures in the islands of Bass Strait with all life stages of this species taken indiscriminately for food, fat and feathers, the collection of eggs and mature birds is now prohibited, and the six-week catching season of young birds, a picturesque and important annual event for the people of the Furneaux Group, is stringently controlled by the Tasmanian Animals and Birds Protection Board. Photo by P. Adam-Smith.

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FROM THE INSIDE

Upper slopes of Cradle Mountain in Cradle Mountain Lake St Clair National Park and the mountains to the NE (above). Wind, ice and rain have sculpted the rugged and majestic terrain that characterises much of Tasmania. Photo by Bruce Jenkins.

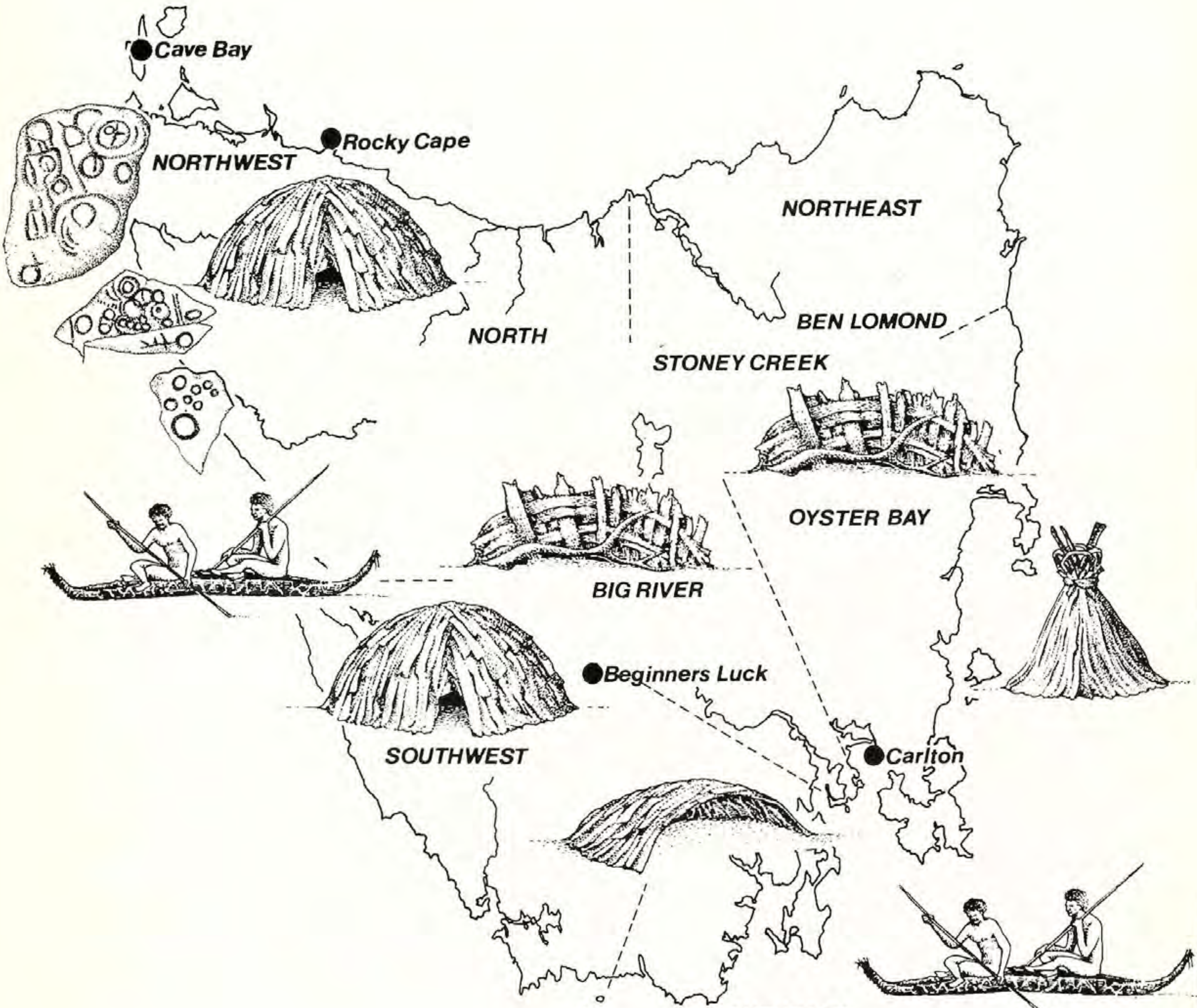
The Gordon Dam (above right)—perhaps just as majestic from a technological point of view. Although maintaining present, and ensuring future, power supplies, hydro-electric development on the island evokes certain environmental consequences that cause grave concern to many people. Photo by Lin Sutherland/The Australian Museum.

Immediately after the Second World War, I went to Tasmania to work and lived in that island state for four years. I went as a stranger to a strange region expecting to find the hostility of the climate to be reflected in the inhospitality of its people—I left, with great reluctance, with firm and generous friendships which endure to this day and with a compelling interest in the smallest Australian state which had proved to be one of the most fascinating areas of Australia I had ever known. That is why I am happy to see this special issue of *Australian Natural History* devoted to Tasmania and the islands of Bass Strait and am proud to be associated with it.

To have visited the region, laboriously climbed the mountains and hills, bathed in the waters, talked and worked with its people and learned to love and respect all, has whetted the appetite for more knowledge. This special issue provides some of that knowledge. Here is a record of the people who belonged to the land, the people who came later and developed it, the monuments of the past, the causes of the present, and here is a record of the ground on which those people live, the waters they sail and the wonderful diversity of the natural life around them. In these, one may seek and find a reason for the seeming isolation of this vital part of Australia, and a reason for the steadily growing unity between the people of the 'apple isle' and the people of the mainland. Flora, fauna and landforms are all threatened with change, and some perhaps with extinction, from the impact of industrial development, hydro-electric power, mining and wood-chipping. The Tasmanians' opposition to the more destructive influences has made headlines in the national press and drawn others from all over Australia into joint action for conservation.

Despite the limitation on topics imposed by space restrictions I believe this issue of *Australian Natural History* gives readers a comprehensive picture of our smallest state, of its plants and animals, of its geology, primary industries, early explorers, the culture of its original Aboriginal occupants—now, sadly, extinct—and other aspects of the environment. Each subject has been rigorously researched by authorities in the field who present their views without editorial censor. The coming together of these views is purpose in itself, for the information gathered into a single issue of this magazine will engender interest and contribute to the sum of knowledge needed to protect and conserve the Tasmanian heritage—the heritage of all Australians.

Barbara Purse
Editor


Cave Bay
Rocky Cape
NORTHWEST
NORTHEAST
NORTH
BEN LOMOND
STONEY CREEK
OYSTER BAY
BIG RIVER
Beginners Luck
SOUTHWEST
Carlton
SOUTHEAST

A VIGOROUS AND AGREEABLE PEOPLE

The isolated world of the Tasmanian Aborigine was suddenly opened up with the coming of European man, and within two generations the race and culture was no more. This article by Peter Murray, Curator of Anthropology at the Tasmanian Museum in Hobart, depicts the Tasmanians as "having been resourceful, flexible and well-adapted for life on the Island of Tasmania" and provides a brief account of the life of the Tasmanian Aborigines from the time of their arrival on the extreme southern end of the Australian continent until their contact with European explorers.

by Peter Murray

Distribution of Tasmanian tribes (left) at the time of European contact and some associated cultural traits. All tribes except in the northeast used the canoe raft. Conical bark 'tombs' were noted by Peron on Maria Island, off the east coast. Windbreaks made of woven *Eucalyptus* bark were used by tribes occupying the warmer drier eastern half of the state, while in the northwestern portion and southeast as far as Bruny Island conical huts were made. Rock carvings are confined to the northwest of the island. The map also shows the location of several archaeological sites. Drawing by Peter Murray.

Composite engraving from various water colours (above) made by the artist Petit on Baudin's 1801-1802 expedition to Tasmania. The engraving depicts many aspects of Tasmanian life with reasonable accuracy. Note the stance of the male (third from the right), the manner in which children were carried in kangaroo skin capes, the woven bark shelters, the small cooking fires and the spears. Food remains consist of shells of red abalone, *Notohaliotus ruber*; warrener, *Subninella undulata*; and tibia and tarsus of wallaby, *Macropus rufogriseus*.

Twenty-five thousand years ago, bands of Aborigines occupied an immense lowland plain that stretched from the southern coast of Victoria to the northwest coast of Tasmania. This grassy expanse and the wide river valleys that wound down from the glaciated uplands to the south supported large numbers of marsupial herbivores that were hunted by the Aborigines until the last few thousand years of the waning Ice Age. A rise in sea level caused by the melting of continental ice sheets resulted in the inundation of the plain. By 12,500 years ago those bands whose hunting range lay to the south of the newly formed strait were totally isolated from the Australian mainland. They were the direct ancestors of the next 350-500 generations of people who occupied the island of Tasmania until the death of Truganini in 1876.

Fully modern humans who closely resembled the Tasmanians both physically and culturally were present in Australia by at least 40,000 years ago. Human remains from Lake Mungo in western NSW and the nearly perfect Keilor cranium from an ancient terrace of the Maribyrnong River near Melbourne probably represent the same basic population from which the Tasmanians were derived.

The ultimate source of this population is still guess-work. Tasmanian skulls show tantalising similarities with those of certain Melanesian people living today on the Gazelle Peninsula of New Britain. It is possible that the Tasmanians and some Melanesians express many of the genetic features that were once common to a widely dispersed 'Old Melanesian' population that occupied the Sunda Shelf, Australia, and possibly even certain Pacific continental islands. Tasmanian stone technology was clearly derived from a 'flake and core' tradition similarly distributed. This technology, called the 'Kartan' culture in Australia, was largely superseded on the mainland after the separation of Tasmania.

The earliest reliably dated evidence of the Kartan culture in Tasmania comes from the lowest levels of Cave Bay Cave on Hunter Island off the northwest coast. This site demonstrates that Aboriginal man was present 75 km inland on the Bass Plain 22,000 years ago, where they hunted a species of small gregarious wallaby. Archaeological evidence from caves show that Aborigines hunted a large kangaroo species (*Macropus titan*) at about the same time 250 km to the southeast near the very centre of Tasmania and were clearly contemporary with other extinct marsupials such as *Sthenurus* and *Protemnodon*. Between 10,000 and 15,000 years ago higher winter temperatures and increased rainfall culminated in the replacement of grasslands by a variety of forest, scrub and sedgeland communities. This succession resulted in greatly reduced carrying capacities for the land, and the largest and most specialised marsupials became extinct.

Subsequently, the Tasmanians came to rely heavily on the sea for their subsistence. Sites at Rocky Cape and in the Carlton River Estuary show that by 8,000 to 9,000 years ago this same agency which had separated the Tasmanians from the people and culture of the mainland came to dominate many aspects of their lives, remoulding their culture and modifying their distribution and numbers.

European explorers found the Tasmanians living close to the shore sheltered by simple windbreaks constructed from loosely woven sheets of *Eucalyptus* bark. Women were seen diving and wading in the icy waters of the D'Entrecasteau Channel for abalone and rock lobsters which they carried ashore in open work baskets to be placed on the small cooking fires. Heaps of shells denoted similar repasts going back through the centuries.

In 1802 Nicolas Baudin's expedition anchored at Port Cygnet in the mouth of the Huon River. There on Bruny Island and somewhat later on the central east coast at Oyster Cove, the French scientists and explorers made generally friendly contact with the natives and had the opportunity to examine and describe them.

Baudin observed that Tasmanian men and women were slightly shorter than average Europeans and were of generally good proportions except for having thin arms, spindly legs with little calf and stomachs that protruded roundly. Their hair was invariably frizzy. Baudin remarked several times that they were paler in colour than Africans, resembling more the people of the Caribbean. One child had light brown skin. They generally had broad noses that were unlike those of Africans, although some had 'long well-proportioned noses'. Their wide mouths displayed perfect teeth with the incisors being ground flat. There was little sign of disease, only some burns, large ulcerations on the legs and a mutilated finger.

Baudin found the Tasmanians to be generally vigorous and agreeable people with a lively and restless glance. The Frenchmen were greatly amused by the usual standing posture of Tasmanian men in which they held and stretched out their foreskin while standing at rest or in conversation. As a consequence Baudin remarked, the "prepuce is very long".

Despite Tasmania's cold, damp winter climate, the Tasmanian Aborigines wore nothing of practical value to protect themselves. Adult women wore a kangaroo skin cloak that covered one shoulder and sometimes part of the breasts. Young girls and boys went completely naked. Men only rarely wore cloaks. Both men and women wore attractive shell necklaces and daubed their faces with charcoal moistened with saliva. Adult males rubbed red ochre over their faces and upper torso. All men and women past the age of puberty had cicatrised (scar) designs, usually composed of a number of regular lines on the shoulders, arms and abdomen. Their hair was styled in several ways. Men coated each lock with grease and red ochre. These shook like bangles with every movement of the head. However Baudin described one man who had his head shaved except for a thin strip that trimmed the circumference of his scalp. Women paid less attention to their hair, usually cropping it short with a stone flake or sharpened shell.

Tasmanian Aborigines painted by Thomas Bock in 1832: Manalargenna (top), holding a firestick, his hair and beard is coated with a mixture of red ochre and grease, his necklaces are composed of kangaroo sinew rolled in red ochre; Fanny (centre), wearing mariner shell necklaces and kangaroo fur, note cicatrices on her arms; and Timmy (bottom), note the human mandible amulet suspended on a grass string necklace and that he is carrying a firestick and a waddie or throwing stick.

The Tasmanians might be viewed in the context of an experiment to see what happens to a culture with a stone age technology operating in complete isolation within a closed but highly productive ecosystem. One interesting theory is that Tasmanian culture stagnated and degenerated over the last 12,000 years due to a lack of outside contact. This idea is based on certain archaeological evidence indicating that Tasmanians stopped eating scale fish and discontinued making ground bone artifacts several thousand years ago. To this is added some speculative embellishment: Are the tattered kangaroo skin cloaks mere rudiments of more sophisticated tailoring abilities of the past? Were other cultural elements known from the mainland possessed and eventually lost by the Tasmanian due to the inexorable thermodynamic process of 'winding down' in a closed system?

However, a closer look at Tasmanian technology seems to denote what I would call a striking example of 'closeness of fit' in a cultural adaptation. Tasmanian spears, for example, are technically simple for sound adaptive reasons. Smoothed, straightened and pointed tea-tree shafts (*Leptospermum* and *Melaleuca* spp.) were made 3-5 m long for aerodynamic stability. Small diameters were selected for lightness and reduced wind resistance. Several of these spears could be carried in a free hand. The design strategy was for hunting in brushy country where spears are easily lost during the chase, and where more than one attempt at partially concealed game is highly advantageous.

Tasmanian stone technology has often been described as the most primitive possessed by modern man. One of the questions most often asked about Tasmanians is, why didn't their stone technology continue to evolve? It did in a subtle way—by adapting to the specific needs of the culture in relation to available resources. Stone suitable for making tools is widely distributed in Tasmania. Simple flakes struck from a nodule of good quality silicious stone make perfectly efficient tools for almost any purpose provided there are plenty of flakes from which to choose.

More specialised ways of making tools relate to the relative scarcity of stone, available time for production and competition for resources as well as advances in technique. In Tasmania the factors of scarcity and competition were minimised by the even distribution of resources. Even so, a variety of discrete tool types were made including several kinds of scrapers, a notched piece—or spokeshave, spurred or denticulated flakes, large flake and core choppers and stone grinders.

Perhaps the most remarkable Tasmanian innovation is a unique kind of temporary water craft composed of three roles of paper bark, or sometimes a kind of reed bundled together by a network of twine. This streamlined canoe-raft, capable of holding several adults, could be constructed in a few hours. Canoe-rafts were used to cross the wide estuaries that formed barriers to movement up and down the Tasmanian coast and for making regular voyages to islets, some as far as 17 km off-shore. This canoe was an extremely efficient way of increasing the amount of exploitable coastline. At the same time, the temporary nature of the craft left the incessantly mobile foragers unencumbered and unrestricted in their overland movements.

A temporary water carrier made from a strip of bull kelp (*Durvillea potatorum*) is another uniquely Tasmanian utensil. The natural flexibility of this throw-away container was also an asset for collecting water from shallow springs and seeps. Bull kelp strips were also used to make shoes for sore feet. Similarly, women constructed a kind of instant basket by tying a bundle of sedge or grass together at each end and lashing to these ends a smaller bunch to form a sturdy handle. The large bunch was then spread and used for carrying items.

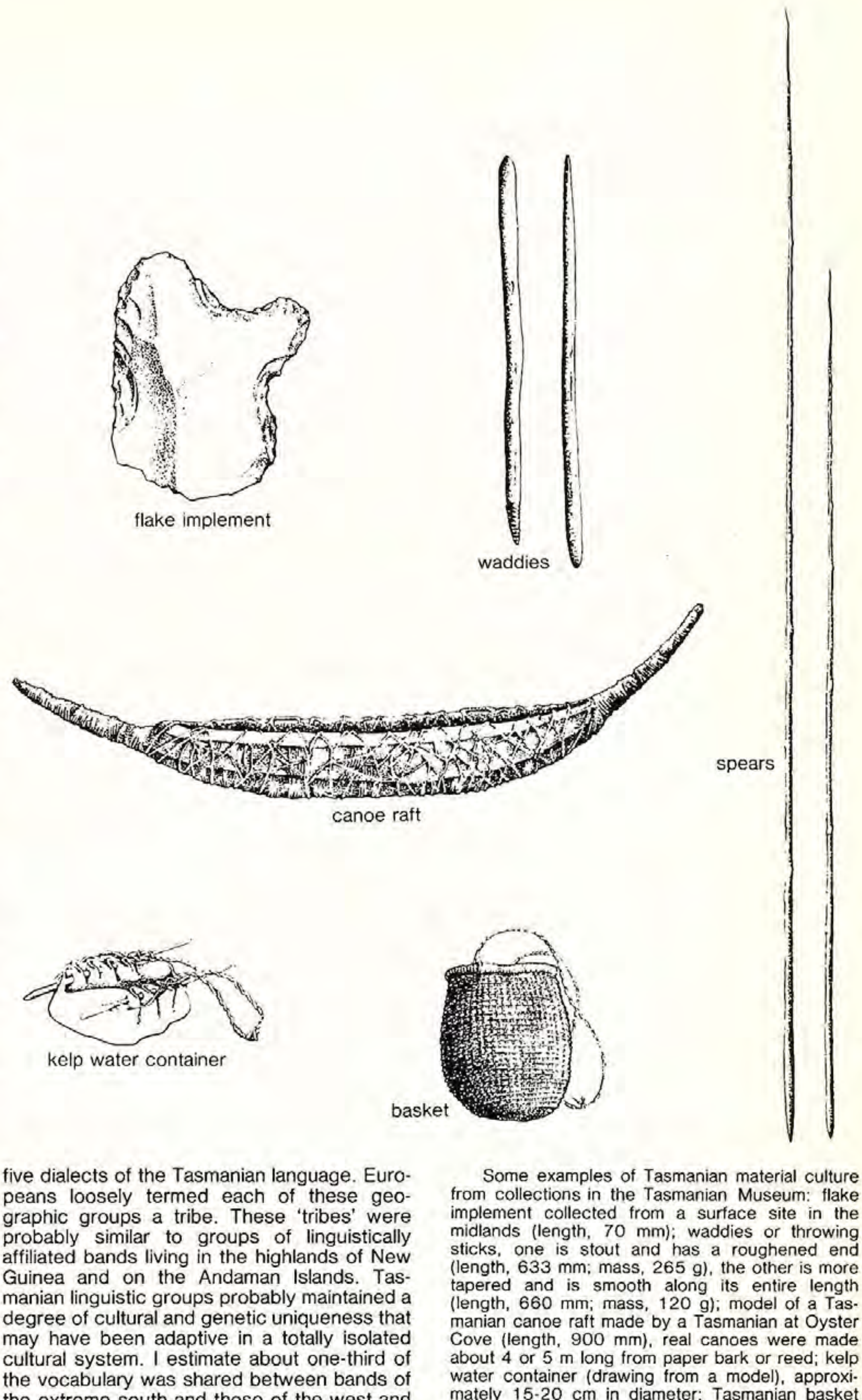
The question of whether or not Tasmanians possessed a fire-making technology can also be examined in an adaptive context. Tasmanians were not observed to generate fire by any of the methods practised by people on the mainland. They transported live coals and carried firesticks instead. If their fires went out, they reignited their firesticks from a nearby bush fire or by borrowing from another band. The firestick is more likely to be an adaptation to living in a cold wet temperate climate rather than evidence of a primitive or degenerate kind of technology.

The Tasmanians also made some carefully constructed permanent items. Their basketry is identical to neatly twined baskets made by certain mainland Australian women. Good quality string and rope was also made, although hair string was not used, possibly because of its tight curl.

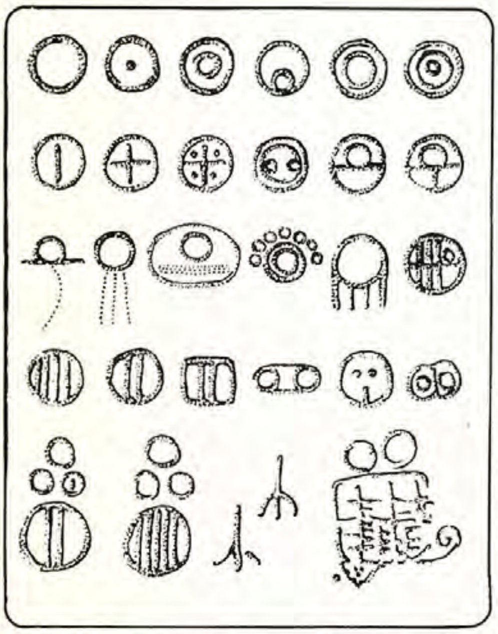
The presence of a single, plentiful food type usually determined the location of occupation sites for the Tasmanians. The mud oyster and mussels were staple foods along the entire southeastern and eastern Tasmanian coastline. In the northwest, west and southwest, abalone and turban shells predominated as food. These reliable, but monotonous, resources were supplemented by a variety of other marine and non-marine invertebrates, reptiles, birds, bird eggs, marine and terrestrial mammals and plants.

The Tasmanians lived in small bands consisting of from 30 to 60 individuals. At the time of European contact, 70 or more of these bands roamed through nine territories comprising the coastal margin and major river valleys of the island. The several bands associated with each territory spoke one of five dialects of the Tasmanian language. Europeans loosely termed each of these geographic groups a tribe. These 'tribes' were probably similar to groups of linguistically affiliated bands living in the highlands of New Guinea and on the Andaman Islands. Tasmanian linguistic groups probably maintained a degree of cultural and genetic uniqueness that may have been adaptive in a totally isolated cultural system. I estimate about one-third of the vocabulary was shared between bands of the extreme south and those of the west and northwest, and approximately half between the bands of the south and southeast. Each tribe had some different customs and local adaptations of which various food prohibitions figure prominently. Also, west and northwest coast dwellings differed from those found elsewhere, and for some as yet unexplained reason, the northeastern tribes did not make or use the canoe-raft.

The little information that is known about early Tasmanian beliefs and religion include a short list of evil personifications, a few mythological fragments having celestial connotations and some descriptions of disposal of

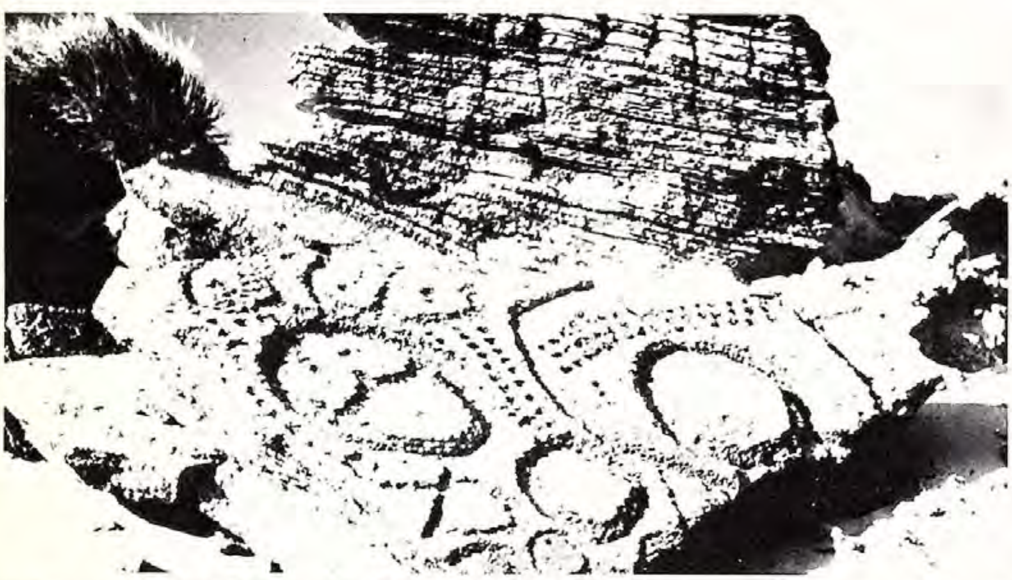


Some examples of Tasmanian material culture from collections in the Tasmanian Museum: flake implement collected from a surface site in the midlands (length, 70 mm); waddies or throwing sticks, one is stout and has a roughened end (length, 633 mm; mass, 265 g), the other is more tapered and is smooth along its entire length (length, 660 mm; mass, 120 g); model of a Tasmanian canoe raft made by a Tasmanian at Oyster Cove (length, 900 mm), real canoes were made about 4 or 5 m long from paper bark or reed; kelp water container (drawing from a model), approximately 15-20 cm in diameter; Tasmanian basket (height, 210 mm; diameter, 140 mm); and spears from *Melaleuca* spp., the longer spear is 4.46 m and weighs 773 g and the smaller is 3.52 m and weighs 737 g. Drawings by Peter Murray.



Line drawing (left) of selected motifs from several northwest coast petroglyph localities. These probably relate to Tasmanian mythology. Some motifs appear to represent astronomical and meteorological phenomena while others may represent female figures and animals. A particularly rich area for petroglyphs is at Mt. Cameron West in northwestern Tasmania (below). Drawings by Peter Murray and photo by P. Bassett-Smith.

This old photograph (bottom) taken at the Oyster Cove Settlement illustrates the effect European contact had on Tasmanian Aborigines; an effect that ultimately had more severe repercussions for the survival of their culture. Photo by F. R. Nixon.



the dead. They practised magic to control weather and sickness, and to both cause and prevent life and death.

Amulets—consisting of mandibles, thighbones and skulls of infants—were carried or worn both as remembrances and magical charms. These were sometimes applied to ailments in an effort to draw out the evil influence. In serious illnesses various parts of the body were lacerated with a stone tool. On the more practical side, they used splints to set broken limbs and had performed successful amputations. They practised cremation of the dead and in some areas made bark 'tombs' for the remains.

Only their rock art remains to remind us of some aspect of their nonsecular lives. These petroglyphs, confined to the west and northwest coasts of Tasmania, are composed of a number of recurring motifs in the form of certain boldly executed geometric designs that refer to astronomy, women and animals.

The few recorded elements of Tasmanian culture and society seem to me to indicate a resourceful, vital and ingenious system, rather than a degenerate one on the way to collapse. The Tasmanians possessed a culture and technology that was apparently in equilibrium with the ecosystem.

The disintegration of Tasmanian culture did not begin until after European contact. It was well underway by 1820, and by the mid-1830s when the few remaining Aborigines were confined to a settlement on Flinders Island the end was clearly in sight. Torn from their land and placed in an unfamiliar and regimented environment, those who had not succumbed to influenza, pneumonia, the common cold, epidemic tuberculosis or venereal disease wasted away psychologically. When their culture was removed from the context in which it served for thousands of years, its meanings were destroyed and while the last few Tasmanians appeared to have tried very hard indeed, they ultimately failed to readapt their culture for survival in a European context.

FURTHER READING

Bowdler, S. 1974. An account of an archaeological reconnaissance of Hunter's Isles northwest Tasmania, 1973-4. *Rec. Q. Vict. Mus.*, Launceston, No. 54, 22 pp.

Geode, A. and P. Murray. 1977. Pleistocene Man in south central Tasmania: evidence from a cave site in the Florentine Valley. *Mankind*, 11: 2-10.

Hiatt, B. 1967-68. The food quest and the economy of the Tasmanian Aborigines. *Oceania*, 38: 99-133, 190-219.

Jones, R. 1977. The Tasmanian paradox. In R. V. S. Wright (ed.) *Stone tools as cultural markers.* Australian Inst. Aboriginal Studies, Canberra.

Peron, F. 1810. *Voyage de decouvertes aux Terres Australes.* 2 vol. translated by Richard Philips, London.

Plomley, N. J. B. 1971. *Friendly mission, the Tasmanian journals and papers of George Augustus Robinson 1829-1834.* T.H.R.A. Supplement.

Roth, L. 1899. *The Aborigines of Tasmania.* 2nd ed., Halifax.

TASMAN AND A DUTCH DISCOVERY

In the mid seventeenth century the world of the Tasmanian Aborigine was to be touched for the first time by European man. The Dutch 'discovery' of Van Diemen's Land (Tasmania) initiated a new era—the modern era—that has seen the island's recorded exploration, colonial and penal settlement, statehood and environmental exploitation and the demise of the Tasmanian Aborigine. As a Senior Research Assistant in the History Department of the University of Tasmania, Peter Chapman is interested in the initial reactions of the European imagination to Van Diemen's Land and the consequences of those reactions for later Australian history. His account of the discovery voyage by the navigator Abel Janszoon Tasman places European man's impact upon Tasmania into an historical perspective.

by Peter Chapman

Portrait of Abel Janszoon Tasman, the discoverer of Van Diemen's Land, from *Historical photographs relating to Tasmania* by J. W. Beattie, Hobart, 1912, in the Mitchell Library, Sydney. Beattie's photograph is of an oil painting in the possession of L. G. Cockhead Esq. of Hobart. The original was bequeathed to the Royal Empire Society in 1947.

The discovery of Van Diemen's Land may be seen as the southernmost thrust of the great Dutch maritime initiative following the revolt of the Protestant Netherlands from Catholic Spain in 1581. Seventy-seven years of bitter, intermittent warfare were to pass before the Spanish recognised the complete independence of the Netherlands in 1648, but by the beginning of the seventeenth century the Dutch were already mounting a startling challenge to the long-established Spanish and Portuguese maritime empires in the Pacific.[1]

The thrust had been coming from independent seafaring syndicates in the privateer tradition but in 1602 became far more formidable with the co-ordination of these groups into the United East India Company with full powers of 'commerce and war' and the Dutch monopoly of the East. The company pursued trade and war with such vigour that by the Twelve Years' Truce of 1609 between the Netherlands and Spain it was conceded that the Dutch be allowed to trade freely in the East. Henceforward, development was rapid: in 1619 Batavia was founded by the able Dutch Governor-General Jan Coen, commanding the straits of Sunda and forming a base for the maturation of an ambitious vision of an expanding trade empire extending from Formosa to Madagascar.

While the first Dutch contact with Australia was that of the *Duyfken* in 1605, touching on Cape York on a voyage off the coast of New Guinea, the decisive explorations about the 'great South-land' (dubbed Austrialia by the last great Spanish navigator, Quiros, in the previous year[2]) were to follow under Coen's successors, Van Speult and Van Diemen.

There were numerous voyages of exploration in the seas to the north of Australia, but it was not until the Governor-Generalship of Anthony Van Diemen at Batavia (first appointed in 1636) that there was an attempt to explore the 'South-land' by probing *from* the south. Like his predecessors, ambitious to expand the Dutch trading empire, Van Diemen was perhaps the ablest of the early Governor-Generals at Batavia and issued wise advice to his captains; to treat the natives "with great kindness, wary caution, and skilful judgement. Whoever endeavours to discover unknown lands and tribes had need to be patient and long suffering . . ."[3] This was to be prophetic advice for the early explorers and settlers of Van Diemen's Land and New Zealand.

Apart from Van Diemen, the inception and indeed the success of the southern voyage of Abel Janszoon Tasman (1603-1659) also owed much to the advice and expertise of Frans Jacobszoon Visscher, recognised as a master pilot and hydrographer and who accompanied Tasman on the voyage as Pilot-major. His *Memoir concerning the Discovery of the South-land* appeared in January, 1642 and included the suggestion which was to shape the outline of Tasman's voyage, namely to use Mauritius as a forward re-victualling base and to sail south from Mauritius at the end of August, which would leave the southern summer for exploration, and continue south till 52-54 degrees of latitude. Thence, if the south-land had not been discovered, the expedition was to sail east until it did so, or until it reached the longitude of New Guinea, whence it might sail northward. Visscher's memoir contained ambitious projects, including a suggestion the expedition might make a southern circumnavigation to discover "the Southern portion of the world all around the globe, and to find out what it consists of, whether land, sea, or icebergs, all that God has ordained there", in the event the explorers were to find enough to occupy their time in the more modest journey.

Tasman, who had been born in the Groenigen village of Lutjegast in the Netherlands, was now an experienced mariner. For the previous nine years he had been voyaging and trading in the East Indian seas, and there had been episodes which included dangerous encounters with natives. In 1639 he had embarked on a major voyage of exploration as second in command to the navigator Matthijas Quast, a harsh long voyage six hundred miles east of Japan and deep into the North Pacific which cost the lives of nearly half the ships' companies.

Quast's voyage had included an unsuccessful quest for the legendary islands of Rica de Oro and Rica de Plata, rumoured to be "Rich in Gold . . . and Silver". Instructions issued to Tasman by Van Diemen for his 1642 voyage in search of the "remaining unknown part of the terrestrial globe" had referred to the sister latitudes of the silver and gold rich countries of Chile and Peru, and had advised him, should he encounter people in the lands of his discoveries, to enquire of them "what commodities their country yields, likewise enquiring after gold and silver whether the latter are by them held in high esteem; making them believe that you are by no means eager for precious metals, as to leave them ignorant of the value of the same".[4] Yet while it is clear that ultimate economic exploitation was a prime aim of the expedition it is fair to note that Van Diemen again counselled gentle behaviour toward native populations.

Tasman sailed with two ships, the *Heemskerck* and *Zeehaen*, from Batavia on 14 August, 1642. They arrived at Mauritius on 5 September but the necessity for an extensive refit detained them there till well after Visscher's optimum departure date and they did not leave until 8 October. Soon they were beating into heavy seas and stormy weather, and by 6 November, having reached latitude 49°4', progress was deteriorating. Tasman noted in his journal ". . . a storm from the west, with hail and snow . . . the sea ran very high and our men begin to suffer badly from the severe cold . . ."[5] Buffeted by south-southwesterly winds, it was clear that the expedition was not able to make Visscher's original prescription of a minimum southern latitude of 52°.

Visscher now recommended a change of course which was to lead directly to the discovery of Tasmania: he suggested they run northward till the 44th degree latitude, and then "stick to the 44th degree S. Latitude running east until we shall have passed the 150th degree of Longitude, and then run north as far as the 40th degree S. Latitude, remaining there with an easterly course, until we shall then have reached the 220th degree of Longitude . . ." He also opined "We cannot but think that if we find no land up to 150 Longitude we shall be in open sea again, unless we should meet with islands; all which time and experience being the best of teachers will no doubt bring to light . . ." As Tasmania lies between 40°-45°, and between, by Dutch reckoning, 205°-210° longitude, these directions would have led the expedition to strike or sight either the north-west corner of the Tasmanian coast or the Bass Strait islands.[6]

Tasman accepted the thrust of his Pilot-major's advice, commenting on 7 November: "wind still westerly, with hail and snow, so we had to run on with a furled foresail as before, and as we could not make any progress in this way, we deemed it best to alter our course to northward . . ."[7] On the following day he confirmed they should "shape our course north-east as far as 44°S Latitude and then keep a due east course as far as 150° Longitude".

Tasman crossed the 150th longitude on 18 November without further incident, but as he then elected to steer a rather more southerly bearing than that suggested by Visscher, never running further north than 42°25', in effect laid a course which would take them directly to the central west Tasmanian coast, which was sighted on 24 November: "In the afternoon, about 4 o'clock, we saw land, bearing east by north of us, at about 10 miles' distance . . . the land we sighted was very high; towards evening we also saw east-south-east of us three high mountains, and to the north-east two more mountains, but less high than those to southward . . ." These mountains were to be named after Tasman's ships by Flinders, 156 years later.

Next day they sailed to within a mile of the shore and took soundings of "clean, fine white sand" and Tasman recorded in his journal: "This land being the first land we have met with in the South Sea, and not known to any European nation, we have conferred on it the name of Anthony van Diemenslandt in honour of the Hon. Governor-General, our illustrious master, who sent us to make this discovery . . ." (Van Diemen's Land was formally re-named Tasmania in 1856 after transportation of convicts to the colony ceased and it became self-governing.) They were now rather south of Macquarie Harbour, and proceeded south, while gales and heavy seas made landing impossible until they rounded the southern end of the island where a further storm forced them from a promising anchorage in 'Storm' Bay and drove them south and east round Tasman Peninsula. They eventually anchored off Visscher Island, near Cape Frederick Hendrick (so named by Tasman after the Stadtholder of the United Provinces) on the north-east corner of Forestier Peninsula on 1 December. On the following day Tasman sent Visscher ashore in command of a pinnace and a cock-boat—the first Europeans to set foot on Van Diemen's Land, eighteen men in all.

Visscher landed at what is now known as Blackman's Bay but which Tasman named Frederick Henry Bay. He returned with his party intact in mid afternoon having discovered fresh water, an "abundance of excellent timber" and bearing "various samples of vegetables which they had seen growing there in great abundance . . ." Perhaps of more immediate interest to Tasman however was Visscher's report that "they had heard certain human sounds, and also sounds nearly resembling the music of a trump, or a small gong, not far from them, though they had seen no one" and "that they had seen two trees about 2 or 2½ fathom in thickness, measuring from 60 to 65 feet from the ground to the lowermost branches, which trees bore notches made with flint implements, the bark having been removed for the purpose; these notches, forming a kind of steps to enable persons to go up the trees and rob the bird's nest in their tops, were fully 5 feet apart, so [we] concluded that the natives here must be of very tall stature, or must be in possession of some sort of artifice for getting up . . . in one of the trees these notched steps were so fresh and new that they seemed to have been cut less than four days ago."[8] This was the first, tenuous, European 'contact' with the Tasmanian Aborigines, and though Tasman and his party sighted no Aborigines, they had no doubt from the fires that struck up in woodlands of the vicinity that they were under constant observation during their brief stay in Tasmania.[9]

On 3 December, the following and last day of Tasman's stay in Tasmanian waters, he claimed the land formally for the company. Heavy seas made this ceremony difficult and in the end the ship's carpenter Pieter Jacobaz was obliged to swim ashore bearing a "pole with the Company's mark carved into it, and a Prince-flag to be set up there, that those who shall come after us may become aware that we have been here, and have taken possession of the said land as our lawful property . . ." He planted the pole "about the centre of the bay [modern Prince of Wales Bay] near four tall

Tasman's discovery ships, *Heemskerck* and *Zeehaen*, from *Historical photographs relating to Tasmania* by J. W. Beattie, Hobart, 1912, in the Mitchell Library, Sydney. This photograph is of an oil painting by Capt. Forrest of Hobart from the original drawings in Tasman's diary.

trees easily recognisable and standing in the form of a crescent . . ."[10]

This ended Tasman's effective exploration of Tasmania. On 4 December after further unfavourable winds deterred him from making a further landing for water, he sailed eastwards, naming Maria and Schouten Islands and Van der Lyn (later Freycinet Peninsula) as he did so. He had failed to detect either the Derwent estuary or the connection or otherwise of Van Diemen's Land to the 'South-land' to the north, but his voyage of discovery was by no means over. On 13 December he discovered New Zealand, touched on the northern end of the southern island where, despite his usual caution, he lost four of his men in an encounter with Maoris, explored but did not penetrate the gulf between the islands, and charted the western coast of the northern island. Leaving this at Cape Maria Van Diemen (so named, like Maria Island, after the Governor-General's wife) he sailed home via the Tongan Islands (a further discovery) to arrive at Batavia on 14 June, 1643, concluding his journal on the following day: "In the morning at daybreak I went to Batavia in the pinnace. God be praised and thanked for this happy voyage."

Governor Van Diemen and his Council however showed less gratitude for what was a remarkable navigational achievement. While commending him for his voyage, they were unable to mask their disappointment at the lack of promising economic discovery and commented dourly that he "had been to some extent remiss in investigating the . . . *nature* of the lands discovered and left the main part of this to some more inquisitive successor"[11]. Nevertheless, Tasman (and Visscher) was commissioned to make a further voyage of discovery in 1644. This time his route followed the north Australian coastline from the top of Cape York Peninsula (approaching it from the west and skirting the southern coastline of New Guinea), westward, charting the interior of the Gulf of Carpentaria and continuing westward beyond North West Cape to latitude 24. Although, as with Van Diemen's Land, Tasman failed to discover the strait (Torres Strait) separating New Guinea from Australia, assuming it to be part of the continent, this was another great pioneering voyage. However, like the previous expedition, it was not one which returned tangible profits to the East India Company, indeed, of such prospects Tasman could only write of the "naked beach-roving wretches, destitute even of rice . . . miserably poor, and in many places of a very bad disposition . . ."[12], a far cry from the precious metals desired by the Directors of the Company.

Indeed, while Governor Van Diemen in Batavia was eager to continue explorations of the 'South-lands', the Directors of the United East India Company in Amsterdam were beginning to consider these expensive and hitherto profitless voyages of discovery a poor return on investment. "These plans," they wrote to him, "somewhat aim beyond our mark . . . the gold and silver mines that will best serve the Company's turn have already been found . . ."[13] Van Diemen died in April 1645 and the great initiative to the south was quietly abandoned. No European was to set foot on Tasmania for another 150 years.[14]

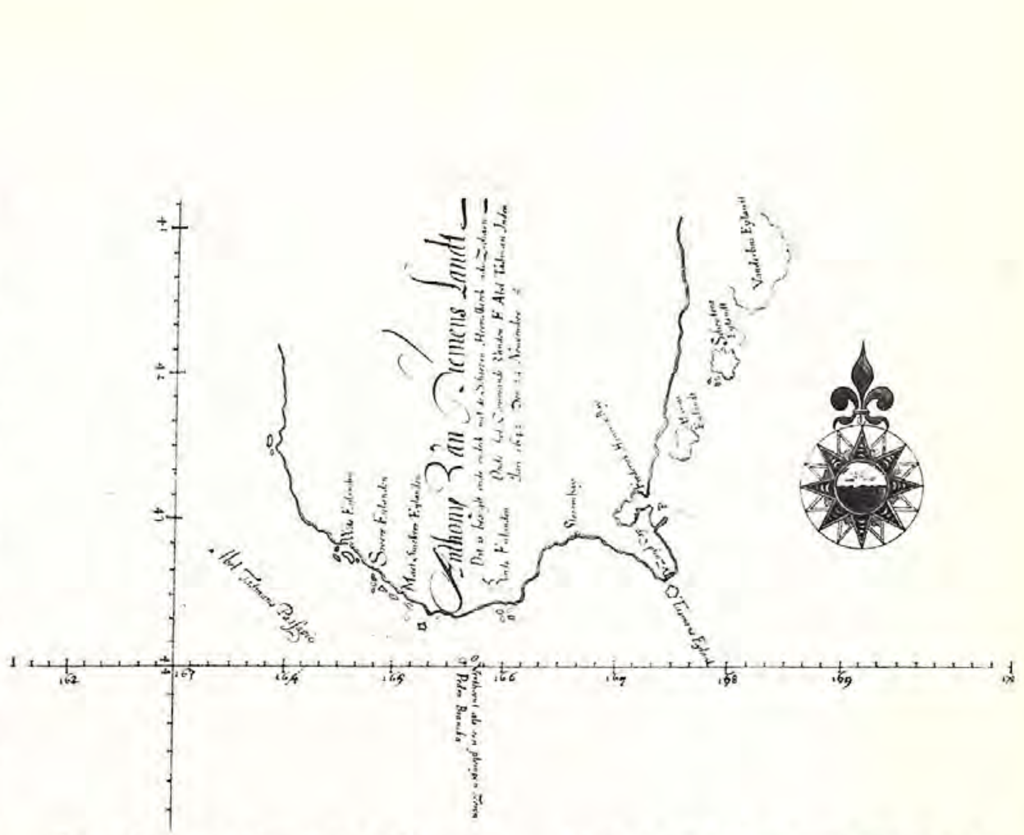


Chart of the surveyed coast of "Anthony Van Diemens Landt" from *Abel Janszoon Tasman's Journal of His Discovery* . . . (full title given in note 5 at the end of the article), Amsterdam, 1898, in the Mitchell Library. Tasman's first sight of Van Diemen's Land was a point on the central west coast on 24 November, 1642. From here he sailed southward, rounded South West Cape, continued eastward and eventually anchored on 2 December at Cape Frederick Hendrick. Leaving the anchorage, Tasman sailed northward past Maria and Schouten Islands to about Freycinet Peninsula and then continued eastward to discover New Zealand.

Tasman's career subsequent to these expeditions, while not attended by the disasters which attended later explorers of Tasmania (Du Fresne was killed and eaten by Maori cannibals; D'Entrecasteaux died on his homeward voyage; Bligh suffered both the mutiny of the *Bounty* and deposition as Governor of New South Wales; Flinders was imprisoned for nearly seven years on Mauritius by the French when he called there in 1803), was certainly anti-climactic. The unpromising report of his second voyage had again drawn criticism from Van Diemen as to the "need for a closer investigation by more vigilant and courageous persons than hitherto employed on this service . . ."[15], and while he was promoted to Commandeur in 1644 and given command of two further expeditions, to Dambi in 1646 and Siam in 1647, these were lesser missions and his commission was to terminate sadly on a third expedition in 1648-9. This was a privateering raid to check the Spanish presence in the Philippines, and while the object of the mission (the storming of fort at Albay on Luzon) was accomplished successfully, in the aftermath Tasman, who was later accused of "banqueting and carousing", so lost his temper with two delinquent (Dutch) sailors that he attempted (and was nearly successful in so trying) to hang them with his own hands—an excess which led to his disgrace in the following year (1649). Ignoring his plea that he "had put the halter round the sailors neck as a 'deterrent menace' ", the Batavian Council of Justice deprived him of his rank and pay and ordered him to "declare in public court with uncovered head" that he had attempted to sentence the sailors "extra-judicially, of his own will and against all forms of law"[16], a sentence which resulted in Tasman's loss of certain civic positions as well.

While he was fully re-instated in 1651, this was the end of Tasman's public career with the company. He continued to live in Batavia with his second wife in comfortable circumstances, residing on a large estate which included a pleasure garden of six acres. However he maintained his lifelong interest in the sea to the end, engaging in mercantile trading ventures, still satisfying perhaps that urge which led him to his great journeys. He died in Batavia in 1659.

Despite the reservations of the East India Company, Tasman's first voyage in particular remained an enduring achievement. While it was commemorated in the ornate form of a marble mosaic of two hemispheres set in the floor of the Amsterdam Town Hall (1655), accounts of the voyage and abstracts from his journal were published in numerous editions and translated into French and English.[17] These were the languages of the later explorers of Van Diemen's Land who were, in turn, both to make an intimate acquaintanceship with Tasmania's mysterious inhabitants[18] and chart its coastline to the point of at last uncovering its island form and claiming it for their own[19], an annexation with dire consequences for the Aborigines.

Meanwhile, news of the discovery was not limited to nautical accounts. Swift, in writing *Gulliver's Travels* (1726) located Lilliput "to the north-west of Van Diemen's Land . . . 30 degrees 2 minutes south"[20], an arid locality perhaps (in southern Australia), but evidence of the secure establishment in the European imagination of the remote land Tasman had discovered.

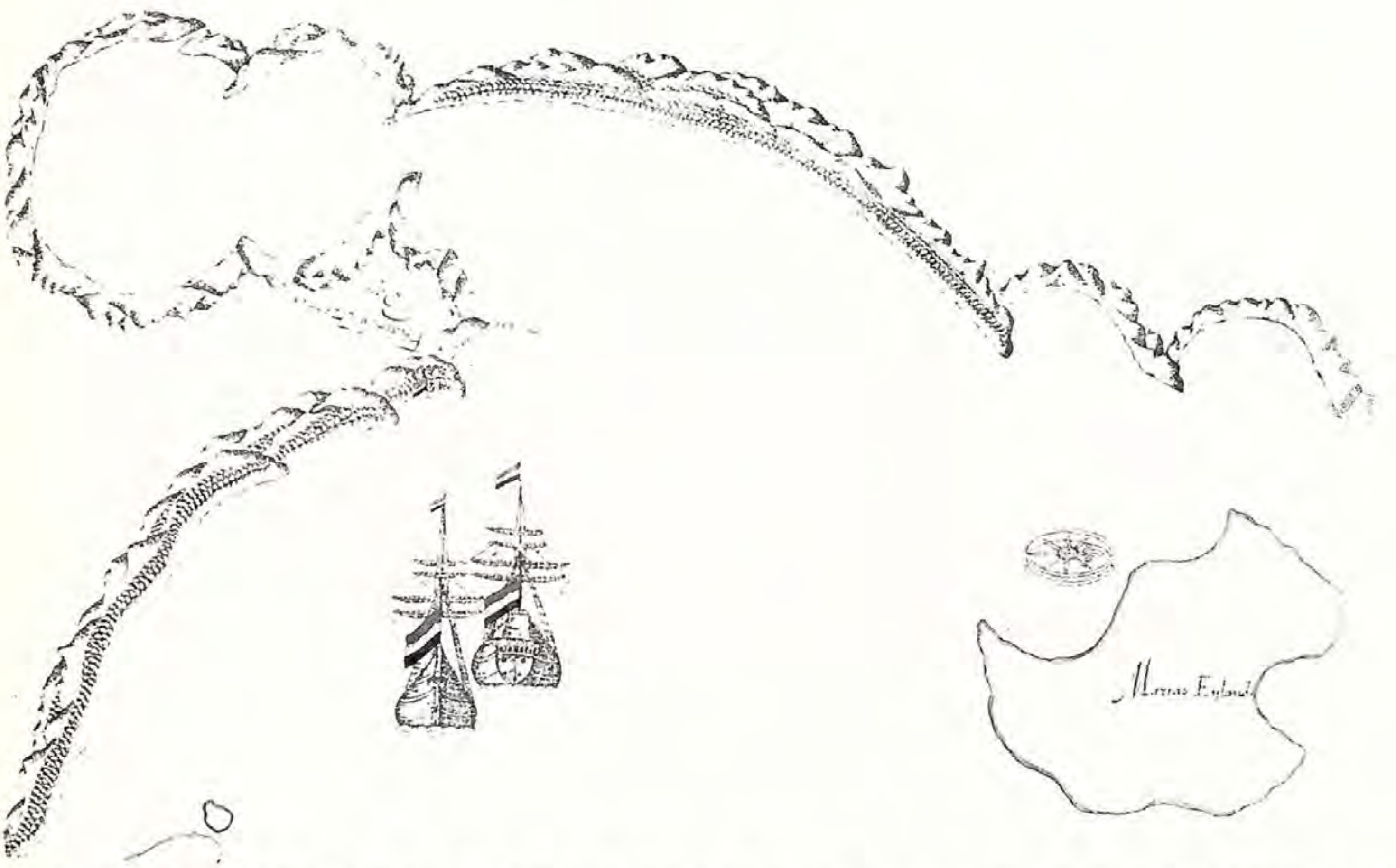


Chart of "Frederick Henricx Bay with Maria's Island" from *Abel Janszoon Tasman's Journal of His Discovery . . .* , Amsterdam, 1898, in the Mitchell Library. The present-day name for the bay illustrated by Tasman is Blackman's Bay and the name 'Frederick Henry' is now given to a bay in the northern section of Storm Bay further to the west. Tasman's anchorage (illustrated by the ships on Tasman's chart) would correspond to a position in south Marion Bay. Controversy surrounds the exact point where the first Europeans did set foot on Tasmania. Both Tasman Bay and the adjoining North Bay (small bays on the south coast of Marion Bay) have been proposed as probable landing points.

REFERENCES AND NOTES

1. For ingenious reconstructions of earlier, conventionally Portuguese initiatives about Australia (yet to be conclusively proven) see *The Secret Discovery of Australia* (Adelaide 1977) by K. G. McIntyre; and I. McKiggan, The Portuguese Expedition to Bass Strait in A.D. 1522, *Journal of Australian Studies*, No. 1, June 1977, p. 2.
2. J. C. Beaglehole, *The Exploration of the Pacific* (London 1966), p. 94. Landing at the New Hebrides in May, Quiros had declared "all the lands which I have sighted and am going to sight . . . as far as the Pole . . . shall be called Austrialia del Espiritu Santo . . ." But the name was in honour of the house of Austria; the popularisation of modern 'Australia' from 'Terra Australis' owed much to the French advocate of colonial expansion, Charles de Brossess, author of *Histoire des navigations aux terres australes* (1757), and was first applied by Matthew Flinders, the first circumnavigator of the entire Australian coastline, and adopted by Governor Macquarie of New South Wales in 1817; see C. M. H. Clark, *A History of Australia*, I. (Melbourne 1962), pp. 182 and 317.
3. Beaglehole, p. 139.
4. Beaglehole, p. 145.
5. Tasman, *The Journal of Abel Jansz Tasman 1642 with Documents Relating to His Exploration of Australia in 1644*, entry, 6 November, 1642. This accessible edition is a very fair rendering of Tasman's Journal, but serious readers should consult the classic and now very rare edition by J. E. Heeres and C. H. Coote, *Abel Janszoon Tasman's Journal of His Discovery of Van Diemen's Land and New Zealand in 1642 with Documents Relating to His Exploration of Australia in 1644 being Photo-lithographic Facsimiles of the Original Manuscript in the Colonial Archives at the Hague with an English Translation and Facsimiles of the Original Maps to which Added Life and Labours of Abel Janszoon Tasman by J. E. Heeres LL. D.* (Amsterdam 1898).
6. By 'Dutch reckoning', 220° was equivalent to 160° west of Greenwich.
7. Tasman, entry, 7 November, 1642.
8. Tasman, entry, 2 December, 1642.
9. Tasman's phrase is puzzling: "at various times and points in the wood they also had seen clouds of smoke ascending. So there can be no doubt there must be men here of extraordinary stature." Possibly some hollow eucalypts were burning from the centre with the flames emerging high up the trunk, giving the illusion to the Dutch, unfamiliar with such trees or such bushfires, that the trees had been *litten* high up? In view of the later behaviour of the Aborigines toward the French their 'invisibility' is surprising. Perhaps all the Dutch saw *were* bushfires.
10. This was most probably on the northwestern section of Tasman Bay (formerly Prince of Wales Bay). For the view it may have been the adjoining North Bay, see G. Halligan's hypothesis in *Papers & Proceedings of the Royal Society of Tasmania* (1925), pp. 195-202, and in the same journal C. Lords' more convincing reply (1926), pp. 25-34.
11. Cited in J. E. Heeres, *Life and Labours of Abel Janszoon Tasman*, p. 114, in Heeres and Coote, *Abel Janszoon Tasman's Journal . . .*
12. Beaglehole, p. 158.
13. Beaglehole, pp. 159-160.
14. I.e. the Frenchman, Marrion Du Fresne on 6 March, 1772.
15. Heeres, p. 118.
16. Heeres, p. 125.
17. There were at least seven such editions by 1770 including Arnold Montanus, *De Nieuwe en Onbekende Weereld of beschrijving van America en 't Zuid-land* (1671); Dirk Rembrantzoon Van Nierop, *Een Kort Verhaet uyt het Journael van den Kommandeur Jansen Tasman int ontdekken 'tonbekende Suit-lant* (1674) and Nicolaas Witsen, *Noord en Oost Tartarye* (1692).
18. La Billardiere of D'Entrecastreaux's 1792-3 expedition, and Francois Peron, of Baudin's 1801 expedition, left invaluable accounts of the Tasmanian Aborigines in *Relation du Voyage a la Recherche de La Perouse* (Paris 1800) and *Voyage de découvertes aux Terres Australes* (Paris 1807-17), respectively.
19. Tasmania was claimed for the British Crown by Governor King of New South Wales in 1802; he was fearful of being anticipated by the French. See *Historical Records of Australia*, Series I, Vol. III, p. 737: Despatch, King to Hobart, 23 November, 1802.
20. *Gulliver's Travels*, chapter I, Oxford Standard Authors (Oxford 1956) p. 18. In Swift's earlier *Tale of a Tub* (1705) the author of 'A Project for the Universal Benefit of Mankind' wrote prophetically of his intention "to print by subscription . . . an exact description of *Terra Australis Incognita* . . . this work will be of great use to all men . . . because it contains exact accounts of all the provinces of that spacious country, where by a general doom, all transgressors of the law are to be transported . . ."

THE ISLANDS OF BASS STRAIT

The inhabitants of the islands that dot the channel between the Australian mainland and Tasmania are a hardy people—one that has survived a turbulent history in an often inhospitable environment. Patsy Adam-Smith OBE has had a twenty-five year relationship with the islands of Bass Strait which started in 1954 when she sailed these waters for six years on a trading vessel. She later lived for periods on the islands, worked with CSIRO bird-banding teams, and to this date returns each year for 'the birdin' season'. Her article indicates an intimacy with the islands and their people that is matched by few outsiders.

by Patsy Adam-Smith

The *Sheerwater*, here taking on cargo off Flinders Island, is one of the most familiar and audacious of the small ships in Bass Strait during this century. Photo by P. Adam-Smith.

On the 39th parallel—the edge of the Roaring Forties—the strait that divides Tasmania from the mainland is about 210 km in length north to south and 560 km east to west. All that remains of the land that once joined the continent to the island state is the high mountain range that today presses its peaks up through the Bass Strait to form 120 islands or rocks from the Victorian to the Tasmanian coast. The 42 islands of the Furneaux Group lie at the eastern entrance to Bass Strait, only three-quarters of an hour flying time from Melbourne, half an hour from Tasmania yet relatively still as isolated as when settlement there, was the first south of Sydney. Scarcely 20 km separates any rock or island from the Glennies to the Kent Group and the Furneaux on to Swan Island.

The Furneaux Islands were named after Captain Tobias Furneaux who discovered them when sailing with Captain James Cook in 1773. They were charted, but roughly, on a map that as yet did not separate Tasmania from the mainland of Australia. It was the coming of Guy Hamilton, an eighty-year-old Scot mariner, that set in motion the group's swashbuckling era that has hardly ended.

Hamilton was the Master of the *Sydney Cove* (renamed in 1796 as a cunning compliment to the founding settlement in New South Wales). One of the East India Company's more expendable vessels, she was old and unseaworthy, just fine to risk sending with a speculation cargo, the first ship to attempt to open trade with the colony. The company knew the cargo the colony might best buy and when the old ship wallowed out of the Hughli, India, on 10 November, 1796 she carried 7,000 gallons of rum and whisky.

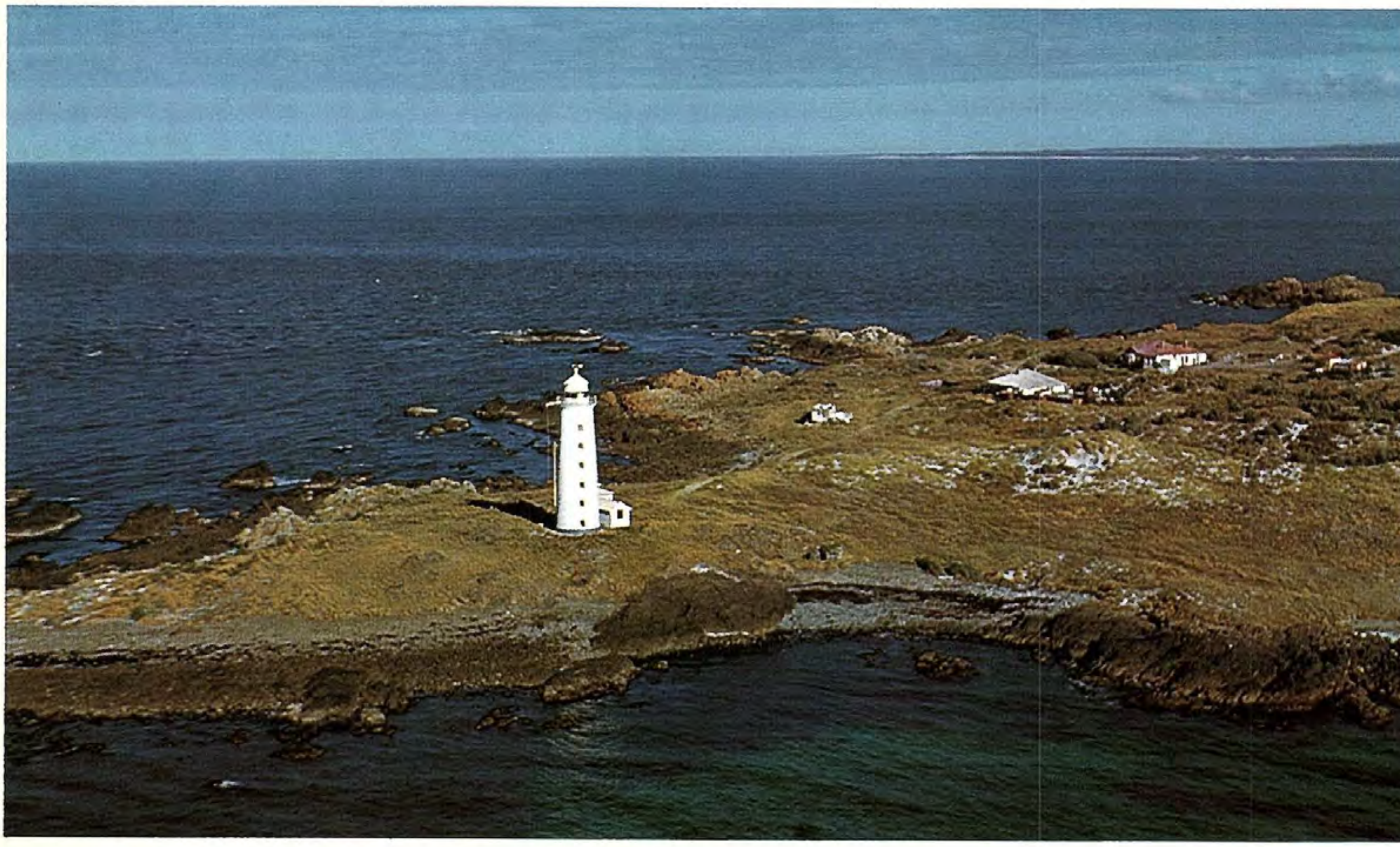
The old man sailed down into the Roaring Forties, south of Tasmania, not then known to be an island, and from the first onslaught of those wild waters she began to open up. In the cold wastelands of the southern seas some of the Lascar crew died at the pumps, the second mate was swept overboard and the ship's sails were rent. Hamilton dragged her around the south coast of Tasmania and headed her north. Within twenty-four hours a gale of hurricane-force hit the distressed ship and water poured in. In the dark of night the gale drove her through Banks Strait (the ship's company were unaware of its existence, they being the first recorded travellers to pass this way), a rocky, inhospitable shore, even now uninhabited.

As day dawned on 8 February, 1797 Captain Hamilton saw, for the first time since he left India, a place where he could safely run his ship aground. He called it Preservation Island. When his crew were safely ashore he had them salvage the rum and place it on a nearby island which he named Rum Island. The wreck of the *Sydney Cove* named a host of other points and before the saga was done another ship was lost, the stage was set for the birth of a whole new race of people, two of the greatest navigators in Australia's history made important discoveries and the first settlement south of Sydney was begun.

Two little ships, *Francis* and *Eliza*, were sent from Sydney on 16 May, 1797 to rescue the crew of the *Sydney Cove* and salvage the cargo and arrived 11 June, 1797. The *Eliza* disappeared without trace on her voyage back to Sydney. The *Francis* on her second salvaging trip in February, 1798 had Matthew Flinders on board "to make what observations he could among these islands relating to anchorages etc." On his return to Sydney he conferred with George Bass about his observations and experience of the tides and currents and the two men agreed to prove their theory that Van Diemen's Land (Tasmania) was divided from New South Wales. This they did in October, 1798.

In the wake of the wreck of the *Sydney Cove* came desperadoes, lured to the islands by hopes of what the wreck would yield and by reports of the life in the sea brought back by Flinders. The islands became the mecca of time-expired convicts, deserting or abandoned seamen and any man who needed to reject society for private reasons. As well, there were the sealers. When Matthew Flinders returned to Sydney in 1798, he reported the vast numbers of fur seals in the Straits. "Seals," he wrote, "the weight of an ox," abounded in the waters of Bass Strait. The sealers raced southward to reap the harvest. Before Australia rode on the sheep's back she had wealth from the seal.

"The wild geese . . . were always shy. The kangaroo seems to abound, and those . . . remarkable badger-like animals are equally numerous." So writes Flinders, the most reputable explorer of his day, in his journal on 17 September, 1798. But that all men of the period shared the common lack of interest in survival of a species or, indeed, the pain of an animal, is illustrated on the same page of his journal: "The terrors of the young cubs (seals)



A young islander (above) explores the remnants of a bygone industry—the sealers' fry-pots on Great Dog Island. Photo by P. Adam-Smith.

The lighthouse on Swan Island (top left) off the NW tip of Tasmania keeps vigil at the southern part of the Strait. Photo by P. Adam-Smith.

This restored church (bottom left) situated in rich pasture land on Flinders Island was originally built by exiled Tasmanian Aborigines in 1842. Photo by P. Adam-Smith.

who had not yet dared take to the water afforded a good deal of amusement; they huddled together in among the rocks, putting up a dozen noses through the cavities, and expressing their fears of their tormentors by piteous looks and moans. One of the elder would sometimes assume courage enough to bark in a tremulous tone, and indeed became very fierce on our walking away from them. We killed as many large ones as there was time to skin."

His report was leapt upon so rapidly that, by the time of his next trip to the islands in the *Norfolk* at the close of 1798, he was accompanied by the *Nautilus*, Captain Bishop, who came for the seals. This man established the first settlement south of Sydney when he set up sealing operations in Kent Bay on the southern coast of Cape Barren Island. There, were made rough huts with beds, the nucleus of a processing plant and a vegetable garden. Within five months he had 9,000 seal skins ready for the market, and this was the signal for a wholesale migration of sealing men. By 1803 there were 200 men working, some from boats, others from the shore where the seals came to rest.

Originally three different types of seals lived in the Straits and all three were relentlessly pursued for their oil and fur. The elephant seal, *Mirounga leonina*, and the hair seal, *Neophoca cinerea*, were taken in such numbers that their kind are no longer seen in these seas, and the fur seal, *Arctocephalus pusillus doriferus*, is only left in small numbers. Almost 100,000 seal skins were shipped from Bass Strait to Sydney between 1800 and 1806. Indeed the extermination was so rapid that the American whalers who arrived to take part in the spoil left the Straits early in the first decade.

Most of the ships sailed out of Sydney. Once off the islands, they put gangs ashore to kill, skin and extract the oil from the seals. The most novel method of catching seals was utilised and, with it, the most brutal treatment of the natives from the nearby coastal lands of Tasmania. From the earliest time of white settlement, the coastline had been raided for native girls, and now they put them to work.

An early chronicle has told how the girls divested themselves of their kangaroo-hide frocks and smeared their body with oil from the blubber of the seals. They then slithered along the rocks and lay among the seals. They used their arms as flippers, imitating the seals' movements, at times even feigning sleep. When the animals were no longer suspicious, the women arose at a signal and clubbed to death as many seals as they could before the remainder escaped into the sea.

The first children of the white sealers and the girls they raided from the native tribes were growing up when the hand of the Establishment was signalling an end to the lawless days. The most ironical, astonishing thing of all the sad sagas of the abducted girls is that they lived, some to a great age, while the women who were cleaned, fed, corsetted and taught to be 'civilized' pined away and died, leaving poor old Truganini to live alone until she died, the last of her people, in 1876.

The vast numbers of wildlife on the Furneaux Islands have been a joy to visitors and were a source of food to the early settlers. The animals had walked over in the ages when Bass Strait was dry land, and what are now the Furneaux Islands were a mountain range far inland. As the waters began to rise 15,000 years ago only a remnant of the animals on the rich plains survived on the larger islands.

Fossil bones found on Flinders Island have shown that the boomer, the eastern grey kangaroo, *Macropus giganteus*, lived on the island just after the period of the rising of the waters. This kangaroo no longer exists on the Bass Strait islands, nor does the eastern quoll, *Dasyurus viverrinus*, or the barred bandicoot, *Perameles gunnii*, whose fossil bones have been unearthed on Flinders Island. The three still exist in Tasmania, however. The rat-kangaroo, *Aepyprymnus rufescens*, now found only in Queensland and a small area of northern New South Wales, was also once on the islands. The disappearance of these species from the Bass Strait islands was not caused by man but rather was due to the limited areas available both for them to thrive and for their foodstuffs to grow. For the same reasons, those animals that did survive have evolved different forms to their kind on the Australian mainland.

On Flinders and Cape Barren Islands two species that survive—albeit precariously—are the red-necked wallaby, *Macropus rufogriseus*, and the little Tasmanian pademelon, *Thylogale billardierii.* The wallaby is still found on the Australian mainland but the pretty little pademelon is found only on Bass Strait islands and Tasmania, having been hunted to extinction on the mainland before the beginning of this century. The wallaby is shot for bait by cray-fishermen as was the

A mother gannet, *Morus serrator*, regurgitates breakfast for her babies waiting in the gannetry at Cat Island (above). Although now almost deserted, the gannetry once maintained a population in the thousands. Photo by P. Adam-Smith.

In the past a flight of Cape Barren geese, *Cereopsis novaehollandiae* (below), was too often seen only through gunsights. Today, the increase in numbers of this species testifies to a more balanced view that acknowledges recreation, conservation and preservation. Photo by P. Adam-Smith.

most beautiful bird of the waterways, the gannet, *Morus serrator.*

In 1912 a survey of Cat Island, a tiny islet to the east of Flinders, by the Royal Australasian Ornithological Society, recorded 10,000 gannets. It was once one of the most densely populated gannetries in the world and is one of the oldest. The gannetry on Cat Island is built on a bed of guano estimated to be nearly five metres deep—evidence of the long period that the birds have been nesting there. The guano gives the whole nesting area a dazzling white appearance, making good camouflage for the white fluffy young chicks, as well as the white-plumaged adults. In 1975, thirteen gannets nested on Cat Island; a ghostly relic of their 10,000 ancestors.

A happier story is that of the increase in numbers of the Cape Barren goose, *Cereopsis novaehollandiae.* For 150 years it has resisted destruction and, with its numbers now reported to be upwards of 9,000, this species may well survive.

The name, Cape Barren goose, is inaccurate because the bird is distributed not only on all islands of the Furneaux Group but breeds as far west as the Recherche Archipelago and occurs on islands near Albany, Western Australia. It is as big as a domestic goose with a wing span of up to 1.5 metres and weighs up to about 5.5 kilogrammes. Its flesh is said to be delicious, having none of the gaminess usually attached to wild birds, and for this it has been hunted unceasingly since it was first discovered in 1792 by the French naturalist J. J. de Labillardière who called it *cygne cendre*. Labillardière took the skin of one of the geese back to Europe with him and presented it to the Paris museum. It was the first of many to be taken to Europe. John Gould wrote in *Birds of Australia* that he killed a pair of geese on Isabella Island on 12 January, 1839, but added that, far from being still numerous, the bird was "almost extirpated". As with other birds, particularly muttonbirds, the eggs were once gathered for cooking, but that has been banned for many years.

Another form of wildlife that abounds on the islands is one that many feel they could well do without. The snakes of the Furneaux are plentiful, healthy and lethal. They have set up their own divisions and although both tiger and copperhead snakes live on Flinders Island the two do not share any other island; either one or the other have sole occupancy of each of the other islands. Lady Jane Franklin, the Saint Patrick of Van Diemen's Land, after her voyage to the Furneaux in 1842, offered a bounty of fourpence halfpenny a tail—but so many were collected that the offer had to be withdrawn. The Rev. Brownrigg recorded that on Green Island alone 8,000 snakes were killed in eight years. Because of this menace, birders no longer work Chappell Island. On this island in 1952 Trooper Lew Bailey and five men with three guns and three sticks killed 143 tiger snakes in two hours—all over six feet long.

When the seals were exterminated the islanders fell on hard times. Ships no longer came to hire extra hands or to trade. It was then they turned their attention to the strange grey bird that came to the islands from the sea every September. They had watched it come in its myriad thousands at dusk; the short-tailed shearwater, *Puffinus tenuirostris*.

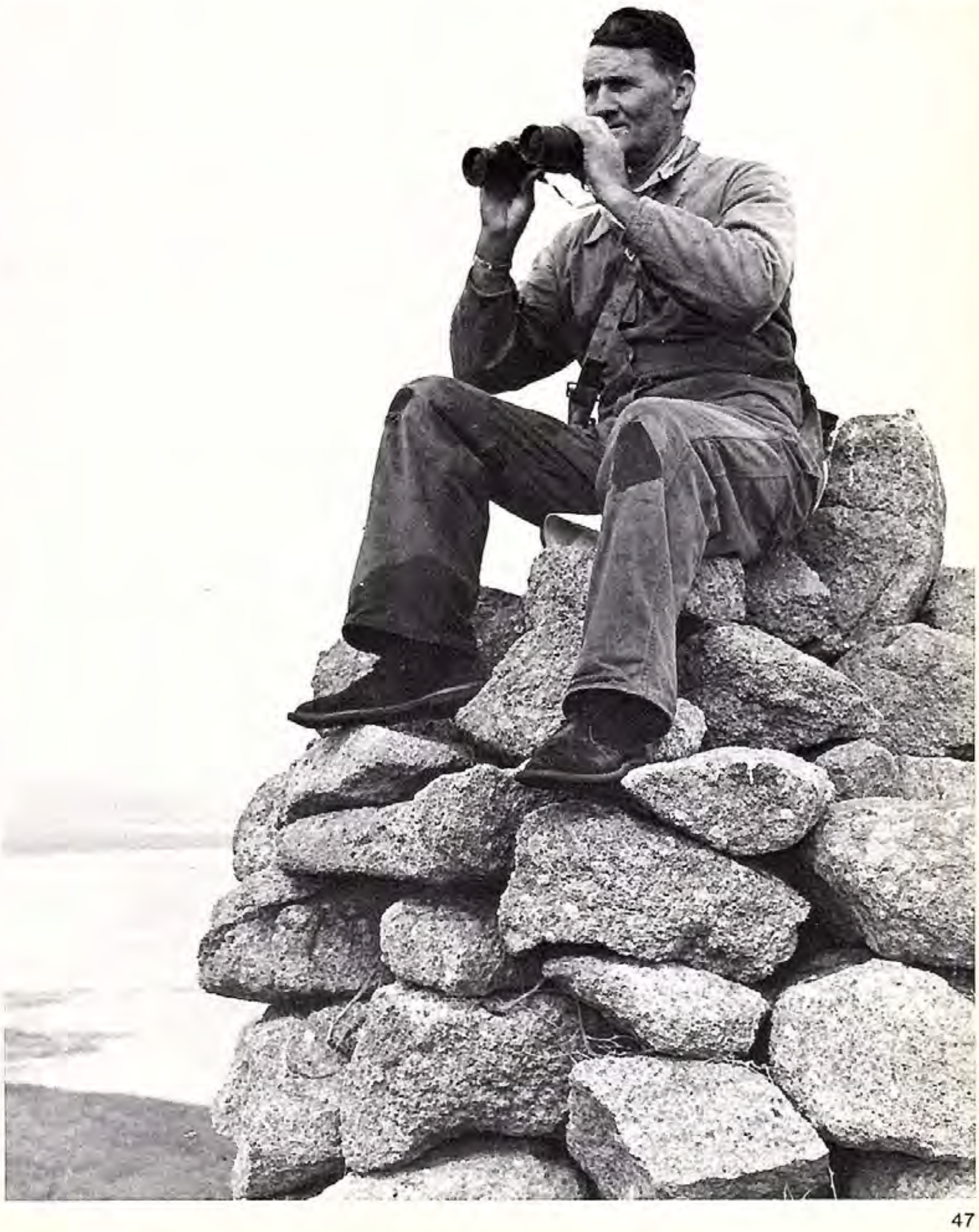
These birds are believed to be among the most numerous of any species. One flock Matthew Flinders saw was estimated to have been 151,500,000 needing 75,750,000 burrows to lodge them. Allowing a square yard to each burrow, he reckoned on their covering more than 18½ square miles. The ship-wrecked crew of the *Sydney Cove* had eaten the bird and the sealers that followed had eaten it; usually the adult bird was taken, and from its flavour it became known as muttonbird.

In the Northern Hemisphere explorers had noted the same species of bird in Arctic waters and it was there that it was given its scientific name by the Dutch ornithologist Conrad Joseph Temminck in 1835, although it had been noted and described by many earlier voyagers.

In June and July of each year fishermen in those waters have frequently reported great groups of the birds feeding on the surface of the sea. But for many years the breeding grounds of these birds remained a mystery. It seemed unlikely that the northern birds and those of Bass Strait were connected because if, in fact, they were the same birds, they would have taken five to six weeks to fly more than 11,000 km, from the time they were last seen in the southern islands in April, and the time they were first seen north of Japan and the Aleutian Islands in June.

Dr Dominic Serventy of Perth, who is the world authority on the short-tailed shearwater, has studied these birds—lived with them is a more appropriate term—for a quarter of a century. He has placed leg bands on some hundreds of thousands of birds to identify them. Each band carries a serial number and a request to contact the Fauna Board. In this way, by checking the number against the bird, burrow, and island pinpointed in a detailed card index system, the patient doctor knew where every bird and its mate lived, when they went to bed, when they were unfaithful, when their young were born and when the young matured and scratched a nest for themselves.

The birds come to the Furneaux Islands in mid-September to scratch out their nests, and, if possible, occupy the same burrow each year. Then suddenly, in the first week in November, they desert the islands and every burrow is empty. It stays that way until the latter part of the month when they swoop ashore in a huge brown cloud and descend, each to their own burrow. Then the females lay their single eggs. The banding scheme has shown that females begin to breed at from five to seven years; males from seven to eight years. For a bird of its size, it has a long period of immaturity. As the bird spends most of its life on the wing, coming in to land only to breed, it develops a great power of flight. It has been known to wander over distances of nearly a thousand kilometres and move away from the islands in search of the plankton and krill which form most of its food intake. For a century before this work was commenced the islanders had known much about the bird. They certainly knew of its remarkable pre-egglaying exodus.



Leaving with a 3 AM start, these short-tailed shearwaters, *Puffinus tenuirostris* (top right), are scrambling up a rock for a take-off into the wind. Photo by P. Adam-Smith.

Dominic Serventy's patient observations (right) have rewarded him with many of the secrets of the short-tailed shearwaters in the Furneaux Islands. Photo by P. Adam-Smith.

The sea has much to say in the everyday life of the 'Toilers of the Straits'. The high rise and fall of tides, as noticed also by Matthew Flinders, leaves ships high and dry at Whitemark, Flinders Island (top). For some islanders, the only transport from their homes is by small ships (above). Photos by P. Adam-Smith.

They that go down to the sea in ships, that do business in great waters, these see the works of the Lord, and his wonders in the deep.
Psalm 107:23-24

Few of the farmers who took up land after the Second World War go down to the sea. The scheme that opened up tracts of land for farming attracted men who wanted to farm and who needed land. A good proportion of these new settlers succeeded and have become an enduring part of the population of the Furneaux Group, but, mainly because their farms were of the size and had the facilities to make them a viable economic proposition, they have not needed to eke out an existence by part-time work at sea on fishing boats.

Few of the older Straitsmen have not been down to the sea in ships. "It's island life," Bill Riddle says. "If you're a Straitsman you're a sailor, a fisherman, a shearer, a farmer, a birder, the lot. It's life." Not many of today's—or yesterday's—Straitsmen made money, but they did live a full life. Today, the descendants of families who have been on the islands for generations still do all the things, all the trades, that Bill Riddle did as a boy.

Crayfish, *Jasus lalandii*; edible shark; barracouta or snoek as it is also known, *Leionura atun*; and the Australian salmon, *Arripis trutta*, are the four most commercially important 'fish' in the seas around the Furneaux. Most of the fishing is done within sight of the islands, rarely more than 24-32 km from the home port. Crayfish, known in other countries as spiny lobster, is a major export-earner. The tails, deep frozen, are exported, mainly to the USA, and the meat from the legs and carapace is picked out and frozen for sale to restaurants for seafood cocktail and crayfish mornay. The cost of fish can be as high as a man's life, and nowhere on earth are men, and their women, as aware of this fact than here where they see ships go out that never return.

King Island, standing sentinel at the western entrance to the Straits, is different from the Furneaux in almost every way. A flat island, 60 km long from north to south, 20 km broad, its settlers are engaged in dairying, pastoral pursuits and at the scheelite mine. Its assumed rainfall of 33 inches (84 cm) and temperate climate deny dry periods, but the winds sweeping in uninterrupted from South America 20,000 km away is said by locals "to blow the horns off a bull". Until recent years Currie has been the main 'safe' harbour if any can be called safe on this island that has been known for over a century as 'The Marine Graveyard'.

Of the five inhabited islands in the Straits only three have sizeable populations—Flinders, Cape Barren and King Islands. Clarke Island boasts a 'health retreat', and a married couple run stock on Three Hummocks in the Hunter Group.

Whereas the early sealers were called the Banditti of the Straits, today's settlers are the Toilers of the Straits. Transport, distance and the hard life imposed by island living have put a stamp on them: in some respects their bravery, stoicism and disregard of the danger that is rarely absent in their dealings with the elements make them kin to the Shetland Islanders, the men of Arran or the women of the Orkneys.

The wave cry, the wind cry, the vast waters
Of the petrel and the porpoise. In the end
is my beginning.
T. S. Eliot

FURTHER READING

Adam-Smith, P. 1964. *There Was a Ship.* Rigby, Adelaide.
—— 1965. *Moonbird People.* Rigby, Adelaide.
—— 1976. *Trader to the Islands.* Seal Books.

A TALE OF TWO CONTINENTS

The present varied landscape of Tasmania gives evidence of the island's long and often turbulent geological history. Lin Sutherland, Curator of the Department of Mineralogy and Petrology at The Australian Museum, has had an absorbing interest in the geology of Tasmania since 1961 when he began studies at the University of Tasmania. During his employment at the Launceston and Hobart Museums and later at The Australian Museum he has concentrated his studies on volcanic rocks, with particular emphasis on fragments of high pressure rocks which were brought up by the lavas. These studies and that of co-workers are valuable contributions to the description of the geological processes that have affected (and are still affecting) Tasmania.

by Lin Sutherland

This majestic erosion remnant, Mt. Pelion East in Cradle Mountain Lake St. Clair National Park, owes its existence to resistant dolerite columns now left resting on sandstone. Photo by Chris Green.

Tasmania is geologically fascinating. For its compact size, the island shows an extraordinary variety of rocks and is a mini-treasure house of minerals. It is the end of the Australian continent, with only the lonely Southern Ocean and Antarctic wastes yawning beyond. Its geology reflects past connections with both eastern Australia and Antarctica, producing a landscape of familiar, yet distinctive, form. Here we see Permo-Triassic strata of strikingly similar age and type to those of the Sydney Basin, but disrupted and overwhelmed by hard outcrops of Jurassic dolerite, a feature found in Antarctica. The final fascination lies in the intervention of Bass Strait. Here past fluctuations of seas periodically exposed land bridges to the mainland and allowed animals to migrate before subsequent isolation by sea rises.

Tasmania's rocks, minerals, structures and fossils illustrate the contrasting geological events that shaped it. Past sea floors, oceanic deeps, shorelines, rivers, lakes, swamps and delta systems have contributed a variety of sediments and fossil remains. Volcanic eruptions in island chains or continental settings, and intrusions of molten magmas beneath the surface have created a wide range of igneous rocks and structures. Mineralising fluids have deposited ore-bodies in host rocks. Deformations during the rigours of mountain building have imprinted folds and faults within rocks. Shearing and recrystallisation under more extreme conditions of pressure and temperature have produced suites of metamorphosed rocks. Burial has converted plant and animal remains into fossil fuels such as coal, oil and gas. Uplifts and rifting have tilted and faulted the terrain. Glaciers have scarred the landscape and dumped their debris. Groundwaters have leached and dissolved rocks leaving insoluble residues or precipitations of minerals in soils and caves. Slopes have slid or crept under gravity. Past winds have blown sands into dunes. Even extra-terrestrial impacts have left their record. All these events have played their part, sometimes many times, over the one thousand million years of Tasmania's geological history.

The geological structure of Tasmania may be simplified into two broad units. The older basement rocks, marked by episodes of folding, intrusion of large granite masses and mineralisation, are overlain and blanketed by a younger cover of sedimentary rocks invaded by dolerite (a dark silica-poor igneous rock) intrusions and covered by basaltic lavas. The marked contrast between the horizontal cover and the folded strata of the underlying basement rocks is seen in many geological sections through the island. Exposures of the basement rocks, mostly in western Tasmania, reveal ridges of hard rocks lying along the fold directions. The drainage systems, etched by greater erosion into the softer flanks, cross the ridges through successions of spectacular gorges. In the cover rocks, mostly in central and eastern Tasmania, resistant layers of dolerite and numerous block faults result in plateaus and scarps in a tiered landscape.

The oldest basement rocks in Tasmania, a core of metamorphosed Precambrian rocks extending through the central western regions, date back at least 800-900 million years. They include quartzites, schists and phyllites (recrystallised and sheared sandstones and mudstones) and some amphibolites (recrystallised dolerites). Repeated deformation and fracturing during earth movements have crumpled and squeezed the less massive schists and phyllites into intricate folds and crenulations. The highest grades of metamorphism occur in the central area around Frenchmans Cap, as a result of mountain building during the Frenchman Orogeny.

Cradle Mountain itself (top) is a dolerite sill—an igneous intrusion of columnar dolerite—perched upon sedimentary rocks and folded metamorphics. Dove Lake in the foreground lies in the metamorphics basement. Photo by Bruce Jenkins.

Periods of crustal upheavals—mountain building—with the intervention of molten igneous rock from deep within the Earth resulted in repeated deformation and fracturing in the rocks. Illustrated (above) is a pattern formed on a small scale by several episodes of folding in metamorphic rocks in South-west Tasmania. The white bands represent thin layers of more solid quartzite rock (recrystallised sandstone) in the more easily deformed phyllite rock (sheared mudstone). Drawing by Gill Brady/The Australian Museum.

Younger Precambrian strata, flanking the old core, were laid down between 570-800 million years ago on partly subsiding sea floors sloping off the highlands. Quartzitic sandstones and slaty mudstones dominate the successions, but some basaltic volcanic rocks and calcium-magnesium carbonate rocks (dolomites) appear at the top. The oldest fossils found in Tasmania are preserved in the dolomites as algal colonies called stromatolites. Most exposures are seen in northwestern Tasmania, where beds accumulated to 11,000 metres in thickness before being deformed by mountain building during the Penguin Orogeny. The oldest granites in Tasmania, about 750 million years old, along western King Island, have been affected by these movements. Swarms of dolerite dykes, injected into northwestern Tasmania during the folding, are dated around 720 million years. The movements were sufficiently strong to overturn the folds or break them along thrust faults in a number of places and intense enough to metamorphose the rocks into quartzite, schists, phyllites and amphibolites along a narrow belt extending northeasterly through the Pieman and Arthur Rivers. This belt contains the large iron ore body at Savage River, the ore being mined and pumped as a slurry through a pipeline over 85 km of rugged terrain to Port Latta. The estimated reserves of magnetite ore approach 100 million tonnes.

Geological events in Tasmania became more varied in the Cambrian period, between 500-570 million years ago. Extension of the continental area caused rifting and developed troughs which deepened into actively subsiding oceanic floors. The main trough passed through the Dundas region, west Tasmania, with subsidiary troughs passing through Adamsfield, south Tasmania, and Dial Range, Fossey Mountain, Smithton and east King Island in north-west Tasmania. The typical sedimentary rocks of these troughs are slaty mudstones, alternating with greywacke sandstones and breccias, derived from oceanic muds interspersed with coarser debris brought in by underwater landslides. In some places the avalanches eroded and redeposited earlier Cambrian sediments, exposed by active uplifts along trough margins. Fossils appear mostly as impressions of trilobites (extinct marine arthropods) associated with some primative brachiopod shells and floating colonial organisms.

Basaltic lavas pouring out from rifts in the Cambrian sea floors produced rounded pillow forms on contact with water. These lavas, beautifully exposed at City of Melbourne Bay, King Island, are the source of ilmenite worked for titanium in nearby beach sands. Molten chambers formed below the large rifts. The rocks crystallised within them were later thrust upwards, altering into sepentinite and shearing into fibrous veins of asbestos. The rocks introduced nickel and osmiridium, the latter being sought during a mining boom to supply nib tips for fountain pens from 1910-1954.

Volcanic island chains in some of the troughs erupted silica-rich (rhyolitic) lavas, coarse explosive deposits and hot ash flows. Granite cores rose into these volcanic piles or in small isolated masses at Mt. Murchison, Mt. Darwin, Elliot Bay and around Dove River. Mineralising fluids invaded and altered the host rocks, particularly along fault and shear zones, so extensively that geologists have argued for decades about the exact nature of the original rocks. Massive sulphide ore bodies are mined as zinc-lead ores around Rosebery and as copper ores at Queenstown, originally being worked for gold in their ironstone gossan cappings. Mt. Lyell struck a timely silver ore bonanza in its early development and, like the Rosebery working, produces gold and silver as by-products. Elsewhere, numerous small deposits of iron, copper, lead, zinc and barium ores are found in the Cambrian rocks.

More placid conditions returned to Tasmania during much of the Palaeozoic era through the Ordovician, Silurian and early Devonian periods, between 380-500 million years ago. During the Ordovician, earth movements had largely ceased, and the uplifted highlands were being rapidly eroded. Debris, spreading down scarps into the old rifts and shallow seas in large alluvial fans, formed breccias, siliceous conglomerates and sandstones. As the land eroded further and became submerged, the supply of detritus dwindled until shales, and finally carbonate muds and skeletal deposits of shelly fossils, accumulated in extensive tidal flats and shoals to form widespread limestones. Fossils in these beds include sponges, polyzoa, large coral colonies (but no reefs), brachiopods, gastropods, pelecypods, trilobites, ostracods, sea lilies, echinoderms, annelid worms and algae. They reflect abundant life in warm shallow waters. The limestones are quarried for manufacture of cement, paper and agricultural lime. Cavern systems within them contain many beautiful displays of cave formations and are open to tourists around Mole Creek and Gunns Plains.

Rhythmic sedimentation formed sandstones and shales during the Silurian-early Devonian periods, but some limestone was deposited at a late stage at Point Hibbs. Fossils again indicate shallow waters teeming with life. In contrast, the contemporaneous sedimentary beds of north-east Tasmania are typically mudstones with sparse graptolite fossils and sandstones with transported material containing poorly preserved fragments of stunted corals, polyzoa, brachiopods, sea lilies and primitive plants. This sharp change is attributed to later sideways movement along a fundamental fault under the Tamar Valley, which brought the deeper water beds from the Victorian region against the shallow water beds of the Tasmanian margin.

Such movements were part of the last great episode of mountain building in Tasmania which warped and broke the rocks about 380 million years ago during the Tabberabberan Orogeny of eastern Australia. With uplift and final release of pressure, molten granite rose up to form large intrusive masses within the basement rocks.

The granite rose in several pulses over about 15 million years, mainly concentrating in northeastern, northwestern and western Tasmania. Gravity measurements over some of the masses show that they may extend down 12 km to their original zones of melting in the lower crust. The molten granites probably came in at temperatures around 750-800°C, baking and mineralising the country rocks along their contacts. The granite has been used as a building and monumental-stone, with the attractive red variety at Coles Bay producing 2000 cubic metres of rock.

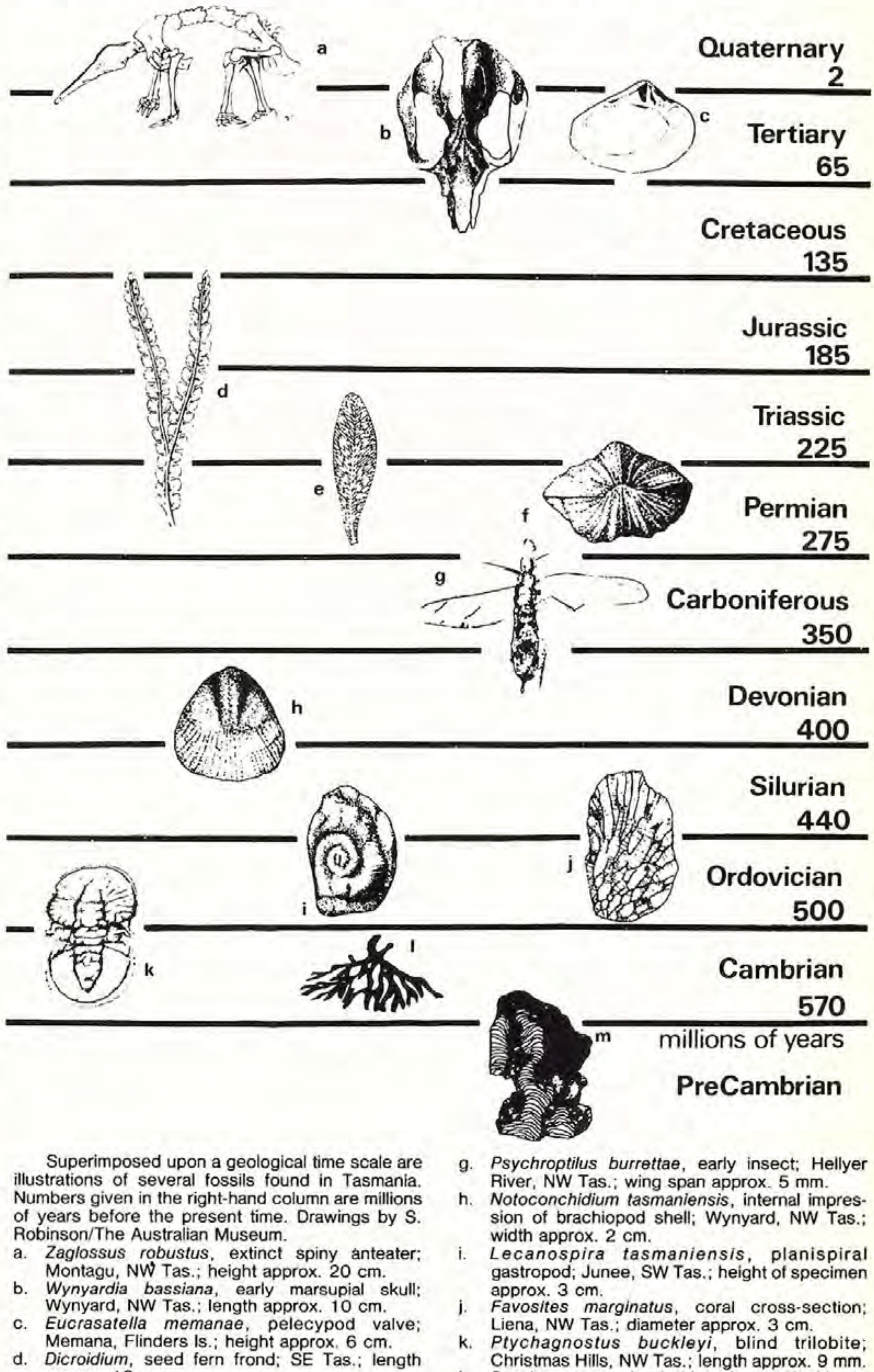
Important tin lodes include the famous Mt. Bischoff deposit, discovered in 1877 by the perseverance of 'Philosopher' Smith. It became the single largest tin mine then known in the world. Huge reserves of tin ore are now mined in large operations at Renison Bell and Cleveland, but the ore is scattered in sulphides making its recovery difficult. Tin and tungsten veins are mined at Storys Creek and Rossarden. Scheelite ore is mined for tungsten from replacement zones near a granite contact at Grassy, King Island.

Some of the lead and zinc deposits in Tasmania are zoned around granite bodies. The most celebrated are the Zeehan and Dundas fields west of the Heemskirk granite. They produced over 5 million tonnes of silver-bearing galena, with the Dundas ores commonly showing higher zinc. Some of the lead mines reached abnormally high silver contents, up to 70 ounces per tonne, and produced 30,000 fine ounces during the life of the field. The boom, starting in 1887, collapsed soon after the turn of the century when lodes proved fickle at depth. Some lead deposits at Dundas developed splendid crystallisations of orange-red crocoite and the yellow-chrome variety of cerussite. They are regarded as the finest occurrences of two of the most beautifully crystallised minerals known and are greatly prized by mineral collectors.

Gold was discovered in Tasmania near Fingal in 1852, and the early gold rush quickly proved associations of alluvial deposits with quartz reefs. The lode at Beaconsfield produced 854,000 ounces of gold between 1877 and 1914. Thirty reefs around Lefroy gave 172,000 ounces, but gold grades declined quickly at depth. The northeastern lodes yielded 527,000 fine ounces, with nearly half coming from the Golden Gate Mine at Mathinna.

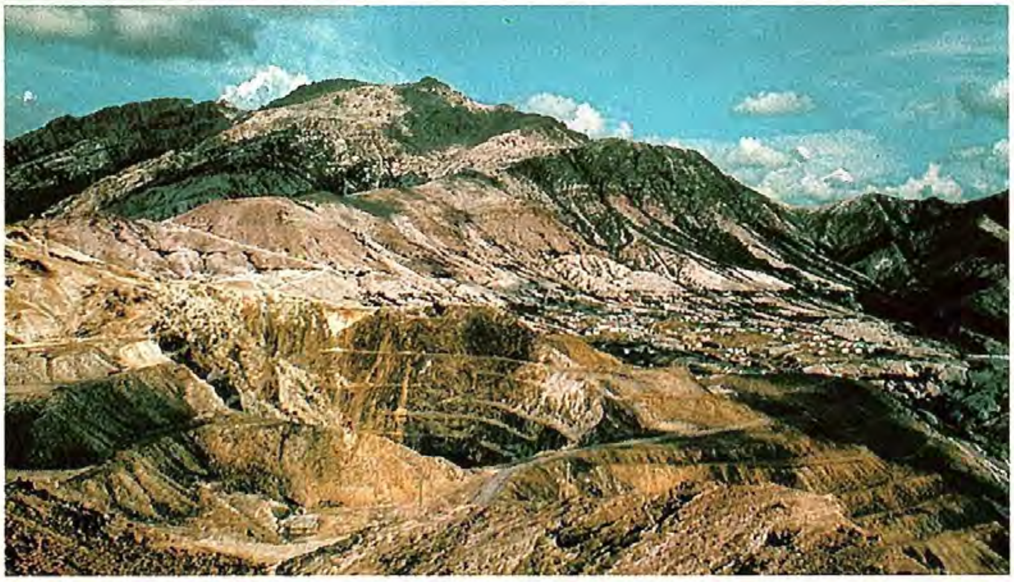
The chapter on the folded basement rocks came to a close as ice-sheets formed in the late Carboniferous-early Permian periods, be-

SOME TASMANIAN FOSSILS



Superimposed upon a geological time scale are illustrations of several fossils found in Tasmania. Numbers given in the right-hand column are millions of years before the present time. Drawings by S. Robinson/The Australian Museum.

a. *Zaglossus robustus*, extinct spiny anteater; Montagu, NW Tas.; height approx. 20 cm.
b. *Wynyardia bassiana*, early marsupial skull; Wynyard, NW Tas.; length approx. 10 cm.
c. *Eucrasatella memanae*, pelecypod valve; Memana, Flinders Is.; height approx. 6 cm.
d. *Dicroidium*, seed fern frond; SE Tas.; length approx. 13 cm.
e. *Glossopteris*, gymnosperm leaf; Henty River, W Tas.; length approx. 12 cm.
f. *Grantonia hobartensis*, brachiopod shell; Granton, Hobart, SE Tas.; width approx. 5 cm.
g. *Psychroptilus burrettae*, early insect; Hellyer River, NW Tas.; wing span approx. 5 mm.
h. *Notoconchidium tasmaniensis*, internal impression of brachiopod shell; Wynyard, NW Tas.; width approx. 2 cm.
i. *Lecanospira tasmaniensis*, planispiral gastropod; Junee, SW Tas.; height of specimen approx. 3 cm.
j. *Favosites marginatus*, coral cross-section; Liena, NW Tas.; diameter approx. 3 cm.
k. *Ptychagnostus buckleyi*, blind trilobite; Christmas Hills, NW Tas.; length approx. 9 mm.
l. *Dendograptus*, dendroid colony; Huskisson River, W Tas.; width approx. 2 cm.
m. *Baicalia*, stromatolite algal colony; Trowatta, NW Tas.; height of specimen approx. 15 cm.



The world's finest specimens of the rare lead chromate mineral crocoite are from Dundas, Tasmania. The bright red crystals of crocoite (top) grew from the interaction of mine solutions containing lead with chromium from associated serpentinite rocks. Photo by Greg Millen/The Australian Museum.

This lunar-like landscape (above) includes Mt Lyell and the mine workings near Queenstown, W Tasmania. In addition to the direct results of opencut mining on the terrain, the roasting of pyrite to release valuable metals yields sulphuric acid fumes that have denuded this area of vegetation. Photo by Robert Jones/The Australian Museum.

tween 280-300 million years ago. The moving, melting ice deposited the first of the overlying cover rocks on the old worn surface. Coarse debris, dropped into the sea by glaciers, was deposited in layers with fine clays. Glacial beds up to 600 m thick, between Wynyard and Hellyer River, contain occasional fossils, including one of the oldest known insects in the Southern Hemisphere and tracks of crustaceans. Deposition of sediments continued through the Permian period in seas, estuaries and coastal waterways intermingled with some fall-out from melting icebergs and distant volcanoes. Some of the mudstones, limestones and sandstones are rich in marine fossils such as brachiopods, polyzoa, pelecypods, gastropods and sea lilies, and others are freshwater deposits with plant fossils. Coal measures and oil shales have been mined. The shales were intermittently worked by several companies between 1910 and 1934 to produce 360,000 gallons of oil.

Freshwater deposits characteristic of the Triassic sections of the cover beds consist of sandstones, shales, clay pellet conglomerates, feldspathic sandstones containing volcanic material and coal seams. Plants are common fossils, but in some places amphibian, reptile and fish remains have been found. An important fossil site at Old Beach near Hobart has allowed palaeontologists to reconstruct details of an animal and plant community. The massive sandstones provided building stone for historic buildings and bridges, but are now often used as decorative stone. The coal measures are the most extensive workings for Tasmanian coal mines, and have yielded over 9 million tonnes of bituminous coal.

The fossil faunas and floras in the pre-Jurassic cover beds of Tasmania show links with continents now widely separated. They assist in reassembling the old shape of the supercontinent of Gondwanaland, then comprising Australasia, Antarctica, Africa, India and South America.

Dramatic dolerite invasions broke through rifts as Gondwanaland started to break up in the Jurassic period. A stupendous volume of molten rock was generated under Tasmania and eastern Antarctica. Five thousand cubic kilometres of melt rose into Tasmania between 165-170 million years ago with several pulses from many different feeders spreading transgressively through the cover rocks as sills and dykes. The chilled base of a dolerite sill, capping Triassic beds, can be seen on the Pinnacle Road to Mount Wellington. Gravity measurements have located the exact positions of many of the underlying feeders for the dense dolerite and these show a high concentration throughout the Hobart district. Some sills reach over 450 m in thickness and needed 100,000 years to cool down from 11,000°C to 200°C when cooling joints would appear in the solidifying rock. A period of erosion followed for 30 million years, eating away the Jurassic land surface. The resistance of the solid dolerite to erosion commonly leaves it capping high areas and also makes it very suitable to quarry for road metal and aggregate.

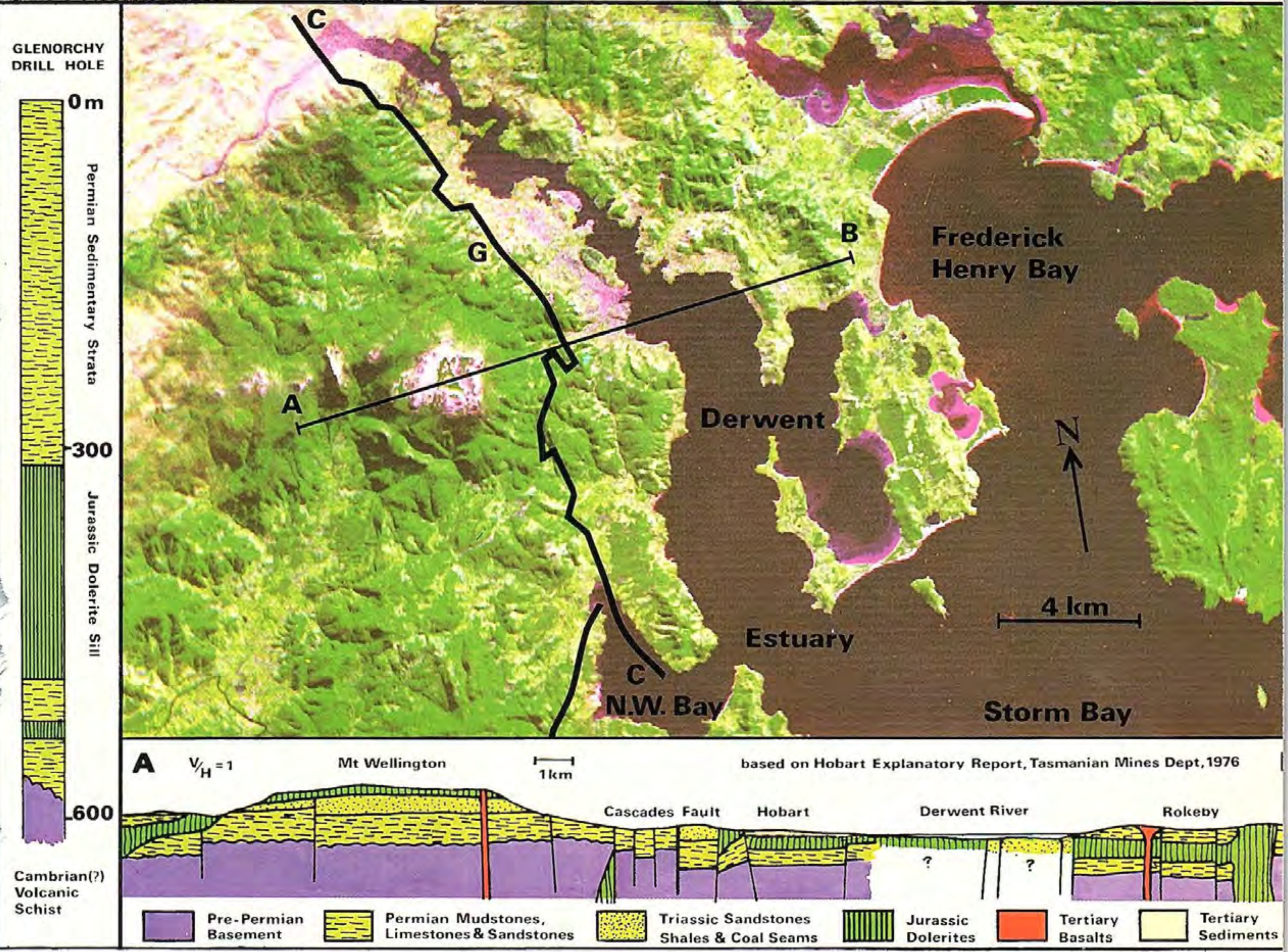
Continued on page 57

GEOLOGICAL CONSTRUCTION OF TASMANIA

An Illustrated Summary in Colour

by Lin Sutherland and Sally Robinson
The Australian Museum, Sydney

Prepared in conjunction with Australian Natural History
Special issue on Tasmania, March-April 1980



Landscape and geological features of the Hobart area. The satellite image (false colour composite) clearly shows the resistant dolerite plateau capping Mt Wellington (snow covered) and the drowned valley and coast lines which were formed by a rise in sea-level to its present position about 6,000 years ago after the last glaciation. The positions of the geological section (A-B) through Mt Wellington and the Derwent Estuary, the Glenorchy drill hole (G) which reached the underlying basement rocks and the line of the Cascades-North West Bay Fault System (C-C) which uplifted the Mt Wellington side are shown on the image.

Block stream of dolerite fragments, Mt Wellington. *Photo: J.L. Davies*

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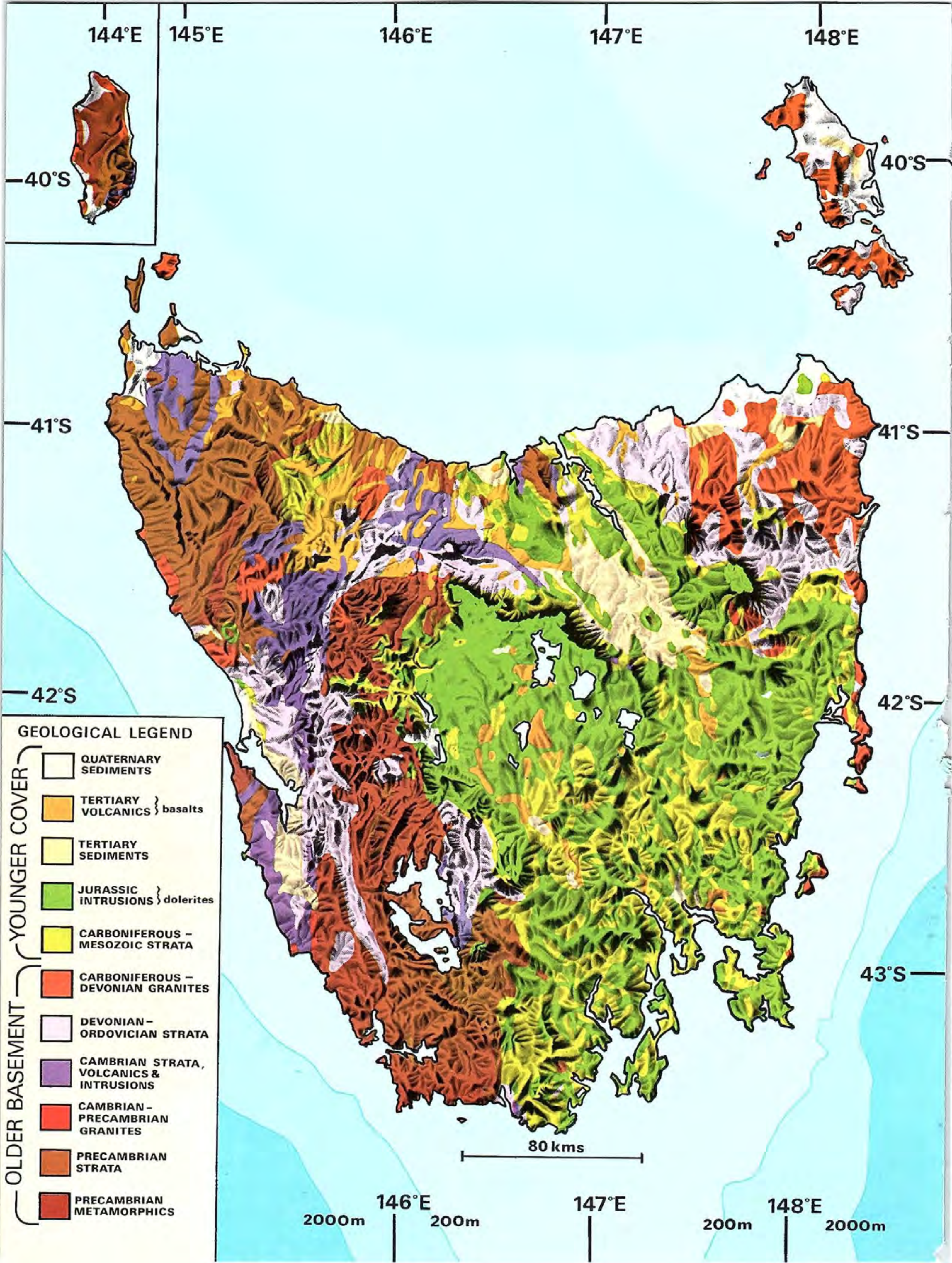
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145°E
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GEOLOGICAL LEGEND
YOUNGER COVER
QUATERNARY SEDIMENTS
TERTIARY VOLCANICS } basalts
TERTIARY SEDIMENTS
JURASSIC INTRUSIONS } dolerites
CARBONIFEROUS - MESOZOIC STRATA
OLDER BASEMENT
CARBONIFEROUS - DEVONIAN GRANITES
DEVONIAN- ORDOVICIAN STRATA
CAMBRIAN STRATA, VOLCANICS & INTRUSIONS
CAMBRIAN - PRECAMBRIAN GRANITES
PRECAMBRIAN STRATA
PRECAMBRIAN METAMORPHICS
80 kms
2000m
200m
200m
2000m

GEOLOGY OF TASMANIA

MAP AND LEGEND (OPPOSITE)

SECTIONS & ORE DEPOSITS

◯ **Mineralized Basement Rocks (Precambrian – Carboniferous Age)**

◯ **Stratified Cover Rocks (Carboniferous – Tertiary Age)**

not shown – Superficial Sediments & Volcanics (Tertiary – Quaternary Age)

A——B **Structure Section Line** $V/_H = 2/_1$

METAL LODE & ALLUVIAL DEPOSITS

○ Gold ○ Copper ○ Tin ○ Tungsten

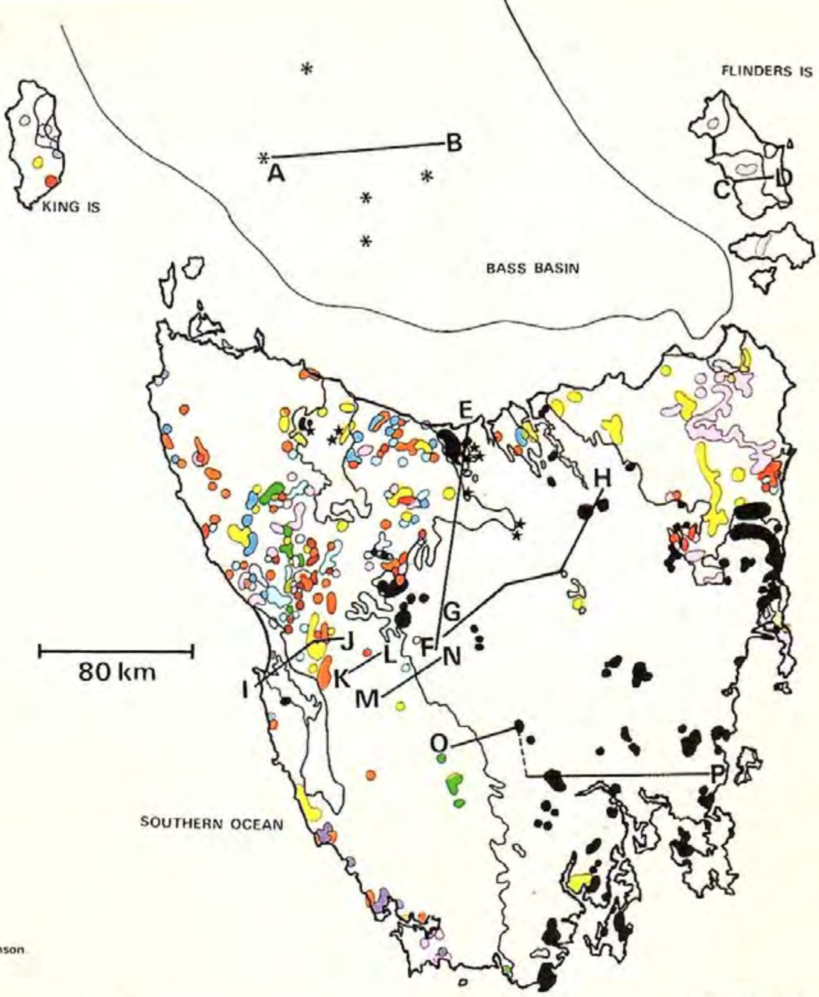
○ Silver Lead ○ Zinc Lead ○ Iron

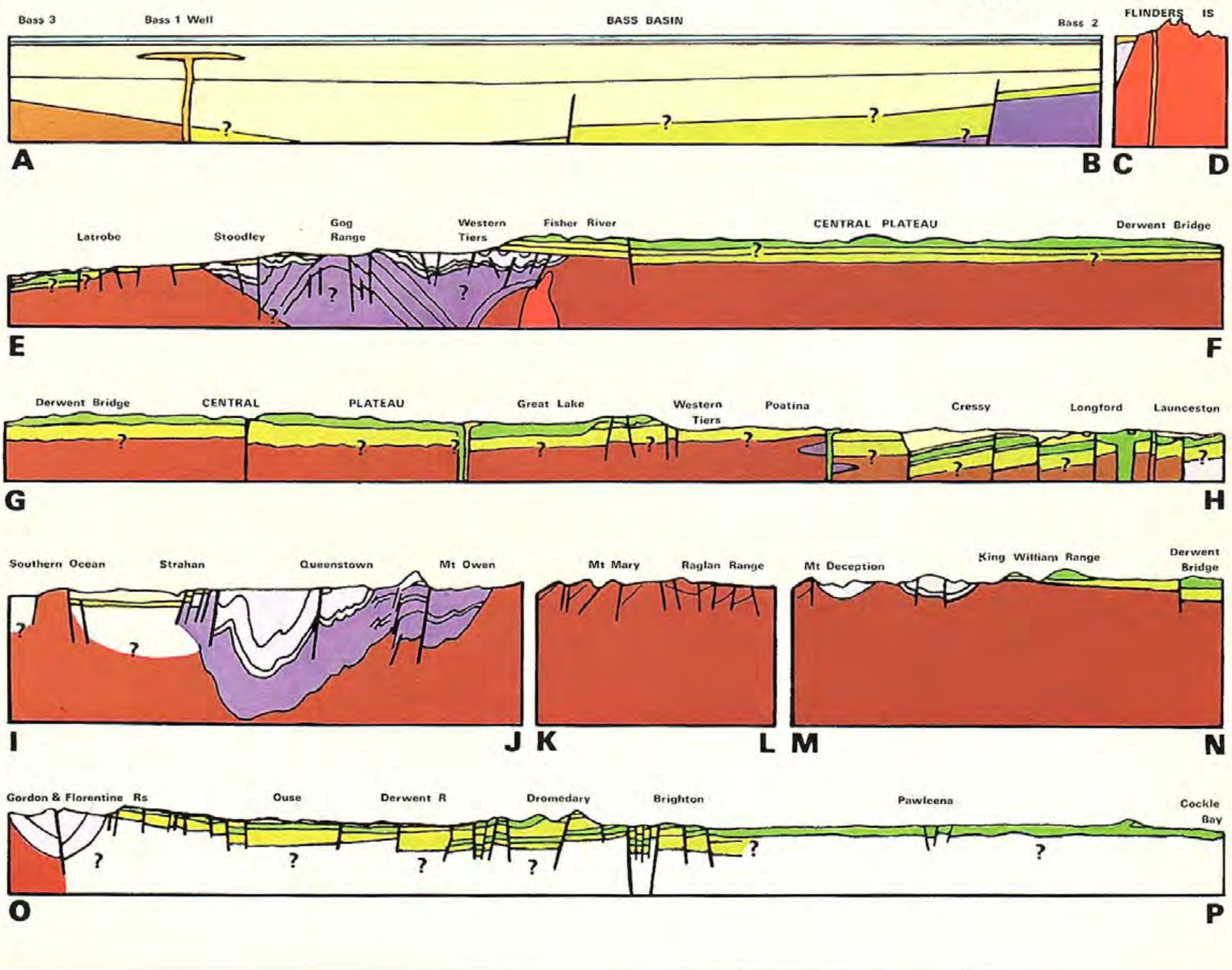
○ Titanium ○ Nickel ○ Osmiridium

FOSSIL CARBON AND HYDROCARBONS

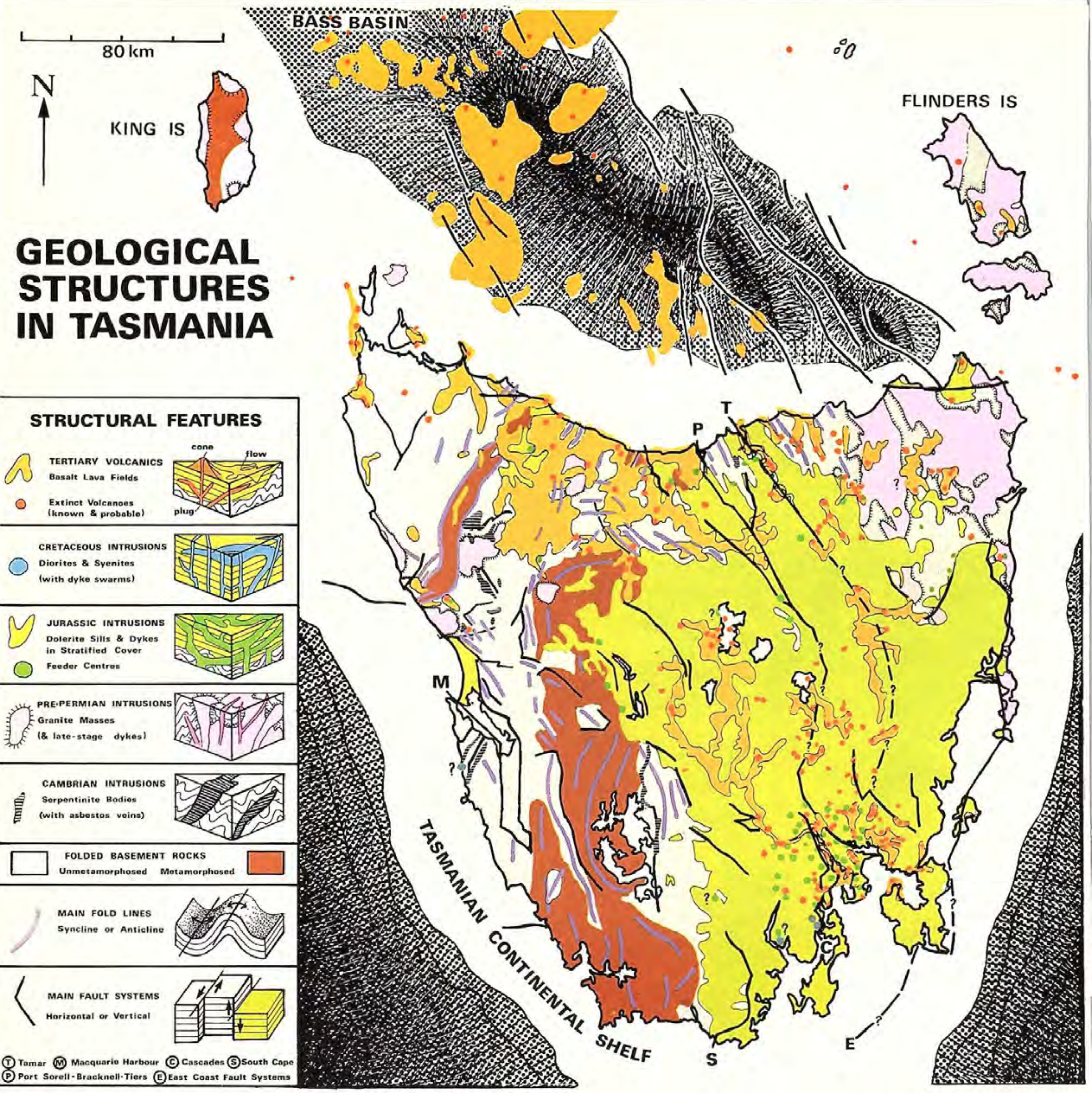
● Coal ★ Oil Shale * Gas & Oil

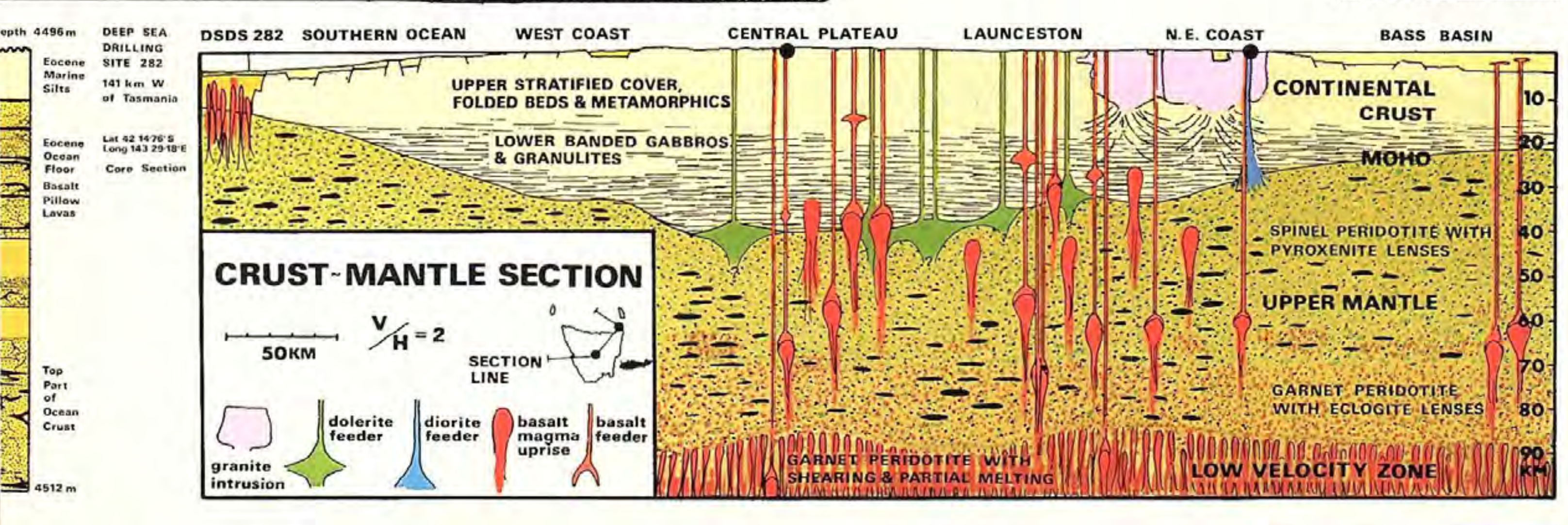
Geological compilation by F.L. Sutherland from 'Geology of Tasmania, 1962. 'Atlas of Tasmania, 1965. 'Geology and Mineral Resources of Tasmania,' 1967 and later sources. Art Design by S. Robinson.





GEOLOGICAL STRUCTURES IN TASMANIA





Continued from page 52

In the Cretaceous period, significant events affected the margins of Tasmania, but were limited inland. Major rifts formed deep troughs in the Bass Basin structure, which filled with over 1200 m thickness of sediments. Much of the sediment contains volcanic fragments which seem to come from voluminous volcanism concentrated near the Otway and Gippsland regions, north in Victoria. Minor results of this activity were the formation of small intrusions of syenite, diorite and possibly granite around Cygnet, Cape Portland and western Tasmania. These date around 100-140 million years and are associated with swarms of lamprophyre dykes. The eastern margin of Tasmania formed by rifting. From here, sea-floor spreading created new oceanic crust as the Tasman sea opened separating Lord Howe Rise from Tasmania between 85-60 million years ago.

Rifting extended further into Tasmania by the Tertiary period. It formed the western margin of the island along the great split which started to separate Australia from Antarctica about 50 million years ago. From this, seafloor spreading gradually opened up the present Southern Ocean. This oceanic crust was sampled off Tasmania in 1973, during the global Deep Sea Drilling Project at Site 282, at a depth around 4000 metres. It is composed of basalt lavas with pillow structures formed by chilling on the sea-floor. On land, the rifting uplifted plateaus and reactivated many earlier fault systems. The cracking under tension imposed strong cross joints expressed as columnar organ pipes in the dolerites and blocky cliffs, and tessellated pavements in the sedimentary strata; all seen to great effect around Tasman Peninsula. Fault troughs formed through Bass Basin, Tamar Valley, Midlands, Boobyalla, Macquarie Harbour and Derwent Valley and accumulated sediments washed in by ancestral river systems. Leaves and wood are typical fossil remains in these sediments, and mussel shells appear in the Tamar beds. Oil and gas prospects are found in Bass Basin beds, but so far no commercial deposits have been tapped.

Seas transgressed Bass Basin and northern coasts of Tasmania during mid-Tertiary times. Their deposits contain fossils of tropical shells, relatives of those now found much further north. These fossils are easily seen at Fossil Bluff, Wynyard, a site also noted for chance discoveries of fossil whales and the transported remains of an early fossil marsupial. A late Tertiary undersea graveyard containing fossilised bones of several members of the whale family and teeth of extinct sharks is an exciting recent find, being dredged by scientists 3 km off SE Flinders Island.

Between 15-40 million years ago, Tertiary basalt lavas erupted from many of the structural weaknesses in Tasmania, being particularly voluminous over the large Bass Basin structure. Over 220 vents have been located, mainly as eroded cones and plugs. Some volcanoes collapsed back into their vents; one can be visited at Sandy Bay in Hobart itself. Volcanic 'bombs' can be seen in vent deposits in a tourist feature at Margate. Where vents erupted into seas, or into river valleys dammed by earlier lava flows, chilling with water or steam explosions formed excellent examples of pillow lavas, pillow breccias and water-laid tuffs, typical of emerging volcanoes. Fossil forests were overwhelmed by volcanic fall-out at Macquarie Plains. A spring deposit, overrun by lava about 25 million years ago at Geilston Bay, Hobart, preserved the oldest fossil marsupial remains yet recovered from Australia. The Tasmanian volcanoes brought up many fragments of deep, high pressure rocks broken off by the ascending lava. These give clues to the lower regions under Tasmania.

These shells on an ancient seashore—the Permian strata of Maria Island—include primarily the clam *Eurydesma* and a few extinct brachiopods (left). Photo by Alex Ritchie/The Australian Museum.

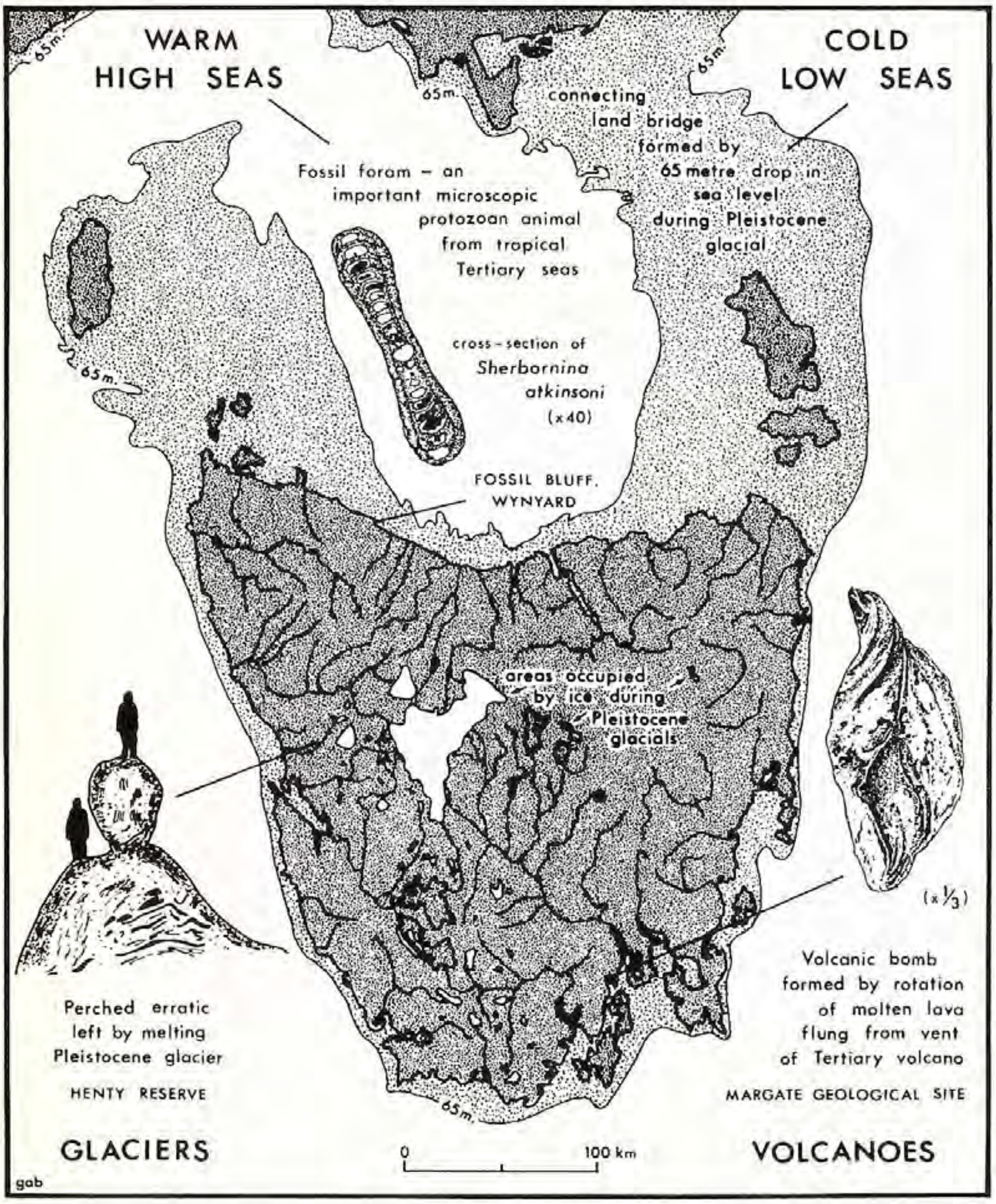
The tarns and U-shaped valleys (above) in Mt Fields National Park indicate that this was a site of a former glacier. Photo by Anthony Friend.

The river systems in Tasmania were established by the end of the Tertiary, after some diversions of their courses by the lava outpourings. Buried courses, known as deep leads, have been mined in some areas for heavy metals. These and superficial alluvials are important sources of gold and tin, particularly in northeastern Tasmania which has provided 250,000 ounces of gold from around Lisle and 30% of the State's total lode and alluvial tin. Gemstones recovered from alluvials include quartz varieties, topaz derived from granites and sapphire and zircons probably released from basalts.

Glacial cycles dominated the Tasmanian scene during the Quaternary period over the last 1-2 million years. There is evidence for three stages of Pleistocene glaciation. The first began over 26,000 years ago; the second, around 14,000 years ago, was the most extensive, when icefields and glaciers covered large areas, particularly in the central and western highlands. The last glaciation between 7,500-10,000 years ago left many prominent features. Cirques, moraines and lakes provide some of the most imposing scenery. The lake country of Tasmania, with over 4,000 lakes, is unique in Australia and is a legacy cut by a 200 metres thickness of ice on the Central Plateau. Splendid views of glacial landforms can be seen from many tourist parks and reserves such as Cradle Mountain, Lake St. Clair and Mt. Field. The Henty Geological Reserve near Queenstown features erratic boulders brought down by the ice. Block streams, or rock rivers, form another conspicuous feature around Tasmanian highlands and resulted from strong periglacial frost action. A circular depression discovered recently near Mt. Darwin is not a glacial feature, but is believed to be a meteorite crater. The impact of this about 710,000 years ago fused the country rocks into spatter called Darwin Glass.

Tasmania's size waxed and waned as sea-levels fluctuated between glacials and interglacials. Seas dropped as much as 135-180 m below present levels during glacials as the polar ice caps expanded. Retreats of Bass Strait linked Tasmania to Victoria through the present northeastern islands. This assisted migration of animals from the mainland. Fossil remains of large Pleistocene marsupials, such as diprotodonts, giant kangaroos, giant spiny anteaters and marsupial lions, all now extinct, have been found in swamp and cave deposits dating back between 8,000-54,000 years. Recent archaeological excavations show that Aborigines occupied a cave on Hunter Island 24,000 years ago and must have migrated down the land link prior to this. The Tasmanian Aborigines worked stone extensively for tools, and well over a hundred and fifty quarry sites have been identified.

Sea-level rises periodically severed Tasmania from the mainland during interglacials, isolating the animal populations. Old sea caves, shell beds and beach deposits have been found at various levels up to 45 m above present sea level. Tasmania assumed its familiar form about 6000 years ago when post-glacial seas rose to their present level, partly submerging valleys and producing a



The development of drainage in relation to coastlines, climates and geological events that have modified river courses during the Cainozoic era (Tertiary and Quaternary) is pictured (left). Drafting and artwork by G. A. Brady and S. Robinson/The Australian Museum. Fossil foram drawing from P. J. Quilty; volcanic bomb and perched erratic based on University of Tasmania Geology Department information brochures.

Evidence of fairly recent earth movements can be seen along the Lake Edgar Fault at the southern end of Lake Pedder, SW Tasmania (bottom left). Photo by Sally Robinson/The Australian Museum.

drowned coastline. Beach ridge and dune systems wreathe this new coast around sand traps. The predominant southwesterly wave attack has tended over time to concentrate sands with the greatest proportion of beaches towards the northeastern coasts.

In final reflection, Tasmania blends both broad and local geological events to give diverse scenic charm. This partly independent behaviour continues. The island is drifting slowly northwards tagging behind Australia as the Southern Ocean continues opening by 7-8 cm per year. However, recent studies of coastal deposits suggest that since the last interglacial, the island has been behaving abnormally, slowly rising and tilting up to the north east. Whether this is a prelude to further rifting or volcanism, only time will tell.

FURTHER READING

Banks, M. R. 1965. Geology and mineral deposits. In *Atlas of Tasmania*. Lands and Survey Department, Hobart.

—— 1978. *Foundations of our scenery. The geology and landforms of Tasmania.* Teacher's guide and 13 wallets of slides and regional notes. Tasmania Media Centre, Education Department, Hobart.

Blainey, G. 1954. *The peaks of Lyell*. Melbourne University Press.

Davies, J. L. 1967. Tasmanian landforms and Quaternary climates. In *Landform studies from Australia and New Guinea*. ANU Press, Canberra.

Derbyshire, E., M. R. Banks and J. L. Davies. 1965. Glacial Map of Tasmania. *Royal Soc. Tasm. Publ.*, No. 2.

Jennings, I. B., A. J. Noldart and E. Williams. 1967. Geology and mineral resources of Tasmania. *Geol. Surv. Tas. Bull.* 50.

Johnston, R. M. 1888. *Systematic account of the geology of Tasmania.* Govt Printer, Hobart.

Royal Society of Tasmania. 1977. Landscape and man. A symposium published Hobart.

Spry, A. H. and M. R. Banks (eds.). 1962. The geology of Tasmania. *J. Geol. Soc. Aust.* 9, 2.

Tasmanian Department of Mines. 1969. Catalogue of the minerals of Tasmania. *Geol. Surv. Rec.* 9.

Williams, E., M. Solomon and G. R. Green. 1976. The geological setting of metalliferous ore deposits in Tasmania. In C. L. Knight (ed.) Economic geology of Australia and Papua New Guinea—1, Metals, 567-581. *Australas. Inst. Min. Metall. Monograph* 5.

LIFE WHERE WATERS MEET

As Tasmania is completely surrounded by oceanic waters, marine organisms represent a significant, and interesting, portion of this state's biology. Alan Dartnall, now a freelance zoologist and designer in Townsville, became interested in the role of hydrodynamics in the distributions of aquatic animals while at the University of Tasmania. In this article he takes us behind the scenes of a scientific investigation of Tasmania's marine environment that attempts to contribute to the rationalisation of Australia's marine biogeographical units, and to unravel the complex mechanisms that control the distributions of some of their organisms.

by Alan Dartnall

A world of its own, the waters along the coastline of Tasmania support an interesting array of marine life. The rocky shores present a vertical sequence of organisms which can be read like an open textbook, telling a story of the struggle for survival of marine animals and plants against a complex of environmental factors. Dark lichen bands can be seen in this shot of the coast of Isles de Phoques, lying south of the entrance to Great Oyster Bay. Photo by A. J. Dartnall.

The island of Tasmania lies at a meeting place of oceanic waters. Along its southern and western coasts a rugged coastline has been sculpted by great waves driven by the wind engine of the West Wind Drift. This water is cold and originates in the surface subantarctic waters south of the Subtropical Convergence.

Further north, eddies peel off the East Australian Current during summer and send warmer water south along the east coast of the continent keeping the eastern Tasmanian waters about 2°C warmer than those of the west coast.

Bass Strait, a shallow link with continental Australia guarded at each end by islands, is an area of complex currents and mixed waters. The Strait receives subantarctic water, water which may originate in the gulfs of South Australia and cold fresh water from the rivers of northern Tasmania. In summer water from the East Australian Current moves westwards through the Strait.

Water movements around Tasmania are not yet well known. Recent work by CSIRO Division of Fisheries and Oceanography involved tracking free-floating buoys by satellite. Maps of the buoys' tracks have shown that eddies from the complex water masses of the East Australian Current follow irregular patterns and may persist for periods longer than a year. Other work has postulated that changes in the patterns of marine climates may fluctuate around oscillations of about two years, and longer term trends have also been detected. It is apparent that the patterns and trends of water movement around Tasmania await further research effort.

What is clear, however, is that Tasmanian waters are colder than most around the rest of Australia. It is not surprising, therefore, to find that the animals and plants that live around the coasts of Tasmania often are different from northern species.

Perhaps this is best observed by taking a scientific walk along the east coast of Australia. If we start at Cape York and walk southwards, the lagoon of the Great Barrier Reef lies on the left hand. The waters are shallow and warm and support a rich marine life characterised by a great development of corals. The shore lines are mostly sand and mud, and estuaries and coastline are bordered by mangrove forests.

As we move southwards across the Queensland border, the marine scene begins to change. Mangroves are still present but the great coral associations have disappeared, and different animals appear on the shores. On reaching Wilson's Promontory in Victoria we observe that the coastal scenery is much more rugged than in the far north and that large brown seaweeds are visible at low tidal levels on the open coasts. Mangroves at this latitude are no more than a curiosity, restricted to protected backwaters of Port Philip Bay.

A short hop across Bass Strait lands us on a shore with a mixed fauna containing animals characteristic of the shores of southern Australia and of southern coasts. Sea stars are more abundant here than in the far north where corals, sea urchins and sea cucumbers predominate.

Striding southwards along the east coast of Tasmania two features are noticeable. Firstly, a nearly continuous band of great brown algae can be seen washing back and forth in the waves at low tide level. Secondly, a band of bright orange lichen colours the rocks above the high tide mark. This band of lichen is rarely seen on the coast of continental Australia and is so characteristic that a marine biologist lost on the coasts of Australia could deduce his position to 3° of latitude with some confidence.

A further step southward takes us to the southernmost tip of Tasmania. We pass along an extremely rugged coastline punctuated by the southward pointing fingers of the Freycinet and Tasman Peninsulas and split by the river valleys of the Derwent and Huon. As we walked south we will have observed that the proportion of beaches along the coastline decreases until in the far south less than 10% of the coast consists of sand beaches.

Our journey over, we are now able to examine the marine environment of Tasmania more closely. On rocky shores the plants and animals are distributed in horizontal bands or zones. Surveys around the coasts by Dr E. R. Guiler of the University of Tasmania, Miss E. C. Pope of The Australian Museum and Miss I. Bennett of the University of Sydney have provided a picture of the zonation of the organisms of Tasmanian rocky shores that has enabled comparison with shores throughout Australia and the rest of the world.

The broad picture of Tasmanian littoral

A bright orange lichen (top) colours the rocks above the high tide mark at The Gulch, Bicheno, on the east coast of Tasmania. This lichen is characteristic not only of a level on the shore but also of a quite specific latitude along the coast of Australia.

A small section of the mid-tidal level (above) on the shores at Eaglehawk Neck, halfway between the Forestier and Tasman Peninsulas, exhibits a portion of Tasmania's marine biota. Limpets, *Siphonaria*, are numerous along the rock platform, while clumps of seaweed, *Corallina* (here bleached white); a purple sea anemone, *Actinia tenebrosa*; and several chitons are found within the pot hole. Photos by A. J. Dartnall.

zonation may be summarised as consisting of four main horizontal bands. Each band contains a characteristic suite of animals and plants.

At high levels of the shore which are only rarely covered with sea water, lichens predominate. The orange lichen mentioned earlier is the highest in the marine series. A sooty black growth follows and then more lichens among which are found two species of small grey winkles, *Littorina unifasciata* and *L. praetermissa*.

Below the level of lichens and winkles a zone inhabited by barnacles and limpets is found. Two barnacles, *Chamaesipho columna* and *Chthamalus antennatus*, are characteristic of this zone, and they occupy much the same level on Tasmanian shores as they do on the mainland. The limpets, *Cellana solida* and *Patelloida latistrigata latistrigata* are also found in this zone. They are accompanied by species of *Siphonaria* which are limpet-shaped pulmonate snails.

Towards the lower shore a weed mat occurs. The mat consists of species of *Corallina* and occupies the place on the shore which on the mainland is filled with dense growths of encrusting tube worms.

At the lowest levels of the shore, large brown seaweeds are a conspicuous feature. The kelp *Durvillea potatorum* is characteristic of the western and eastern coasts while species of *Cystophora* are dominant on the north coast bordering Bass Strait.

Broad geographical differences in the species composition of zoning organisms are also found at the other levels of the shore described above. For example, among the pulmonate limpets of the upper mid-tidal zone *Siphonaria diemensis* is found all round the Tasmanian coastline. In all areas except on the north coast it is accompanied by *S. tasmanica*. Three species are found on the rocky shores of the east coast where the previous two species are joined by *S. funiculata*. A different distributional phenomenon is seen among the barnacles of the same zone. Their numbers become fewer as one proceeds southwards and *Chthamalus antennatus* disappears altogether in southern Tasmania.

Other differences in zonation pattern may be caused by aspect, exposure and the slope of the shore. Wherever there are flat or gently sloping surfaces at the upper mid-tidal level and the wave action is not too extreme, conspicuous mats of mussels, *Brachiodontes rostratus*, occur.

The sandy shores of Tasmania have not been studied in detail. We do know that surf-beaten beaches support a very characteristic fauna including small crustaceans (often species of amphipods, *Exoediceros* spp.) and small bivalve molluscs, *Donacilla angusta*. These animals are speedy burrowers and are adapted to regain position where surf waves are continually washing them from their habitat. Their success may be gauged from the fact that sampling surf swash with a dip net often produces hundreds of specimens. There are obvious difficulties to working on such high energy beaches, and Tasmanian sand faunas remain a fruitful area for research.

Sheltered shores along Bass Strait, the embayments of the southeast and the enclosed waters of Port Davey and Macquarie Harbour on the west coast trap and hold fine sediments. Apart frcm their characteristic fauna of burrowing invertebrates these areas are often the places where the greatest growth of sea grasses, *Zostera muelleri* and *Z. tasmanica*, occurs. These beds provide a sheltered habitat for many invertebrates and fishes, and the production from sea grass beds is important in the ecology of much of the nearshore fauna. Estuarine and bay flats are also important because they provide much of the food of wading birds such as the curlew sandpiper and the red-necked stint.

Biogeographers are interested in the distributions of living things and attempt to find out reasons for the similarities or differences between the faunas and floras of different areas. They are also interested in the mechanisms which favour the presence of one species in an area and not in another and in the origins of species and associations of species through time and space.

In the early years of this century, workers mapped the distributions of the animals that they had collected and described, and compared the composition and distributions of the fauna of one area with another. In Australia a number of marine biogeographic areas were drawn up from the distributional melting pot. The marine fauna of southeastern Tasmania was contained in a unit called the Maugean province, whereas the Peronian and Flindersian provinces identified faunal units with southeastern and southern mainland Australian distributions, respectively. Not all scientists and naturalists agreed with this interpretation and many workers to this day split the marine fauna and flora of Australia into two components; a northern tropical one and a southern temperate component. Any further Tasmanian distinctiveness, it was argued, was in fact an expression of the alteration of a northern fauna at the southern limits of its temperate range.

Later, I. Bennett and E. C. Pope pointed out that workers had ignored the presence of the cold-loving giant kelps on open Victorian coasts. It was also quite obvious that the Tasmanian intertidal areas contained animals and plants whose distributions extended beyond the island into the warmer climes of mainland Australia. In other words, the distributions of cold-loving marine organisms from Tasmania overlapped those of warmer waters. Thus the old Maugean marine zone, once restricted to southeastern Tasmania, grew to encompass the remainder of the Tasmanian coast and extended its tentacles into New South Wales and along the south coast of Australia at least as far west as the gulfs of South Australia. There was strong evidence for this scheme because the distributions of crabs, molluscs and echinoderms, among others, seemed to support it.

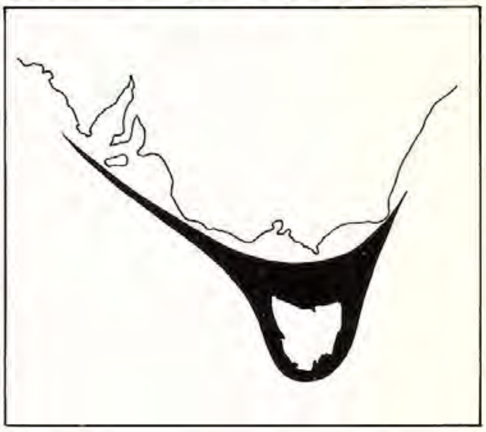
The eastern Tasmanian coastline is ideal for a study of distributions along a transect. Given co-operation from the weather, it is possible to sample the shore and offshore waters within a reasonably short period. A number of recent investigations have been carried out in this manner. Dr R. King, then of the University of Melbourne, studied the distribution of intertidal zone-forming algae along the east coast of Tasmania. His results did not support the idea that the marine fauna and flora of Tasmania were sufficiently distinct to warrant the preservation of the Maugean provincial unit. It appeared that as one traversed southward the algal flora gradually became depauperate, and species with cooler water affinities became more apparent. Also, the distribution patterns of algae did not show any changes that could not be explained by reasons other than discontinuity of habitat.

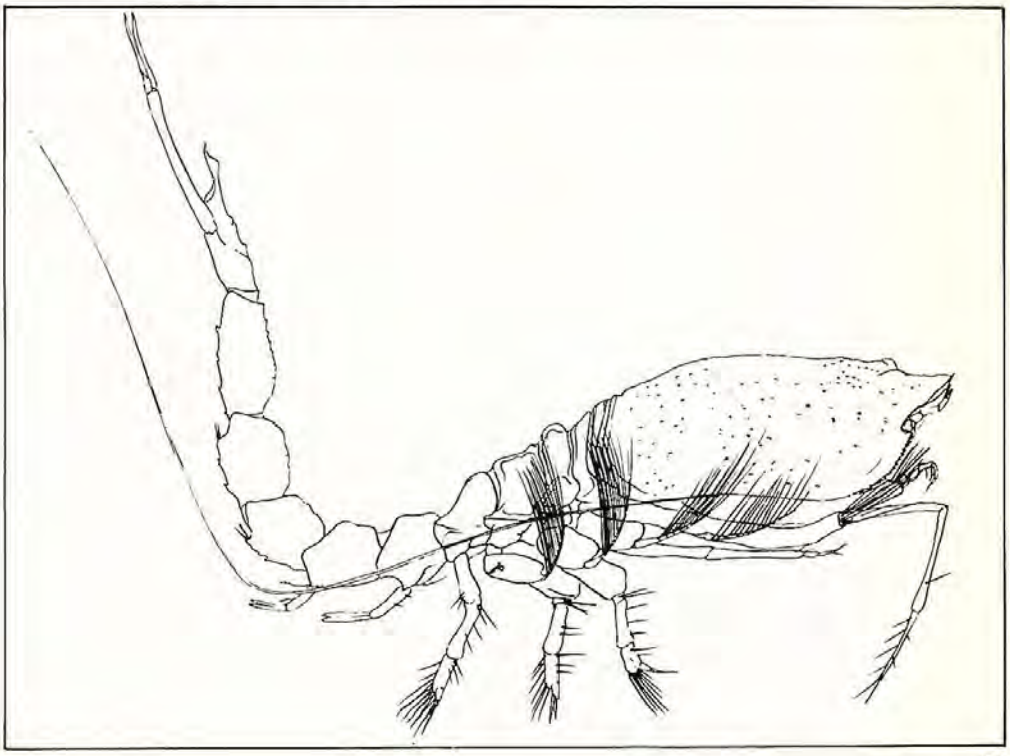
Most of the work upon which the concept of the Maugean province rests has been based on intertidal investigations. Behind all the ideas about the presence or absence of biogeographic marine zones lies the assumption that large-scale mechanisms exist which control the distributions of animals in the sea. Such mechanisms might be temperature, salinity, water movements, the patterns of prevailing global winds or combinations of all of these—in short, marine meteorology. Combinations of factors are more likely to control the distributions of organisms than single factors, and these are particularly difficult to investigate. Thus biologists look for recurring species or associations of species to identify regions and systems that contain such complexes.

An important next step would be an investigation of a group of offshore animals to find out whether their distributions are continuous or discontinuous and if the latter, whether they match any other distributional scheme. The group chosen for investigation by the present author was a small order of crustaceans called the Cumacea. Cumaceans

The Maugean marine province (shaded, below) encompasses Tasmania and sends tentacles of faunal similarity into southern and southeastern Australia, overlapping the zones of warmer waters. The provincial name is derived from that of Maugé who was surgeon to Baudin's expedition to Tasmania in 1802. He died on 21 April of that year during the expedition and was buried on Maria Island.

Dimorphostylis subaculeata var. *praecox* (bottom) is one of the cumacean crustaceans of Tasmanian sublittoral sands. Note the enlarged head and thorax and the elongate tail terminating in a telson and a pair of uropods (only one is shown in this lateral view). The rear four pairs of walking legs are shorter than the first pair that are used to manipulate food. The long second antennae are characteristic of the males of most cumaceans and are often carried tucked under the edge of the carapace and tail. Drawings by A. J. Dartnall.





rarely exceed 15 mm in length and are of distinctive shape—with an enlarged head and thorax and an elongated tail. Apart from a few carnivorous species, cumaceans are either filter-feeders or deposit-feeders. The cumaceans of shallow water sands found during this study were mostly deposit-feeders.

One would expect that if the distributions of cumaceans paralleled those of the littoral algae then the number of species would gradually decline from north to south. This did occur in spite of the fact that as northern species dropped out southern species entered the samples. However, when neighbouring stations were compared with each other a different picture emerged. Although most stations were similar to each other, other stations were distinctively different. The discontinuities discovered occurred close to the latitude of Maria Island and from the tip of the Tasman Peninsula southward.

It is suggested that the discontinuities in cumacean species distribution reflect the effects of a major mechanism—the wave energy regimes which affect Tasmania. Recent work has identified a number of wave energy regimes around the island. Each regime is controlled by the distribution of predominant winds which in turn affect the distribution of oceanic waters. The picture is complicated because land modifies the flowing patterns of oceanic water, and major gyres (rotating water masses) may spin off eddies of water of one set of characteristics into water of different characteristics. It appears that the distribution of cumaceans as well as possibly other groups of Tasmanian marine animals may be controlled by such mechanisms as temperature, salinity and nutrient property which are in turn controlled by wave energy regimes. It is also probable that the dispersal of hydrodynamic energy from each wave regime controls the composition of the sea bed and thus the habitat where organisms live. The coastal and shallow water interface is one of the great sinks of wave energy. We are familiar with the effects of breaking waves upon coasts and man-made structures. It may seem an obvious truism but these forces affect the denizens of the marine world as well.

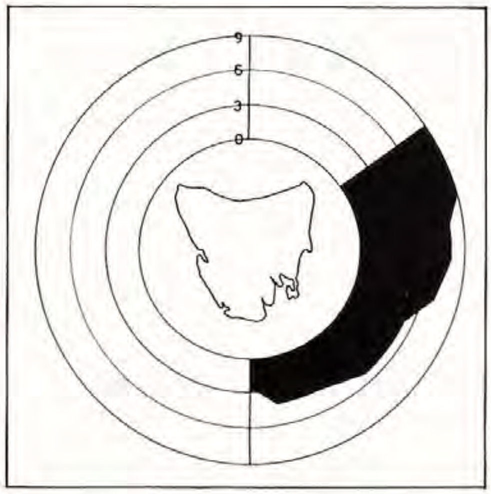
It appears that the old concept of the Maugean marine province may stand, but it needs testing by more detailed work on the effects of environmental hydrodynamics on marine animals. If the concept of wave energy regimes applies around the coasts of Tasmania, the old provincial distribution units are of little use. Only when we have more information relating animal presence, growth and reproduction to the controls exerted by marine meteorology and its vagaries will we be able to produce detailed management schemes for marine exploitation and conservation.

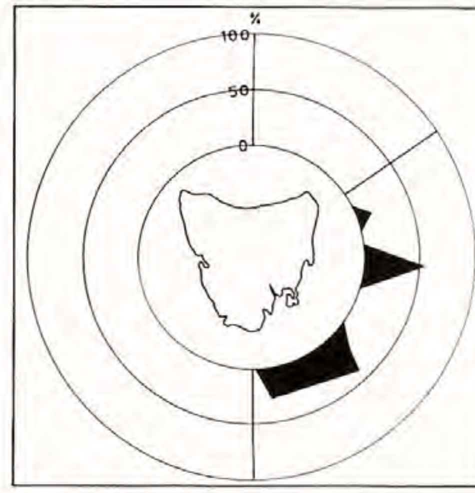
FURTHER READING

Australian Broadcasting Commission. 1969. *Bass Strait: Australia's last frontier.*

Banks, M. R. and T. G. Dix (eds.). 1974. *Resources of the sea. A symposium conducted by the Royal Society of Tasmania at Bicheno, Nov. 2-4.*

Williams, W. D. (ed.). 1974. *Biogeography and ecology in Tasmania.* W. Junk, The Hague.





The numbers of species of cumaceans (above left) that live in shallow water offshore sands along the east coast of Tasmania and their 'distinctiveness' (above) are illustrated. Note that the number of species grows fewer as one progresses southward and that, with respect to species composition, neighbouring sampling stations are most distinctive at the level of Maria Island and southward from the Tasman Peninsula. A 0% distinctiveness indicates that stations are similar to each other. Diagrams by A. J. Dartnall.

Recent research indicates that there are seven wave energy regimes (centre left) around the coast of Tasmania. It is proposed that each of these coastal energy compartments are also ecological units upon which we should base future investigations and management schemes for the marine environment. Diagram by A. J. Dartnall modified from one produced by J. Davies.

One of man's main use of the sea is food production, and Tasmanian waters are no exception. Principle items in the Tasmanian catch are abalone, southern rock lobster, commercial scallop, Pacific oyster, mussels and fish. Potential resources are sea urchins, cockles, crabs and squid. Squid fishing gear is pictured (below) with lines running from inboard drums carrying multiple unbaited jigs. Successful development and management of Tasmania's waters depends upon knowledge of biology and meteorology, and of their complex interrelationships. Photo by J. Grant/Tasmanian Fisheries Development Authority.

GARDEN IN ISOLATION

Since 1960 R. H. Green has been Curator of Zoology with the Queen Victoria Museum and Art Gallery in Launceston, Tasmania. In the course of this position, he has been involved with numerous field studies, seeking to learn more of the distribution, population structure and general ecology of the fauna of Tasmania. As a direct result he has published numerous papers about Tasmanian animals. In addition to general museum duties, he is presently involved in a forest ecology study related to the woodchip industry and in several specific studies of vertebrate and invertebrate animals. For the 20 years prior to his appointment at the museum, he was engaged in the Tasmanian midland's pastoral industry as a sheep breeder and woolgrower. In 50 years of living close to nature, of observing, listening and learning, he has acquired a broad general knowledge of Tasmania's environments and has developed a deep and lasting affection for its flora and fauna. His article introduces us to these environments and their interesting and often unique denizens.

by Robert H. Green

Ghostly relics of a former, more widely distributed, wet sclerophyll forest in Surprise Valley, W Tasmania, stand in stark contrast to recent forest regeneration. Because of the mountainous terrain and/or poor soils, many such areas were unsuited for agriculture, and the forests have been maintained as a timber resource. These areas also provide excellent habitats for many native animals. Photo by John McDougall/The Australian Museum.

The rugged and mountainous Tasmanian terrain, most of which originally supported heavy forests of giant hardwood trees, presented a difficult challenge to the early pioneers. Relatively small areas of the island were suitable for land clearing, agricultural development or domesticated stock grazing, but wherever such land did exist, it was soon taken up and settled for various farming pursuits. Most settlements developed on the fertile hills along the north and east coast and in the lowland valleys of the centre and south. It occurred in a haphazard manner to eventually form a vast mosaic of cleared farmland among forested hills.

The central highlands and most of the western or southern half of Tasmania were found to be too mountainous or the soil unsuitable for agricultural development even by present day methods, and early mining and timber cutting in these regions were very limited in extent and therefore did not greatly affect the flora and fauna. More recently, the development of a woodchip industry and the building of large dams for water conservation and the generation of electricity have created new pressures which may, in the long term, produce important changes to the population and distribution of the plants and animals.

Tasmania, with a total area of about 65,000 square kilometres, is relatively well endowed with National Parks and Nature Reserves. These total 682,731 ha and encompass a diversified sample of the state's terrain, flora and fauna. Included is the 12,787 ha Macquarie Island Nature Reserve, 1,500 km to the south south-east of the island of Tasmania. In the west, the prevailing weather and distribution of annual precipitation of up to 300 cm supports mostly wet vegetation. The east is mostly dry vegetation with as little as 45 cm a year. Temperate rainforest and wet sclerophyll forest predominate in the west, broken up and interspersed with areas of wet sedgeland.

The rainforest is generally dominated by myrtle-beech, *Nothofagus cunninghamii*, with sassafrass, *Atherosperma moschatum*; leatherwood, *Eucryphia lucida*; celery-top pine, *Phyllocladus aspleniifolius*; and horizontal scrub, *Anodopetalum biglandulosum*, being predominant in many places. Over-mature hardwoods, *Eucalyptus* spp., are often present, their decaying, broken tops standing above the forest canopy. The understorey and shrub layer varies in density and may include musk, *Olearia argophylla*; cheesewood, *Pittosporum bicolor*; native pepper, *Drimys lanceolata*; Gunn's persoonia, *Persoonia gunnii*; laurel, *Anopterus glandulosa*; and soft tree fern, *Dicksonia antarctica*, the latter often growing as high as three metres, especially in gullies where it may dominate.

The forest floor is generally littered with decaying timber, heavily carpeted with dense, wet, green moss which extends up onto the trunks and branches of the trees. This in turn provides natural, well-secreted cavities as dwelling places for several species of small terrestrial mammals as well as a specialised rainforest invertebrate fauna.

The wet sclerophyll forest is dominated by hardwoods such as the stringybarks, *Eucalyptus delegatensis* and *E. obliqua*; white gum, *E. dalrympleana*; and mountain ash, *E. regnans*. In favourable conditions, the canopy may be 70 m or more above ground.

In the north-west of the island *E. ovata* occurs prominently in the wet forests, and the Tasmanian blackwood, *Acacia melanoxylon*, though now significantly reduced by milling for its attractive furniture timber, is common in wet situations.

Silver wattle, *Acacia dealbata*, generally a short-lived tree, often occurs in patches and usually represents an early stage of succession. Such patches often develop following fires or other damage to the forests when resulting increase in the amount of light then able to penetrate to ground level permits the wattle to propagate and flourish. It produces a spectacular golden splash of colour when it blossoms in spring.

The understorey and shrub layer is composed of many species, and its composition is dependent upon such factors as rainfall, aspect, light and the stages of regeneration following logging operations or other such canopy disturbances. Dogwood, *Pomaderris apetala*; waratah, *Telopea truncata*; and

The land often reclaims its own. This 1972 picture (above) shows the extent of deterioration of Ernie Bond's 'Gordonvale' homestead in Upper Gordon Valley since his departure from the bush in 1950. Actually, relatively few areas of west and south Tasmania were cleared for agriculture and stock grazing. And among what few homesteaders there were, many appreciated and were concerned with the natural wildlife of the area; although, most not to the extent as was Ernie. Photo by Anthony Friend.

At elevations over 1,000 metres in central Tasmania (below), where winter brings wind, snow and ice, only the hardiest of the alpine plants survive squeezed between the boulders. Photo by Chris Green.

mountain berry, *Cyathodes parvifolia*, occur commonly as well as juveniles of rainforest species. These may form an early stage of succession which, given time and protection from fire, would eventually climax as rainforest. The wet sclerophyll forest is prolific, both botanically and zoologically, and supports a great proportion of the island's flora and fauna.

The forest ecology of Tasmania is often referred to as being 'fire-based'. Fire has always been with us and was probably used more extensively by the Aborigines in the days before European settlement than it is today. It is believed they burnt the vegetation to maintain forest clearings and tracks and to make it easier for them to move about the country and to catch animals. Haphazard firing of the vegetation is partly responsible for the present patchwork distribution of the forest in many areas. Though factors such as rainfall, aspect and soil are all influential and provide necessary elements for the establishment of particular vegetational communities, fire also plays an important role in pruning back the encroachment of rainforest, in the maintenance of treeless sedgeland areas and in helping in the propagation of many sclerophyll forest plants which reseed after or otherwise benefit from periodic burns.

In the western half of Tasmania, from sea level to an altitude of 1,000 m, there are many areas of treeless wet sedgeland which occur in a mosaic pattern of distribution, breaking up the areas of both rainforest and sclerophyll forest. The dominant plant is buttongrass, *Mesomelaena sphaerocephala*, which forms dense clumps of hummocky, coarse sedge, the seeding stems of which may grow to two metres high. It is haphazardly interspersed with rope-rush, *Restio australis*; cord-rush, *Lepidospermum filiforme* and along the edges of streams and in drainage areas it grows with heaths, *Sprengelia incarnata* and *Epacris gunnii*; heath-myrtle, *Baeckea gunniana*; boronia, *Boronia rhomboidea*; and tea-tree, *Leptospermum* spp.

After several years of post-fire regeneration and the accompanying accumulation of vegetation, the buttongrass plains, as they are locally known, become highly fire prone in the dry summer months, and it is at these times that they have been subjected to repeated burning. In more recent years, deliberately lit and controlled burns have been undertaken by forestry personnel in off-peak periods in order to reduce the accumulating fuel and fire hazards so as to provide fire breaks for the protection of adjoining forests.

In the central highlands, at elevations about 1,000 m, there occur treeless areas of moorland, fell field and bog. Here, only alpine plants resistant to snow, ice and winter winds can survive.

The eastern half of Tasmania supports mostly dry sclerophyll forest and woodland with small areas of coastal heathland, principally in the north-east. Isolated pockets of rainforest occur in parts, the principal area being around Mount Barrow at altitudes between 400 and 1,000 m.

The dry sclerophyll forests are dominated by eucalypts with *E. obliqua*, *E. viminalis*, *E. ovata* and *E. globulus* being well represented and widely distributed. Wattles, *Acacia* spp.; honeysuckles, *Banksia* spp.; and sheoaks, *Casuarina* spp., occur in some areas usually as an understorey. The shrub layer is usually far less dense than that of the wet sclerophyll and is sometimes reduced to grasses, *Poa* spp., littered with an accumulation of dried bark, twigs and leaves of eucalypts. It is highly fire prone, especially in the dry summer months, and repeated burning often reduces significantly the number and species of plants which may otherwise propagate in the shrub layer. In many areas bracken-fern, *Pteridium esculentum*, is prominent, being encouraged by repeated burning and uninhibited by an established shrub layer. It occasionally stands to two metres high and forms shelter and hiding places for the larger marsupials.

The less dense ground cover also provides suitable habitat for the larger marsupials which depend on their size and mobility to avoid capture. The dry sclerophyll forest fauna often survives low intensity fires by sheltering in hollows or holes in the ground, or, in the case of the more mobile species, by moving away from the fire or back tracking on to burnt areas.

The coastal heathland is represented by relatively small, though significant, areas and is an important habitat because it supports some specialised species of flora and fauna, adapted to live primarily within its limits. With colonisation by European man, its extent has been considerably reduced by agricultural development and the establishment of holiday resorts. In spring and summer it provides a wealth of colour and interest with the flowering of many species of shrubs, heaths and orchids. Some of the most prolific and spectacular are the pea flower, *Aotus ericifolia* and *Bossiaea cinerea*; tea-tree, *Leptospermum scoparium*; *Tetratheca pilosa*; boronia, *Boronia pilosa*; banksia, *Banksia marginata*; and grass trees, *Xanthorrhea australis* and *X. minor*.

The heathland is also a fire prone habitat. It was probably burnt every few years by the

Aborigines as regrowth reached sufficient density to carry fire. A long history of regular burning has no doubt greatly contributed to the evolution of its present floral composition, and survival in its present form is now dependent upon the continuation of such periodic burns. The heathland is a complex community of opportunists which have evolved to utilise the successive conditions following fire. Though fire is so often obnoxious and destructive in our eyes, it is none the less essential for the perpetuation of heathland ecology as we know it today.

Tasmania is well endowed with endemic flora. Most are beautifully illustrated by Margaret Stones and described by Dr Winifred Curtis in the late Lord Talbot de Malahide's six volume edition of *The Endemic Flora of Tasmania*. A total of 254 species are delineated, though some have since been found growing outside Tasmania. Most are relatively small plants which grow at the higher elevations. The mountain vegetation contains an extremely high proportion of endemic species and shows relationships with the vegetation of both New Zealand and South America. For example, the endemic cushion plants, *Dracophyllum* spp., which grow on the mountains at altitudes above 1,200 metres where snow lies for several months of the year, show a close affinity to New Zealand species.

Of the 29 species of eucalypts in Tasmania, 15 are endemic. Most are relatively small trees, a notable exception being the large and widely distributed black peppermint, *Eucalyptus amygdalina*. Among the gymnosperms, eight of the eleven native pines are endemic. In the banksia family 13 of the 16 Tasmanian species are endemic, and in the heath family endemic species are notable in the genera *Richea, Trochocarpa, Archeria, Prionotes, Cyathodes* and *Dracophyllum*.

The floral emblem of Tasmania is the leatherwood, *Eucryphia lucida*, an endemic shrub which grows to 30 metres in height. It is a rainforest species, and Tasmanian leatherwood honey is exported widely.

The blue gum, *E. globulus*, occurs mainly in the dry sclerophyll forests and woodland areas of eastern and southern Tasmania with isolated pockets on the west coast and on King Island and the Furneaux Islands. Its large blossoms are prolific nectar producers and attract swarms of bees and other nectar feeding insects and birds.

In the last Ice Age, Tasmania was joined to the Australian continent by the Bass Strait land bridge and formed part of a south-eastern Australian peninsula. It is reasonable to assume that a common fauna then ranged over the region, the distribution of some species extending to the north and west of the continent.

The present flooding of Bass Strait is believed to have commenced about 11,000 years ago when the ice barriers receded and the ocean level rose. Tasmania has now been effectively isolated from the Australian mainland for about 10,000 years. In this relatively short geological period, changes in environmental conditions, the effects of isolation and the arrival of European man have all contributed to effect changes in the fauna. The result is the evolution of a Tasmanian faunal unit, distinct in many ways and possessing its own peculiarities and endemic forms.

Contrary to common belief, many Tasmanian animal species are today numerically strong. This is no doubt fostered by the present pattern of land utilisation and is evidenced in the numbers killed by motor vehicles on the highways and byroads throughout the island. The rugged nature of the landscape, so much of which is unsuitable for agriculture and remains undeveloped, continues to provide the habitat requirements of the forest-dwelling species. Agriculture has developed in relatively smaller areas, often by clearing forest from the valleys or from the areas of rich basaltic soil. This pattern of land clearing has resulted in a mosaic-like distribution of open pastoral land bordered by forest. It provides a greatly enhanced food source, both in quantity and in quality for those grazing marsupials which can hide in the forest by day and invade the open pasture land by night. Most notable among these are the eastern grey kangaroo, *Macropus giganteus*; brush wallaby, *Macropus rufogriseus*; pademelon, *Thylogale billardierii*; and brush-tailed possum, *Trichosurus vulpecula*. In recent years, the advent of aerial spreading of superphosphate and other fertilisers on steep and otherwise inaccessible woodland areas has also benefited the grazing marsupials, increasing the potential carrying capacity for them just as it has for the domestic stock for which it is intended.

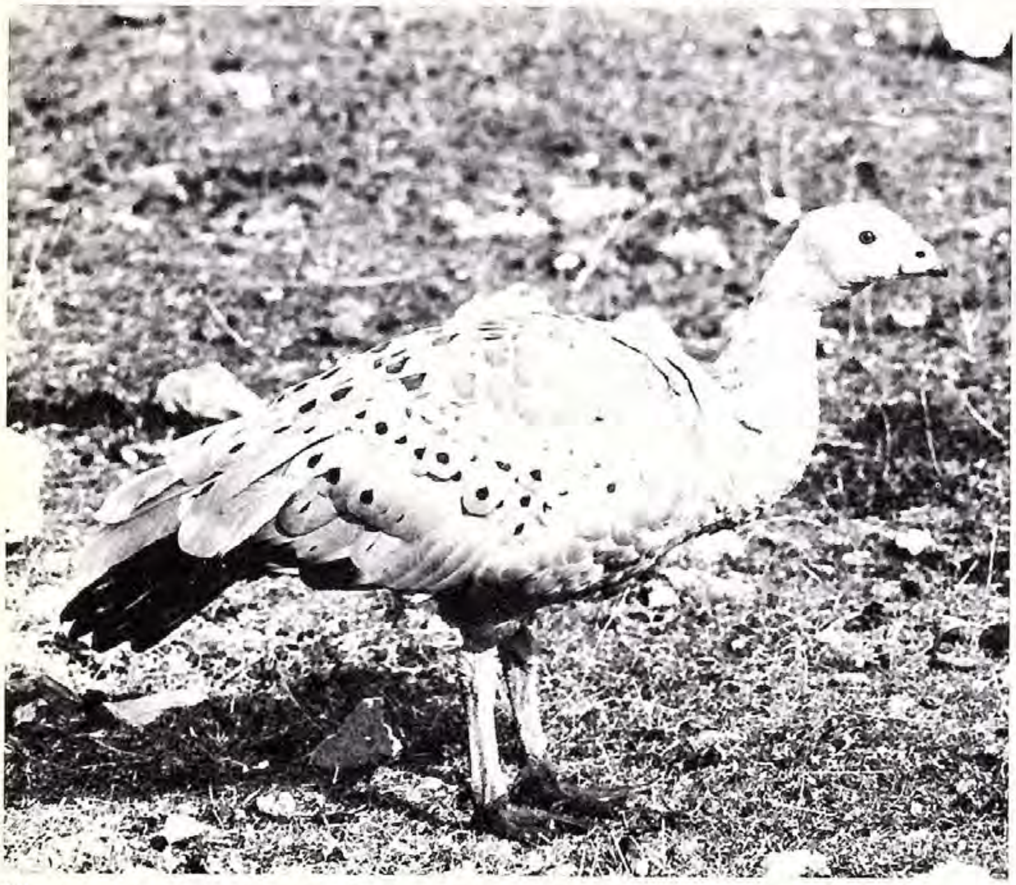
The development of agriculture has benefited other species, both directly and indirectly—for example, the brown bandicoot, *Isodon obesulus*, and barred bandicoot, *Perameles gunnii*, marsupials which emerge at dusk from the shelter of their well-secluded nests to feed on worms, spiders and ground-dwelling insects. Observations have revealed that they like to hunt over pastoral areas, apparently there rewarded by a good food supply which no doubt includes a high proportion of pasture-eating insects.

Rainforests (above) are normally characterised by tall trees with nearly a closed canopy and a floor covered with rotting logs and moss. The soft tree fern, *Dicksonia antarctica*, grows well (occasionally reaching a height of up to three metres) in such damp, shaded localities. Photo by R. H. Green/ Queen Victoria Museum.

The upper northern slopes of Cradle Mountain (1400 m) (below) sport only ground and shrub strata of small cold-resistant alpine plants including heaths, sedges, grasses, mosses and liverworts. Photo by Bruce Jenkins.

Among the most conspicuous of the mammals in Tasmania, because of its size and increasing abundance, is the brush wallaby (also known as Bennett's wallaby), *Macropus rufogriseus* (above). Although primarily a sclerophyll forest-dweller, this grazing marsupial has benefited from the mosaic pattern of agricultural development in the state. Photo by Bruce Jenkins.

The Cape Barren goose, *Cereopsis novaehollandiae* (below), now found in large numbers (even to the point of being a pest in some areas) on the islands of the Furneaux Group of Bass Strait, has also benefited from pastoral development. Photo by John McDougall/The Australian Museum.



The carnivorous, scavenging Tasmanian devil, *Sarcophilus harrisii*, is today in exceptionally high numbers, reaching pest proportions in some areas when it kills new-born lambs and attacks sick, injured or otherwise handicapped domestic stock. It finds an enhanced food supply in the higher numbers of both native and domestic animals now grazing the improved pastures and in scavenging on the carcases of those which inevitably die from various causes. Likewise, the smaller carnivorous and insectivorous native quoll, *Dasyurus viverrinus*, is now common and widely distributed. It preys upon small mammals and birds but has also been observed hunting invertebrates on pasture land.

The Tasmanina native-hen, *Gallinula mortierii*, occurred on the Australian mainland in prehistoric times but is now restricted to Tasmania. It is a flightless rail which feeds almost entirely on green grass and lives along the valleys and areas of semi-open land in the vicinity of lagoons, creeks and rivers. In Aboriginal times its feeding grounds were the marsupial lawns established by grazing kangaroos, wallabies and wombats on the naturally irrigated river flats and verges of creeks and lagoons. With the advent of pastoral development, especially along the fertile river valleys, the native-hen was presented with a great increase in the area of its required habitat, and its distribution and population expanded accordingly. Like the introduced rabbit, it became a pest to farmers because of the pasture it ate and damaged and was subsequently classified as 'declared vermin'. It has recently been removed from the vermin list but its numbers, though fluctuating, are still high in most agricultural areas.

The masked lapwing, *Vanellus miles*, locally known as the spur-winged plover, was an extremely rare bird in Tasmania in the nineteenth century. No doubt its culinary quality was a contributing factor to its low population, especially when it did not have the expansive grassland areas available to it today, so necessary for its propagation and survival. The development of those large pastoral areas, together with it having been afforded total protection, have enabled it to greatly expand its distribution and population. Today, it is probably the most conspicuous Tasmanian bird—sometimes occurring in flocks of more than one hundred when it congregates on agricultural areas in autumn.

The Cape Barren goose, *Cereopsis novaehollandiae*, once shot as a game bird and restricted numerically by the limitations of its summer grazing areas, is yet another example of a species which has benefited from pastoral development. Like the native-hen, it is a grazing bird. At the conclusion of the breeding season, most birds leave the small isolated breeding islands to congregate in flocks during the summer months on areas where short green grass is available. In the Furneaux Islands such areas are to be found on the largest of the group, Flinders Island. Here in the last twenty years pastoral development has greatly enhanced the quality and quantity of its food, and its numbers have responded accordingly. Though an open season for shooting has not been declared for some years, controlled shoots are occasionally undertaken to scare and reduce localised populations when these become sufficiently numerous to damage pastures and thus constitute a pest to farmers. The Furneaux Islands' population has probably never been greater than it is today.

There are numerous other such examples of species which have benefited from the advent of European man and his impact upon the habitat, but it is also evident that others have declined. Spectacular among those which have suffered are the thylacine, *Thylacinus cynocephalus*, present status of which is unknown; the Tasmanian subspecies of the emu, *Dromaius novaehollandiae diemensis*, which was exterminated in its wild state by about 1865; and the dwarf emu, *Dromaius minor*, which lived on King Island in Bass Strait until finally exterminated by the early sealers about 1805. A reading of the accounts given by explorers and early pioneers, together with more recent information, reveals a decline in water fowl, quail, pigeons and rosella. Again, shooting and trapping pressure for 'sport and culinary delights' may well have contributed, but the reasons are usually far more complex and often not fully understood.

No doubt the inhospitable Tasmanian landscape was the cause of many a curse from men trying to clear and develop farming land, but it is because of this rocky, mountainous terrain that so much of the flora and fauna of the nineteenth century still exists today. Had its shores encompassed a fertile, undulating, rock-free island, it seems almost certain that the land-clearing pioneers would have swept across its face, leaving little if any of the native flora and fauna. In retrospect, those pioneering problems associated with land-clearing and pastoral establishment have in many ways proved to be a blessing in disguise.

The establishment of a woodchip industry in 1971 has greatly increased the demand for timber and has brought with it clearfelling and forest regeneration programmes on a scale very much greater than the previous operations. Its eventual effect upon the flora and fauna of the island is widely debated, and it seems certain to produce the greatest impact upon the island's ecology since the arrival of European man.

Thirty-four species of native mammals (excluding seals) are believed to occur in Tasmania. They comprise two monotremes, twenty marsupials and twelve placental mammals. Three species are endemic, two of which, the thylacine and the Tasmanian devil, once lived on the Australian mainland, as evidenced by fossil remains, but both have long since died out there. The status of the thylacine is doubtful, though the persistence of unconfirmed sightings suggests that it still lives in the sclerophyll forests. The Tasmanian devil, a rare animal in the first half of this century, is now widely distributed and in high numbers. The third endemic mammal, the long-tailed rat, *Pseudomys higginsii*, occurs commonly throughout the rainforests.

In addition to the three endemic mammals, another nine mammals are generally considered to be endemic at a subspecific level. In the last 10,000 years of isolation, these have diverged from their mainland relatives to such a degree that they are now separable on various morphological characters. They include the eastern grey kangaroo, *M. g. tasmaniensis*; the brush-tailed possum, *T. v. fuliginosus*; common ringtail, *Pseudocheirus peregrinus convolutor*; the Tasmanian mainland population of the common wombat, *Vombatus ursinus tasmaniensis*, and the Flinders Island population, *V. u. ursinus*; dusky antechinus, *Antechinus swainsonii swainsonii*; swamp antechinus, *Antechinus minimus minimus*; eastern swamp-rat, *Rattus lutreolus velutinus*; and the echidna, *Tachyglossus aculeatus setosus*.

Seven species common in Tasmania are now extremely rare or have a very restricted distribution on the Australian mainland. They are the Tasmanian pademelon, *Thylogale billardierii*; southern potoroo, *Potorous apicalis*; little pigmy possum, *Cercartetus lepidus*; barred bandicoot, *Perameles gunnii*; native quoll, *Dasyurus viverrinus*; white-footed dunnart, *Sminthopsis leucopus*; and the broad-toothed rat, *Mastacomys fuscus*.

Of particular interest was the discovery in 1976 of the New Holland mouse, *Pseudomys novaehollandiae*, in coastal regions of eastern and northern Tasmania. Though skeletal material in subfossil deposits had shown it to have lived in the north of the island about 1,000 years ago, its survival to the present had gone undetected. Previously it was only known from eastern New South Wales and Victoria.

Recent collecting and research has shown that there are at least seven species of insectivorous bats in Tasmania. What was for many years believed to be a single species of lesser long-eared bat, *Nyctophilus geoffroyi*, has now been found to comprise two closely related species. Likewise, the little bat, *Eptesicus pumilus*, previously thought to comprise only one species, has been shown to be in fact several closely related species, two of which occur in Tasmania.

One native Australian mammal has been introduced and become established in Tasmania. This is the sugar glider, *Petaurus breviceps*, which was brought from the mainland about 1835. It is now widely distributed and common, occurring from sea level to the subalpine rainforest. Why it and several other Australian mainland species had not established themselves in Tasmania before the last flooding of Bass Strait remains a mystery.

Fortunately, Tasmania does not have the dingo, *Canis familiaris dingo*, or the fox, *Vulpes vulpes*. These carnivorous predators, introduced to mainland Australia, undoubtedly had a detrimental effect upon the native fauna as they settled into their niche. The Bass Strait water barrier has prevented their spread to Tasmania, and the island's ecology is free from their predatory and competitory influences.

About 300 species of birds have been recorded from Tasmania and the adjacent seas—about 43% of the total Australian species. Exact numbers cannot be given as ornithologists differ in their opinions because the study of bird speciation is not sufficiently

The yellow wattlebird, *Anthochaera paradoxa* (above), is an endemic species to Tasmania and Bass Strait islands in open forests and suburban gardens. Its common name is derived from this species' long pendulous yellow ear wattles, whereas its Latin specific name refers to the bird's paradoxical resemblance to a crow. Photo by R. H. Green/Queen Victoria Museum.

The dusky antechinus, *Antechinus swainsonii* (below), occurs mostly in rainforest, living among the damp, decaying litter where it feeds upon invertebrate and small vertebrate animals. Photo by R. H. Green/Queen Victoria Museum.

The green rosella, *Platycercus caledonicus*, a spectacular, endemic species, is common and widely distributed throughout the island. The sclerophyll forests are its more favoured habitat. Photo by R. H. Green/Queen Victoria Museum.

advanced for them to reach agreement. Also, bird observers are continually finding representatives of species not previously recorded from the island.

There are now considered to be eleven species endemic to Tasmania. They are the Tasmanian native-hen; green rosella, *Platycercus caledonicus*; dusky robin, *Melanodryas vittata*; scrubtit, *Sericornis magnus*; Tasmanian thornbill, *Acanthiza ewingii*; yellow wattlebird, *Anthochaera paradoxa*; yellow-throated honeyeater, *Lichenostomus flavicollis*; strong-billed honeyeater, *Melithreptus validirostris*; black-headed honeyeater, *Melithreptus affinis*; forty-spotted pardalote, *Pardalotus quadragintus*; and black currawong, *Strepera fuliginosa*. About a dozen others are considered to be endemic subspecies.

Thirteen foreign and two Australian species have been introduced and established in a wild state, the latter two being the laughing kookaburra, *Dacelo novaeguineae*, which is now widespread, and the superb lyrebird, *Menura novaehollandiae* which is restricted to two localities in the south.

The emus are the only birds to have died out since the arrival of European man, but their populations were probably never great. Two species which are now in low numbers with a limited distribution are the orange-bellied parrot, *Neophema chrysogaster*, and the forty-spotted pardalote. The former appears to be restricted to the west coast and King Island, moving north in winter to coastal Victoria and South Australia. Its nest has been found on very few occasions, and its life and habits are not yet understood. The forty-spotted pardalote is known to be in reasonable numbers in several areas in the south, but these are very limited in extent. A small population was recently found on Flinders Island, but it certainly ranks among the rarer birds.

Sixteen species of terrestrial reptiles are known to occur on Tasmania and its off-shore islands. They include three snakes and thirteen lizards, four of which are endemic. Of particular interest are two of the recently described endemic skinks. The Pedra Branca skink, *Pseudemoia palfreymani*, the only Tasmanian representative of its genus, is confined to Pedra Branca Island, a barren, precipitous and almost inaccessible rock about 30 km off the south coast. The island lacks vegetation, but it is the breeding site for a colony of Australian gannets, *Morus serrator*. Decaying gannet nests are also the breeding places of certain species of flies and other insects, and the Pedra Branca skink is probably dependent upon the gannets' breeding colony for its insect food. Because of the inaccessibility of the site, the lizard has not been studied there, and very few specimens have been collected.

The mountain skink, *Leiolopisma greeni*, described in 1975, has been found at only four alpine localities where it appears to live among rocks along the edges of streams. Like the preceding species, it has not yet been studied in the field, and very little is known of its life and habits. The remaining two endemic lizards are the spotted skink, *Leiolopisma ocellata*, and the small-scaled skink, *Leiolopisma pretiosa*, both of which are common and widely distributed.

The amphibian fauna comprises ten species of frogs and includes two endemics. Burrow's tree-frog, *Litoria burrowsi*, is confined to the rainforests in the west and south of Tasmania. It is a large, green frog which often climbs high into the foliage of trees. The Tasmanian froglet, *Geocrinia tasmaniensis*, occurs throughout the island, but its greatest populations are in the highland. It is a spectacularly marked, secretive little frog with a characteristic bleating call which somewhat resembles that of a lamb. Subspeciation among Tasmanian frogs is unclear, and authorities differ in their opinions. No Tasmanian frogs are rare or endangered, though Burrow's tree-frog certainly seems the least plentiful.

The freshwater fish are represented by lampreys, smelt, grayling, whitebait, native trout, eel, perch, pigmy perch, blackfish and freshwater flathead. Endemism is high among the numerous species of native trout which have evolved while locked into their respective lake and river systems, and several genera are involved.

The invertebrate fauna is equally interesting and diverse with numerous new species still awaiting description. Because many are tiny and inconspicuous, they are often unnoticed and forgotten, but they form a vital link in the chain of life, as scavengers, herbivores and predators, just as they in turn are preyed upon by other animals. They too have evolved to include many endemic Tasmanian species and have adapted to the particular conditions to form part of the overall interdependent and wonderful network in the highly specialised flora and fauna of Tasmania.

The vegetation and fauna of Tasmania are extremely interesting and important. There are many habitat types within its relatively small area and because of its geographical location, animals from Antarctic regions often visit its shores.

The cold conditions have produced adaptations in both plants and animals. The alpine vegetation with its hard, dense growth, which is a barrier against cold and water loss, has many endemic species. Some mammals have developed longer and thicker fur and are proportionally larger than their Australian mainland relatives, adaptations which make them better suited to live in a cold climate. Cold and isolation have thus contributed to and influenced the development of both plants and animals with the result that there exists today a high degree of endemism.

Within the relatively small island of Tasmania, there is present a great variety of vegetation and fauna, much of which is unique and most of which is generally abundant.

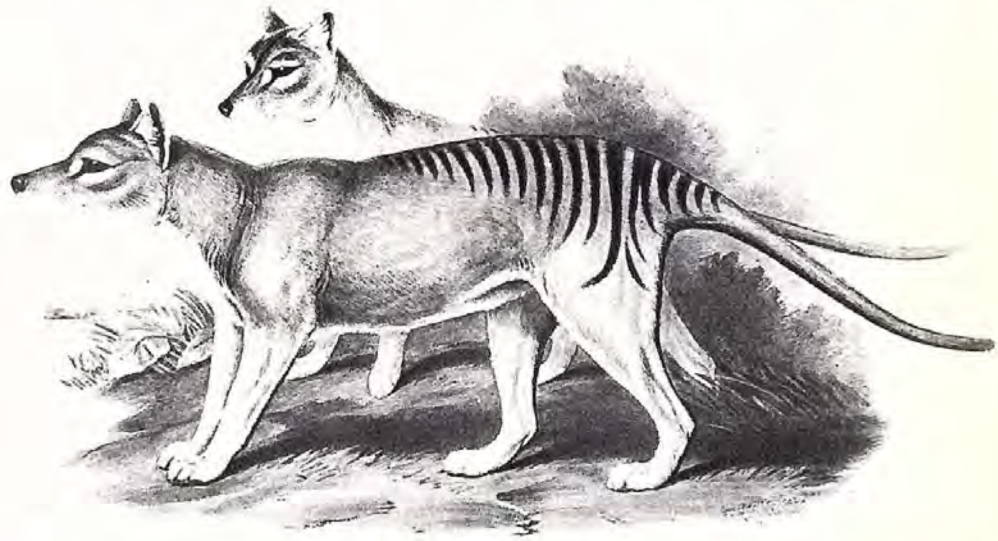
FURTHER READING

Breeden, S. and K. 1972. *Australia's south east.* Collins, Sydney.

Green, R. H. 1977. *Birds of Tasmania.* Mary Fisher Bookshop, Launceston.

Williams, W. D. (ed.). 1974. *Biogeography and ecology in Tasmania.* W. Junk, The Hague.

THE THYLACINE—AN UNSOLVED CASE



Fossil records indicate that the thylacine was once widespread on continental Australia and in New Guinea, but in recent times has been known only from Tasmania. Eric Guiler, a Reader in the School of Zoology at the University of Tasmania interested in marsupial ecology and physiology, organised a search for the thylacine in 1961 and is currently working on a programme sponsored by the World Wildlife Fund (Australia) to photograph a living specimen. His article recounts what is known of this animal's history in Tasmania and of its biology.

by Eric Guiler

When John Gould published in 1863 this painting of thylacines (above) in Volume I of *Mammals of Australia*, London, he predicted a demise of this the largest of the indigenous Australian carnivorous mammals: "When the comparatively small island of Tasmania becomes more densely populated, and its primitive forests are intersected with roads from the eastern to the western coast, the numbers of this singular animal will speedily diminish, extermination will have its full sway, and it will then, like the Wolf in England and Scotland, be recorded as an animal of the past."

Few Australian species have captured the attention of the Australian public as much as the thylacine (or Tasmanian tiger) *Thylacinus cynocephalus*, a dog-like marsupial. Does it continue to exist? Where does it live? What are its habits? The answers are not easy—tragically little is known about the biology of this animal, which, if it lives today, is one of the rarest in the world.

As a position at the apex of a food pyramid would suggest, the thylacine never was an abundant species. Further, as far as we know, its food habits were highly selective. It ate only freshly killed prey, and even in this it specialised on the vascular tissues. Thus any fluctuations in prey abundance would have a corresponding and probably drastic effect upon thylacine numbers. Furthermore, the pre-white man Tasmania with its uncleared land would not have supported as much native game as does the present pasture/forest fringe country. Lending some support to the concept of its scarcity, in the early colonial days a capture or sighting of a thylacine was sufficiently unusual for it to be reported in diaries.

Thylacines were once relatively common in some areas. Northwestern Tasmania, mostly occupied since 1820 by the Van Diemen's Land Company, was one such area. The early settlers believed that 'tigers' killed sheep in large numbers, and so a 'tiger man' was appointed to kill thylacines on Company property. He and his successors were successful in this, and the last capture on the property was in 1914.

The persecution of thylacines occurred over all of Tasmania, reaching a peak in the period 1888-1908 when a bounty was paid on their heads. A total of 2,184 animals were killed during the period. The statistical evidence furnished by the bounty indicated only a small number remained by 1910.

Since that time only a few thylacine corpses have been produced, the last one being at Mawbanna in 1930, although persistent alleged sightings and even rumours of captures have prevailed. One accidental killing of a young thylacine male at Sandy Cape (west coast) was reported in 1960 and probably was authentic. However, nothing now will satisfy the sceptics other than a photograph or a corpse.

A number of expeditions have searched for thylacines starting with the Fleay Expedition in 1945, followed by the Tasmanian Government Expedition of 1961 and lately by the Griffiths-Malley search in the 1970s. In addition, several very amateurish attempts specifically to photograph the species have been made, mainly by people who knew little of the animal or of the problems associated with the exercise. To the present time none of these searches have been successful. It is more likely that some lucky person with a

The live thylacine (top) was photographed within an enclosure in Tasmania at the beginning of this century. Although this particular individual had been given a carcass of a domestic fowl for purposes of the photograph, thylacines were branded as killers of poultry, sheep and calves, and a bounty was paid on their heads during the early settlement days of Tasmania. Photo by Harry Burrell/The Australian Museum.

The 'trophy pose' (centre) of a sheep farmer with his quarry near Mawbanna in 1930 is the most recent photo of a wild thylacine. Photo by Don Stephens.

Along with several red-bellied pademelons, *Thylogale billardierii*, and Bennett's wallabies, *Macropus rufogriseus*, two freshly killed thylacines (left) indicate a successful 'pest control' campaign in Tasmania at the turn of the century. Photo by J. H. Calaby.

camera ready at the right moment will be the one to secure a picture of this elusive animal. Clearly, with such a rare species any attempt to kill one would cause such a stir as to be totally unacceptable.

At the time of the abrupt thylacine decline scientific study of wildlife in Tasmania was largely non-existent. The Tasmanian Museum did not have a zoologist on its staff, and the Foundation Chair of Zoology at the University did not start until 1910. It is hardly surprising that we know so little of the biology of thylacines.

We can, however, build up a partial picture of the habits of thylacines from the snippets of information which are available. Probably the animals are largely nocturnal and hunt in pairs, though larger family groups may exist. Their prey is run to exhaustion, and the vascular tissues of the throat, nose, liver, kidneys and the inside of the ham are eaten. They have a rigid tail and probably do not run very fast. Anatomically, they cannot hop like a kangaroo nor perform prodigies of jumping in spite of the anecdotal stories to the contrary. The mating season reaches a peak about midsummer, and young (maximum number being four) are in the pouch from January to May. From June until the next breeding season the young run with the parents.

The decline of the thylacine in Tasmania remains a puzzle. One wonders whether the thylacine may have been on its way to extinction with the process being only accelerated by man. The species was once widely distributed over continental Australia as well as New Guinea, but since about 3,000 years ago it has been known only from Tasmania. No clear reason has been advanced for its disappearance from Australia, and in view of the climatic stability over that period it is difficult to imagine why it became extinct. Recent evidence suggests that competition with dingoes was not a factor.

Be that as it may, the species never was abundant and even in its day of plenty would be regarded as fragile by modern criteria. It seems likely that persecution combined with disruption of its way of life, as well as possibly a disease, was sufficient to tip an already precariously balanced animal into near oblivion.

Had hunting by man been the sole factor involved then it might be expected that with the cessation of this activity and the total protection which the species has enjoyed since 1939 the number of thylacines would have increased with abundant food. But this has not happened, and we are left with the question—does the thylacine still exist?

FURTHER READING

Fleay, D. 1946. On the trail of the marsupial wolf. *Vict. Nat.*, 63: 129-135, 154-159, 174-177.

Guiler, E. R. 1961. The former distribution and decline of the Thylacine. *Aust. J. Sci.*, 23: 207-210.

Macintosh, N. W. C. 1975. The origin of the dingo: an enigma, pp. 87-106. In M. W. Fox (ed.) *The Wild Canids*. Van Nostrand, New York.

SHRIMPS IN HIGH PLACES

The freshwater environments of Tasmania—including lakes, tarns, creeks, streams, rivers and swamps—are particularly well endowed with crustaceans, from microscopic copepods to crayfish over 25 cm in length. Among this group of arthropods is the Tasmanian mountain shrimp, *Anaspides tasmaniae*, considered to be a 'living fossil' because of its primitive and relatively unspecialised structure. This high altitude dweller has found a haven in the lakes and tarns of central and south-west Tasmania. Gerald Silvey, a neurobiologist who for five years taught physiology to students of pharmacy at the University of Tasmania, was introduced to *Anaspides* by Bill Wilson with whom he collaborated on a study of the nervous control of the animal's behaviour. His article presents the known salient features of the biology and natural history of *Anaspides*, and its near relatives, and seeks to place this animal in perspective with respect to the evolution of the malacostracan crustaceans.

by Gerald E. Silvey

This female Tasmanian mountain shrimp, *Anaspides tasmaniae*, is about 4 cm in length. The species is characterised by eight pairs of thoracic appendages (seven of them biramous), lack of a carapace, exposed gills, free thoracic and abdominal segments, stalked compound eyes and the two pairs of antennae with long flagella. Photo by G. E. Silvey.

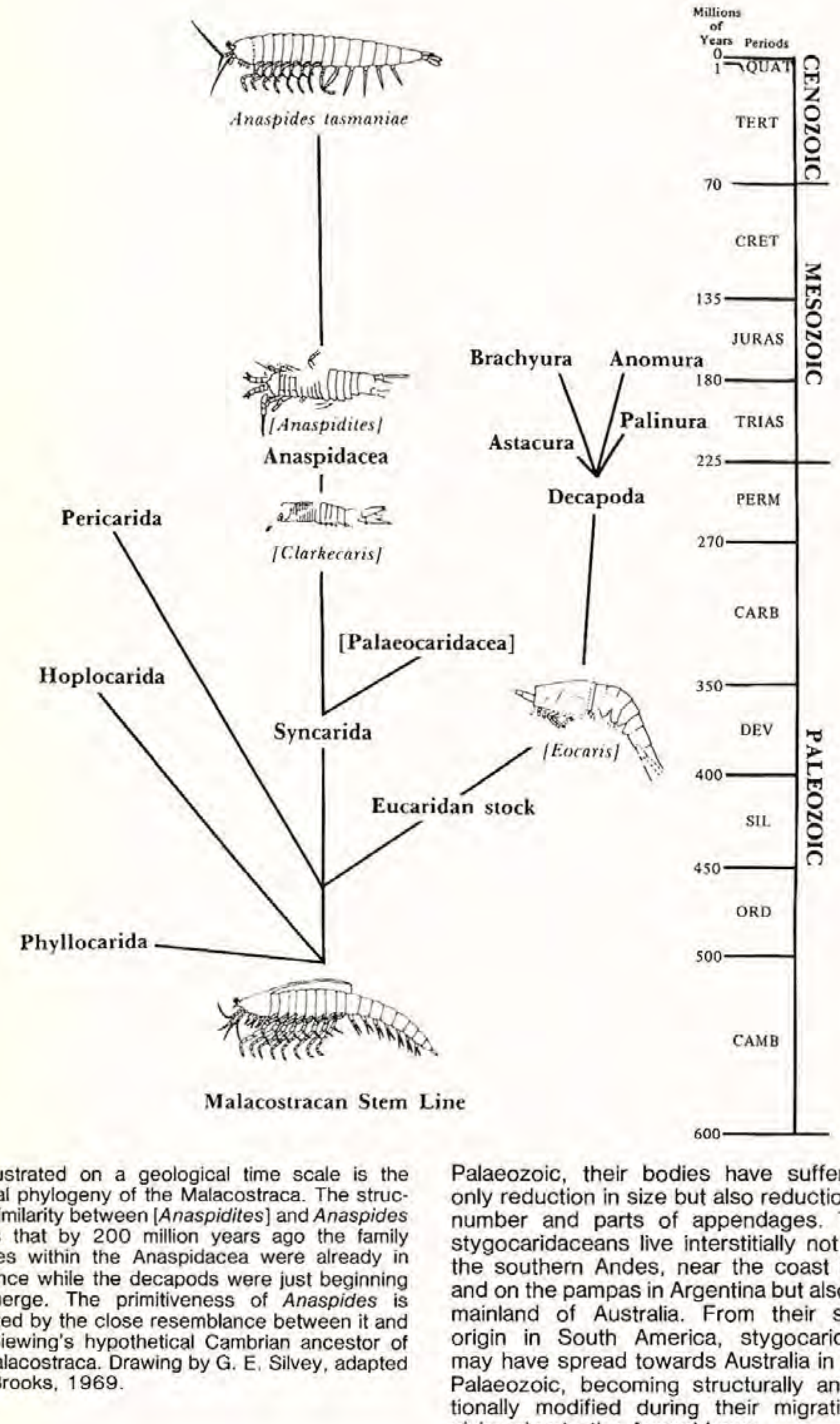
The geological mechanisms that isolated Australia and enabled the marsupials and eucalypts to flourish also ensured the survival of an ancient group of freshwater malacostracan crustaceans. Today, Tasmania with its cool climate and wet mountains is an enclave to species of this group whose members are on the one hand structured simply, thus resembling their ancestors, but, on the other hand, are closely related to the most complex and behaviourally adept of the Crustacea. Their existence is significant because it provides an opportunity to acquire from them interesting insights into a biological organisation that was once widespread and which preceded a sophisticated organisation that is now cosmopolitan.

The animals are the Anaspidacea, an order of the Syncarida, one of the five major groupings of living malacostracan crustaceans. The Syncarida represent what is most simple and primitive among the Malacostraca. They lack a carapace, seven or eight of their thoracic segments are free, and their thoracic appendages are biramous or two-branched. The Eucarida, on the other hand, represent what is most complex and advanced. They possess a carapace, their thoracic segments are fused, and their thoracic appendages are single-branched and often specialised. Included in the Eucarida is the order Decapoda: lobsters and freshwater crayfish, marine crayfish, crabs, hermit crabs, prawns and shrimps. The Decapoda are modern, highly specialised malacostracans that only began differentiating about 200 million years ago—a time when the body plan of the contemporary Anaspidacea was already established, possibly by as many years again before that. Compared to the decapods, the anaspidaceans are ancient, relatively generalised animals whose form dates to the early Carboniferous period.

Within the Anaspidacea, one species is prominent: *Anaspides tasmaniae*. *Anaspides* lives throughout central and southwest Tasmania at elevations greater than 500 m and is commonly known as the mountain shrimp, a name indicative of where it lives and what it looks like. Adults are typically 3-4 cm long. *Anaspides* bears the two pairs of antennae characteristic of crustaceans, but the flagella of these are long and nearly equal in length. Its compound eyes are stalked. Its gills are exposed, plate-like cuticular extensions that arise from proximal segments of its legs. Particularly striking are the animal's articulate or free segments, present not only in the abdomen but also in the thorax of its elongate, straight body. Also notable are the eight pairs of thoracic appendages, all of which are used in locomotion (rather than just the last four or five pairs as in decapods). Habitually a bottom dweller, it prefers to walk rather than swim. All but one pair of its legs, the eighth, are biramous; one branch being a walking leg and the other a flagellum—features typically found only in the most ancient, extinct crustaceans. The abdomen ends in a tail fan, one function of which is immediately apparent to anyone who has disturbed the animal. In response to disturbance the animal rapidly flips away, the propulsive surface being provided largely by the spread tail fan. Indeed, the size, shape, aquatic habitat and behaviour of *Anaspides* remind one of a eucaridan shrimp but fundamentally the mountain shrimp is quite different.

The Anaspidacea arose in the latter part of the Palaeozoic era in the Southern Hemisphere. Throughout their known existence, they have been confined entirely to Australia. They were preceded by the Palaeocaridacea, a widespread group of syncarids that lived in North America and Europe during the Carboniferous period, but which did not outlive the Palaeozoic. Palaeocaridaceans were characterised by all eight thoracic segments being free and the absence of furcal spines on the telson, the medium appendage of the tail fan.

Anaspidaceans are probably descended from a group of Southern Hemisphere syncarids, the Stygocaridacea. They were first known as fossils from South America. Like the Anaspidacea, they have only seven free thoracic segments (the first of the eight being fused to the head), but unlike the Anaspidacea they bear furcal spines, a feature of the earliest malacostracans. *Clarkecaris*, a Brazilian stygocaridacean that lived in the sea during the Permian period, is a possible ancestor of the Anaspidacea. Stygocaridaceans persist today in temperate regions of South America below 30°S latitude. They are quite small, less than 5 mm in length. Since the



Illustrated on a geological time scale is the general phylogeny of the Malacostraca. The structural similarity between [*Anaspidites*] and *Anaspides* shows that by 200 million years ago the family features within the Anaspidacea were already in existence while the decapods were just beginning to emerge. The primitiveness of *Anaspides* is indicated by the close resemblance between it and Rolf Siewing's hypothetical Cambrian ancestor of the Malacostraca. Drawing by G. E. Silvey, adapted from Brooks, 1969.

Palaeozoic, their bodies have suffered not only reduction in size but also reduction in the number and parts of appendages. Today's stygocaridaceans live interstitially not only in the southern Andes, near the coast in Chile and on the pampas in Argentina but also on the mainland of Australia. From their seeming origin in South America, stygocaridaceans may have spread towards Australia in the late Palaeozoic, becoming structurally and functionally modified during their migration and giving rise to the Anaspidacea.

Besides the Anaspidacea, the Stygocaridacea and the extinct Palaeocaridacea, there is a fourth order of Syncarida, the Bathynellacea. They live today in subterranean waters throughout Asia and in Africa, Australia, Europe and South America. They have lost the compound eye and many parts of appendages, and their telson is fused to the abdomen. Their eight thoracic segments are free, a feature which relates them to the extinct Palaeocaridacea, and they bear a furca, which associates them with syncarids that predated the Palaeocaridacea. Unfortunately, their phylogeny is uncertain because they have no fossil record.

The earliest anaspidacean species is *Anaspidites,* an animal known from a 200 million year old Triassic fossil found in Hawkesbury River shale near Sydney. *Anaspidites* was a freshwater animal not much different in shape, size and skeletal form from *Anaspides*, and belongs to the same family group. Thus *Anaspides* is a type of animal that has remained relatively unchanged for at least 200,000,000 years.

The mountain shrimp is not the only living member in the Anaspidacea, although it has received the most attention because of its size and abundance. There is a second species of *Anaspides, Anaspides spinulae,* which is about two-thirds the size of the mountain shrimp and is known only from the bottom of Lake St. Clair. The species *Paranaspides lacustris* is unlike other anaspidaceans in that it frequents surface waters. It is about 2.5 cm long and its body is characterised by a great bend which is thought to help it swim. *Paranaspides* was once abundant in Great Lake of the central Tasmanian highlands, but when the outlet of this lake was dammed in the 1920's, the species was decimated due to the submergence and destruction of the surface weeds upon which it fed. Two species of the genus *Allanaspides* inhabit the burrows of terrestrial crayfish in buttongrass plains of the Lake Pedder region. Both of these animals grow to slightly longer than 1 cm and have a thin cuticulate window in the dorsal surface of their first thoracic segment. Beneath the window is tissue that seemingly regulates the concentration of ions and water in their body fluids. *Koonunga cursor* and *Micraspides calmani* are cryptic species less than a centimetre in length. The former has sessile eyes and the latter is blind. Both are often found associated with the burrows of other crustaceans. *Koonunga* lives at low elevations on the northwest coast of Tasmania and also in southern Victoria. *Micraspides* lives in Tasmania to the north of Lake Pedder and on the west coast near Queenstown. *Psammaspides williamsi* is a blind, interstitial animal no more than a centimetre long. It lives between sand grains in creek beds of northern NSW and in subterranean springs in northern Tasmania.

How did *Anaspides* remain relatively unchanged throughout the Mesozoic and Cenozoic periods while its relatives among the Malacostraca diversified? Some indications of possible causes for *Anaspides'* continued success can be determined from studies of its ecology, physiology and behaviour.

Tasmania has been cut off from the Australian mainland since the end of the last ice age about 12,000 years ago, and Australia from the rest of Gondwanaland, the southern super-continent of the Mesozoic era, since the end of the Cretaceous period about 100 million years ago. Presumably the geological transitions accompanying these separations restricted larger anaspidaceans to a small portion of the modern Australian continent, viz., a southern island in which rainforest conditions persist like those that once prevailed throughout Australian Gondwanaland. The moisture-laden air that sweeps in off the Indian Ocean is forced upward and cooled by the southwest mountains of Tasmania, precipitating as much as 300 cm of rain per year along the west coast. Progressively decreasing amounts fall across the island until only a tenth falls on the shore bordering the Tasman Sea. Mountain elevations above 500 m in the southwest annually receive upward of 100 cm of rain. Streams run all year, pools in alpine plateaus persist through the summer and lakes never dry. In such higher mountain habitats *Anaspides* flourishes.

To completely account for *Anaspides'* survival in Tasmania is difficult because other places in Australia—parts of the Great Dividing Range and the southeastern and southwestern coastal fringes—provide seemingly suitable environments. Evidently the coincidence of height, climate, continuity of habitats, preclusion from would-be predators (for example, the native galaxid fish that dwell in the lower reaches of the streams which *Anaspides* inhabits) and other, unknown factors have sheltered the mountain shrimp and provided it with an environment that has not stressed it beyond its physiological limits.

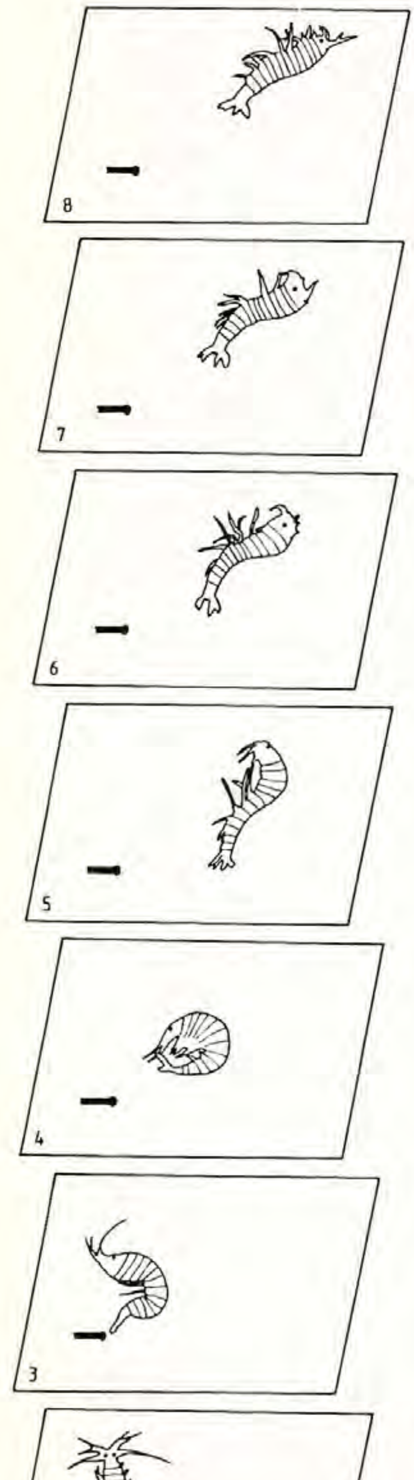
The constancy and seclusion of the Tasmanian high country enable some of *Anaspides'* physiological systems to operate within their narrow limits. Reproduction is one such system. *Anaspides* lays its eggs singly on submerged moss and bark, under stones, and on roots and other forest debris in streams and tarns. The eggs, averaging 1 mm in diameter, are unusually large for a malacostracan the size of *Anaspides*. Vernon Hickman has shown that eggs laid in summer hatch after eight to nine months, and larvae emerge as miniature adults not quite 3 mm long. Larvae are complete in all their segments and in most of their appendages but differ from adults in having a median eye and sessile compound eyes. Larvae develop during successive moults and by the end of their first year are young adults 1-2 cm in length. Unlike most other malacostracans, neither parent protectively harbours eggs or young. The survival of the embryo and young is completely dependant on the environment.

Osmotic and ionic regulation is another system that functions within narrow environmental limits. Roy Swain has found that *Anaspides* cannot adjust to solutions as concentrated as its own blood, which is 110 mM in sodium ions (about one-fourth the concentration of sodium in sea water). *Anaspides'* blood, furthermore, is more dilute than that of other freshwater malacostracans. Freshwater crayfish, for example, have a blood sodium concentration of about 220 mM, and they can happily live for some time in a solution of sodium ions of that concentration. The water in which *Anaspides* lives is soft—unusual for Australian waters which are typically highly concentrated. This is largely due to the high resistance to leaching of the granitic rock which makes up the vast majority of the mountains of the Tasmanian southwest. *Anaspides* is a strictly freshwater animal, able to select and hold the common ions of sea water and blood at levels higher than the water surrounding it, but incapable of coping with salinity changes in its medium caused, for example, by concentration ensuing from evaporation. Fortunately this occurs rarely. How *Anaspides* succeeds and fails at regulating is unknown.

Anaspides and other living syncarids, except for one brackish water species of bathynellacean, all dwell in fresh water. Their ancestors, however, did not. *Clarkecaris* was a marine animal, and probably all the Carboniferous syncarids lived in the sea. This change in habitat from salt to fresh water presumably occurred at the end of the Palaeozoic era and led not only to dilution of the blood but also to the development of a predominantly chitinous skeleton—one not reinforced by minerals that were no longer available in fresh water.

Anaspides can adjust to one condition of its environment that varies considerably. In its alpine pool habitats, the temperature rises in the course of a summer's day from overnight lows of 10°C to 23°C. During the coldest winter month the temperature fluctuates between $-1°$ and $+1°C$. Thus the animal is able to withstand cooling below freezing, and

A number of freshwater habitats are frequented by *Anaspides* including a tarn (encircled by snow) at the base of Mt Rufus (top) and Lake Hartz (bottom). Photos by G. E. Silvey.



The alarm response of *Anaspides* was traced from successive frames of movie film. When touched by a rod (black bar) the mountain shrimp flexes all of its thoracic and abdominal segments (frames 3 and 4) to propel itself upward and forward, away from the stimulus. The complete sequence takes place in less than one-tenth of a second. Drawing by G. E. Silvey.

heating greater than 20°C—a very wide tolerance span. Usually, however, it lives within a temperature range of 0-8°C.

Following the discovery of *Anaspides* and recognition of its phylogenetic significance in the 1890's, the species was first described in its natural surroundings by Geoffrey Smith. He found that the animals usually progress by walking or running although occasionally they swim, rising to the surface where they turn over on their backs. In this position, both young and adult *Anaspides* were seen by Vernon Hickman to sort through particles floating on the surface, searching for food. Smith also observed *Anaspides* to dart forwards or sideways but never backwards when they were alarmed. He noted that the flagellar exopods of the thoracic legs continually beat and suggested that they assist in respiration by agitating the water about the gills—a conclusion that remains to be demonstrated.

In the late 1920's Sidnie Manton determined that *Anaspides* of all ages feed upon algae and detritus and that adults add tadpoles and worms to their diet. This agrees with the observation that the number of tadpoles in mountain pools is inversely proportional to the number of mountain shrimp. To feed, *Anaspides* scrapes particles free. These it collects in the plates and spines of its mouth parts. It may also bite particles by using the incisors of its mandibles. Manton was surprised to find that *Anaspides* did not generate currents to carry small particles to its mouth, because her previous studies on preserved specimens led her to interpret its mouthpart structures as being suitable for filtering and sieving. *Paranaspides*, however, also has these structures and does use them to feed by filtering and sieving.

From her field observations, Manton also pointed out that the mountain shrimp moves its thoracic and abdominal appendages in a metachronal rhythm—it moves its legs sequentially from back to front. This rhythm is used for walking and swimming. Recent films analysed by David Macmillan of the University of Melbourne and Bill Wilson and I of the University of Tasmania demonstrate that there are at least three separate rhythms: one of the flagella of the thoracic appendages, another of the walking legs, and a third of the swimmerets. These can be progressively coupled into one another. While an animal is stationary, only the flagella may beat. When the animal moves slowly, the flagella continue to beat, but not in precise synchrony with the walking legs. During swimming and rapid walking, the swimmerets are recruited along with the flagella and legs into a cyclical, forward-advancing wave of sequential power and return strokes. This means that there is a hierarchy of cyclic pattern generators in the central nervous system. Which particular generator is selected is in some manner related to the speed, power and oxygen required by the animal.

As a young animal and later as an adult, *Anaspides* is vulnerable to disturbance of its environment. It is subject to predation by at least one organism, man. Presumably there are other predators but none has been demonstrated. It can also suffer dislodgement by currents in the water in which it dwells. When the animal is upset by touch, by vibrations in the water, and possibly by sudden changes in illumination, its body flexes rapidly and it is propelled up and away from the stimulus before extending and swimming off. This response is mediated by the lateral of two giant nerve fibres that run the length of each side of its ventral nerve cord.

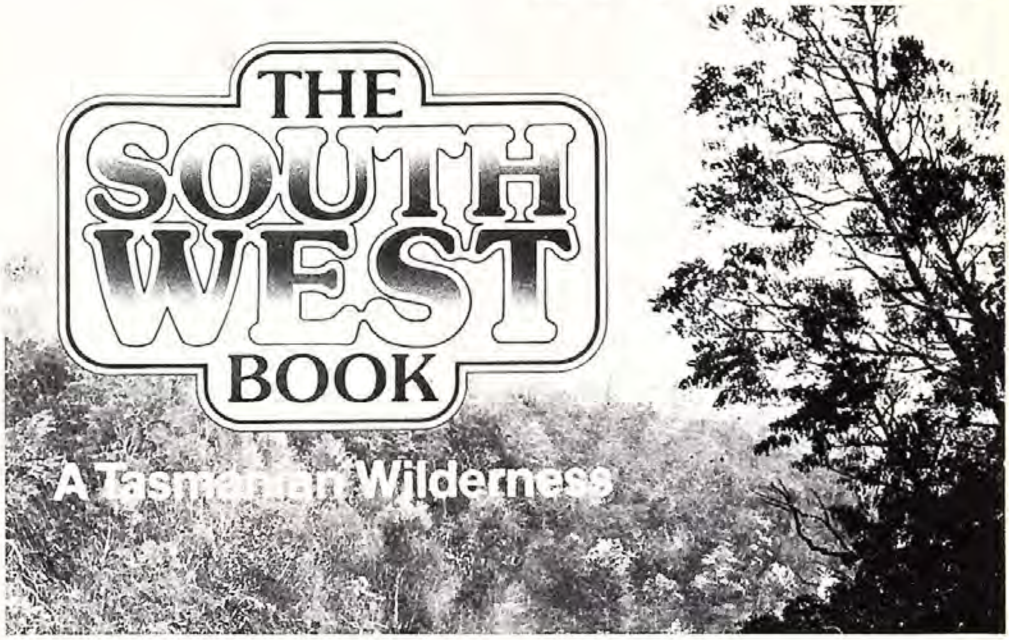
The lateral giant nerve fibre is nearly identical in structure and function to that found in the crayfish and other long-bodied decapods. Undoubtedly the fibres are homologous. This means that the lateral giant fibre and the evasive reaction it mediates predate the origin of the Decapoda and very likely manifest an inheritance from a malacostracan ancestor. The fibre's behavioural significance is that it has given *Anaspides*, an animal with a soft, delicate body and no appendages specialised for anything that borders on the defensive, a mechanism for evading predators by rapid movement away from touch or nearby disturbance.

The phylogenetic age and the structural and functional features of the mountain shrimp render it a precious contemporary animal. It is fortuitous that *Anaspides* has been harboured by an environment that has probably changed little, at least not to a degree that outstripped the animal's capabilities. The morphological and physiological bases of its behaviour are extremely instructive for what they reveal about the form and function of transitional malacostracans, the descendants of Cambrian ancestors and forerunners of the modern, specialised and highly successful decapods. The conservatism that dictated the retention of an animal such as *Anaspides*, despite the introduction of new animals, can be appreciated for what it has left all of us not of an earlier, less complicated generation.

FURTHER READING

Brooks, H.K. 1969. Syncarida. In R.C. Moore (ed.) *Treatise on Invertebrate Palaeontology, Part R, Arthropoda 4*, Vol. 1. pp 345-359, University of Kansas and Geological Society of America, Lawrence.
Manton, S.M. 1930. Notes on the habits and feeding mechanisms of *Anaspides* and *Paranaspides* (Crustacea, Syncarida), *Proc. Zool. Soc. Lond. 1930:* 791-800.
Silvey, G.E. and I.S. Wilson. 1979. Structure and function of the lateral giant neurone of the primitive crustacean *Anaspides tasmaniae*, *J. exp. Biol.* 78: 121-136.
Smith, G. 1909. On the Anaspidacea, living and fossil, *Qt. J. Microsc. Sci.* 53: 489-578
Williams, W.D. 1974. Freshwater Crustacea. In W.D. Williams (ed.) *Biogeography and Ecology in Tasmania*, pp.63-112, Dr. W. Junk, The Hague.

IN REVIEW



The colour photos (overleaf) are from *The South-West Book* and were kindly supplied by Helen Gee. Appreciation is extended to the publisher and editors for permission to reproduce them.

The South-West Book: A Tasmanian Wilderness. **Edited by Helen Gee and Janet Fenton, Australian Conservation Foundation, Melbourne 1978, 307 pages, illustrated, $11.70.**

"A wilderness, in contrast with those areas where man and his works dominate the landscape, is an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain." (United States Wilderness Act of 1964.)

There is little of Australia which can fit this definition of wilderness American style. Unlike North America, Australia is a flat, dry continent with infertile soils and weather which is best described as erratic. Because of this, Australian ecosystems are particularly sensitive to change and the impact of human settlement has been far greater than in North America. First the Aborigines with their use of fire to drive game and clear the bush and recently the colonisation of Australia by Europeans and their domestic animals have altered the continent to an extent that we can but guess at the nature of pre-Aboriginal and pre-European landscapes.

As distinct from the idiosyncrasies of individuals (explorers, adventurers and the like), the search for wilderness is a recent social phenomenon. It is a love affair fuelled by affluence (mid-East oil) and driven by the mindless bureaucracy and unending pursuit of material possessions with which we encumber our lives. A wilderness is a place where we can be human.

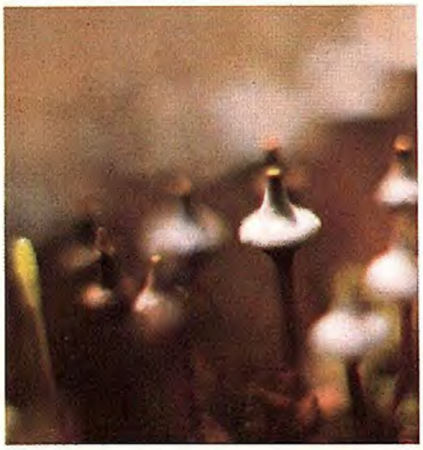
The South-West Book is about the Tasmanian wilderness, but it could be about any of the few remaining wild areas in Australia: places now unique in being remote, rich in wildlife and without significant human presence. Of all the wilderness areas in Australia, the Tasmanian South-west with its water, forests and mountains has the greatest attraction to people. There is a danger in this; the wilderness could be loved to death. Yet this seems a smaller risk to the South-west than the threats posed by yet more Lake Pedders, clearfelling of forests and mining.

The South-West Book explores the attractions of the Tasmanian wilderness; its landscape, people and wildlife. It documents the evolution and ecology of its plants and animals, describes its geology and landforms and tells the story of its people—Aboriginal and European. The editors and the Australian Conservation Foundation are to be congratulated for putting together an informative, readable and superbly illustrated account of one of the world's great natural areas. I wish that such forceful and informed documents existed for other places in Australia threatened by uninformed exploitation. The information exists—"scattered in the dusty corners of museum and library, held in the minds of bushman and academic"—but bringing it together attests to the dedication of those who are fighting to save this part of Australia's heritage.

The South-west is an endangered landscape. As exemplified by the destruction of Lake Pedder, the Tasmanian Government is prepared to destroy the wilderness in the same way that it sacrificed its Aboriginal inhabitants in the last century. Perhaps the editors of *The South-West Book* are correct when they imply that the insensitivity of 'industry' and 'government' arises from a lack of information and that with knowledge will come rational decisions. If correct, this book provides the information, the insight and the ethics required for rational behaviour. Yet, as the editors recognise, few of us have resolved the "conflict between the drive towards an ever higher level of material consumption and the feeling that beautiful natural areas should be protected and cherished".

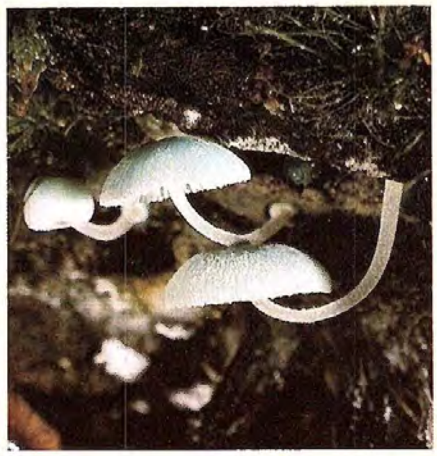
This is a book that should be read. The South-west of Tasmania is not just a wilderness, it is Australia as it was—and, perhaps, as more of it should be.—*H. F. Recher, Curator of Vertebrate Ecology, The Australian Museum.*

Moss capsules. *Bob Graham*



Left
Fern and fungus. *Chris Bell*

Fungi. *Bob Graham*



Fungi. *Bob Graham*

This unusual flower, *Isophysis tasmanica* (Hewardia) is only found in the South-West of Tasmania. *Chris Bell*

Waratah. *Chris Bell*

Richea dracophylla, Picton River. *Bob Graham*

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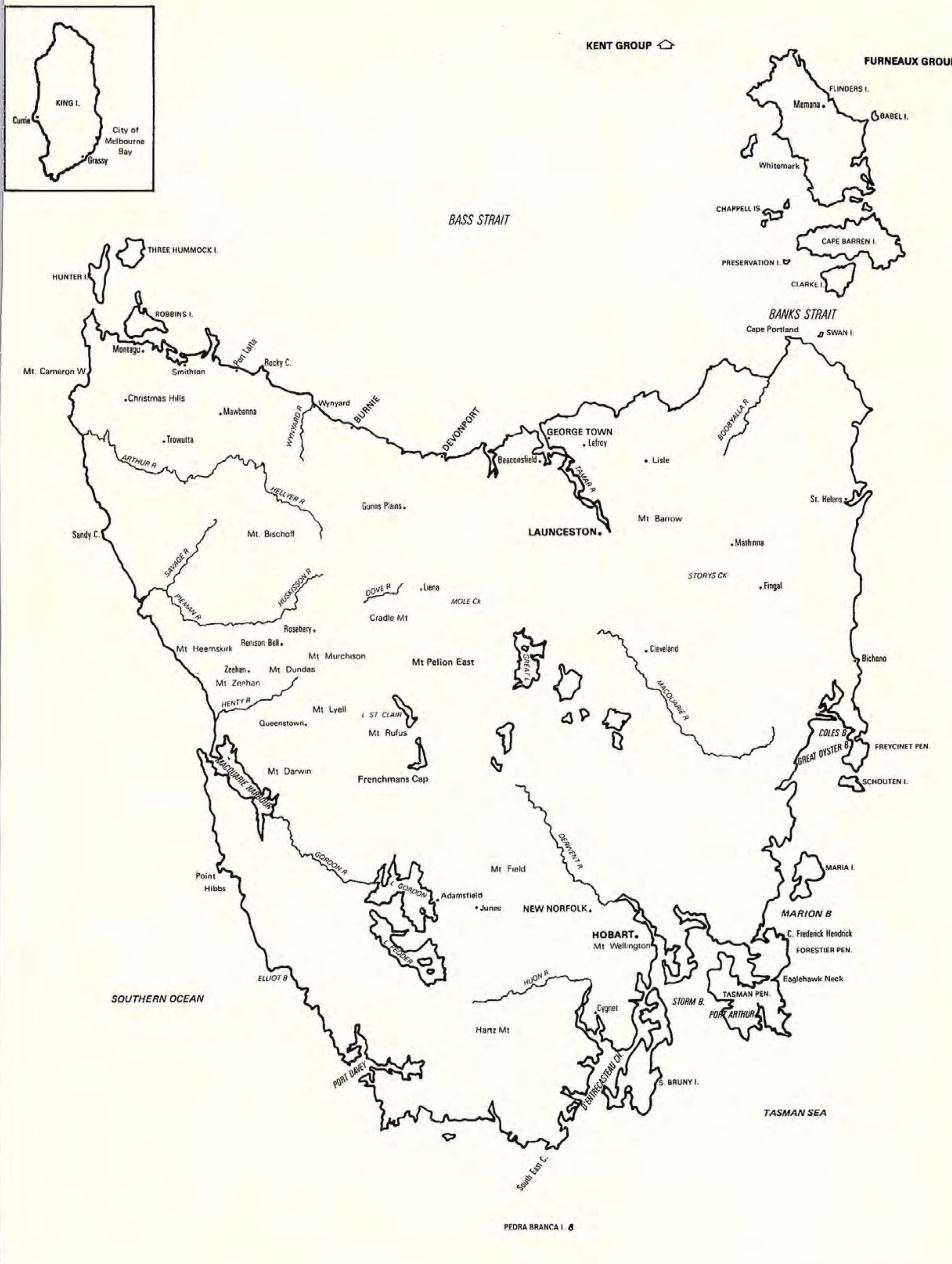

KING I.
Currie
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City of Melbourne Bay
KENT GROUP
FURNEAUX GROUP
FLINDERS I.
Memana
BABEL I.
Whitemark
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CAPE BARREN I.
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CLARKE I.
BANKS STRAIT
Cape Portland
SWAN I.
BASS STRAIT
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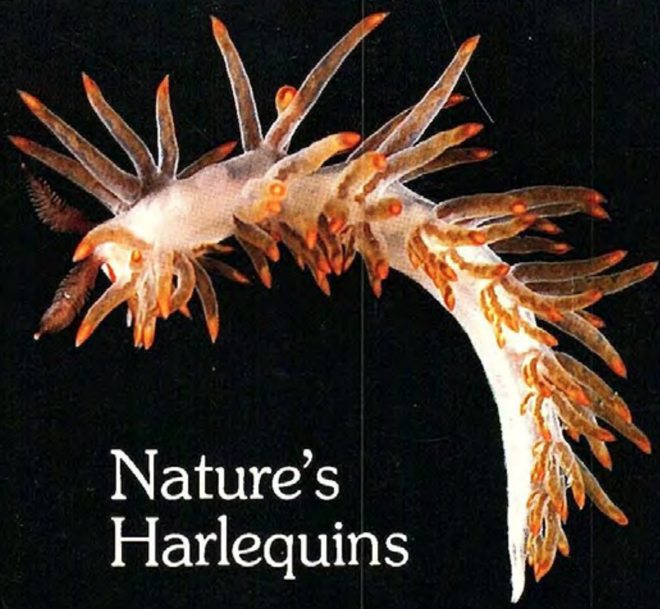
MARION B
HOBART
Mt Wellington
C. Frederick Hendrick
FORESTIER PEN.
L. PEDDER
Eaglehawk Neck
ELLIOT B
HUON R.
SOUTHERN OCEAN
Cygnet
STORM B.
TASMAN PEN.
PORT ARTHUR
Hartz Mt
PORT DAVEY
D'ENTRECASTEAU CH.
S. BRUNY I.
TASMAN SEA
South East C.

Pictured are two of the 13 brilliant and beautiful nudibranchs or sea-slugs featured in the 1981 Calendar of The Australian Museum. Available now—see Order Form inside this issue for your copy.



Nature's Harlequins

1981 calendar
the australian museum