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NATURAL HISTORY OF CURTIS ISLAND, BASS STRAIT

4. THE REPTILES OF CURTIS AND RODONDO ISLANDS

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ABSTRACT

Four species of reptiles and details of their ecology are recorded from Curtis Island and three species from Rodondo Island. Curtis and Rodondo Islands are situated in the deepest part of Bass Strait and were the first islands isolated after the most recent ice age. The paleogeography of the islands is outlined and the origins of the reptile faunas and terrestrial ecosystems are discussed. It is concluded that all four Curtis Island reptile species and two of the three Rodondo Island species are glacial relicts but that the third Rodondo Island species is a post glacial intrusive.

INTRODUCTION

Curtis and Rodondo Islands lie on the W. margin of the "Bassian Rise" (Jennings 1959), a submarine ridge of generally low relief and gentle slopes that runs down the E. side of Bass Strait in a curve from Wilson's Promontory, SE. Victoria, to Cape Portland, NE. Tasmania. Hundreds of Devonian granite masses outcrop abruptly along the Bassian Rise. Many are completely submerged but others project above sea level to form the 90 or so small eastern Bass Strait islands and the rugged granite hills on the three large islands (Flinders, Cape Barren and Clarke Islands). There is now a reasonable amount of published information on the submarine topography of Bass Strait (Admiralty Charts Numbers 1695a and 1695b; Australian Charts Numbers Aus. 144, 145, 150, 151 and 199; Jennings 1959, 1971). These publications reveal that Bass Strait is shallowest along the Bassian Rise, and that the maximum continuous depth of 60 m is in a channel lying between the Hogan and Kent Groups. Most of the Bass Strait islands are isolated by continuous water depths of 55 m or less, the only exceptions being Curtis and Rodondo Islands, both isolated by water 73 m deep, and West Moncoeur and East Moncoeur Islands, both isolated by water 64 m deep (fig. 1). Thus of the islands in Bass Strait,Curtis and Rodondo Islands are those surrounded by the deepest water (table 1), and the only south-eastern Australian islands isolated by deeper water are four small rocky islets composed of Precambrian sandstone which lie off southern Tasmania.

Curtis and Rodondo Islands are very similar in their gross structure and morphology. Curtis is a ridge of granite, 1.78 km long which rises steadily from north to south but is broken into two peaks by a saddle 70 m deep; the bare rounded northern peak reaches 224.3 m while the square capped and vegetated southern peak reaches 335.3 m and ends in a precipitous cliff 250-300 m high. Rodondo is a conical mass of granite 1.07 km at its widest, rising to a distinct and well-vegetated peak 350.5 m high. Both islands are delimited by steep "plunging cliffs" (Jennings 1959) that continue unbroken from about 100 m above sea level (except on the north-eastern tip of Curtis Island, where they descend almost to sea level) to 65-70 m below sea level where they abut abruptly onto the relatively flat floor of the Bassian Rise (figs. 2,3).

The depths of water isolating these two islands, their heights and steep sides, are of great importance to biogeographers and ecologists in the light of climatic and sea level changes that have taken place since the last ice age. Of the terrestrial vertebrates, only reptiles can throw much light on the historical biogeography of

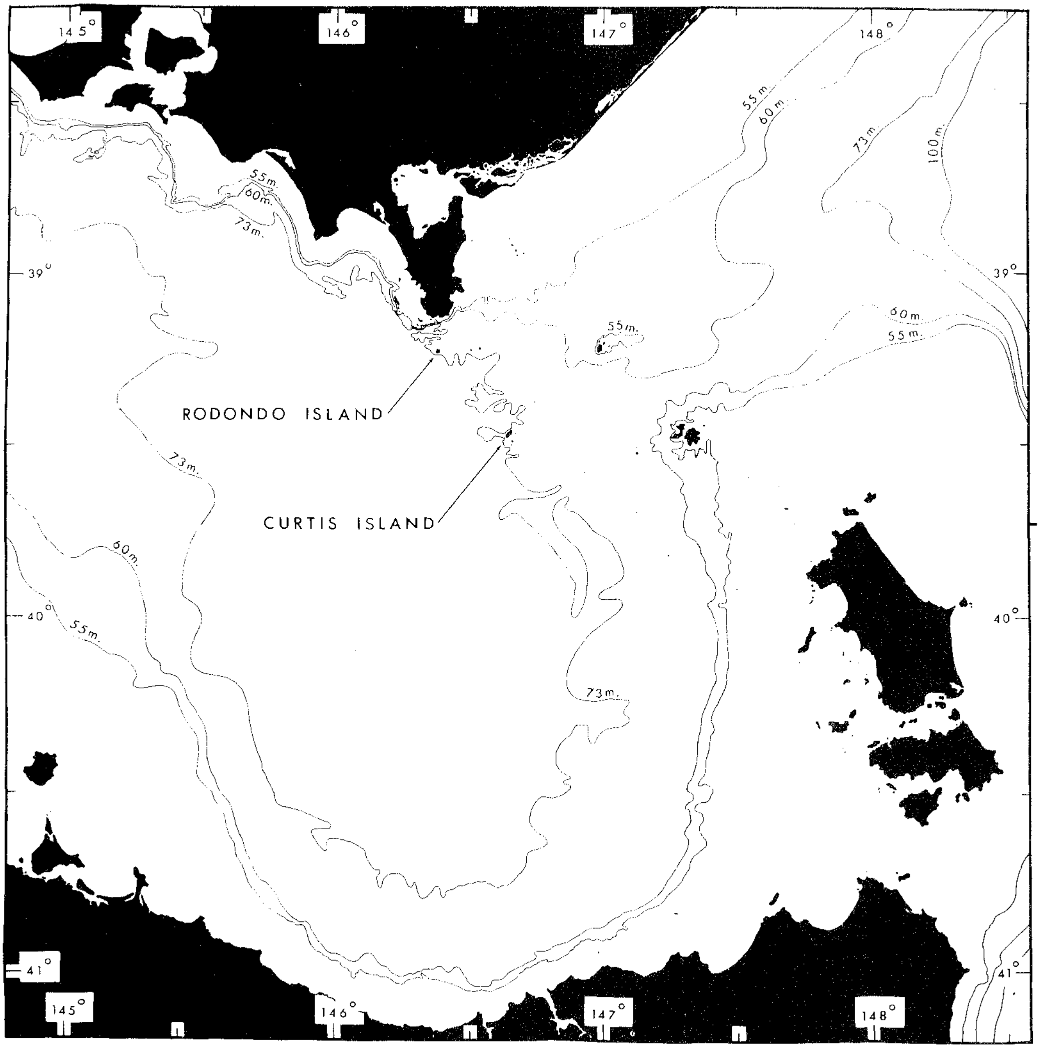

FIG. 1 - Bass Strait showing position of Curtis and Rodondo Islands in relation to the submarine contours and the coastlines of Victoria and Tasmania. (Sources: Jennings 1959; Australian and Admiralty Charts).

these islands as there appear to be no amphibians or mammals and the birds are highly vagile, the present avifauna probably resulting from many invasions and colonizations since the ice age ended. After listing the reptiles of the islands and detailing what is known of their ecology, it is proposed to discuss the available data and attempt to reconstruct the major changes that occurred during and after the ice age.

ECOLOGICAL REQUIREMENTS OF REPTILES

To understand the main ecological requirements of reptiles it is essential to know something of their biology. Body temperature regulation is the only major adaptive function for which reptiles lack physiological (internal) controls. They

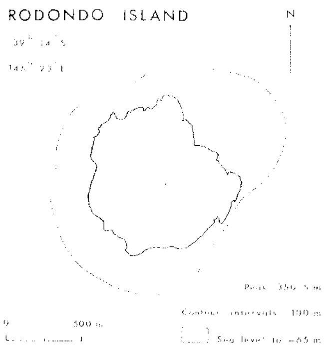

FIG. 2 - Rodondo Island, contour map. (Source: Department of National Development Division of National Mapping. Deal Island Sheet SJ55-15: 8119.I. 1965).

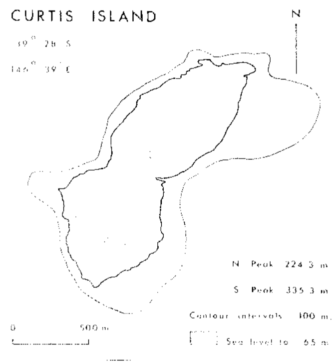

FIG. 3 - Curtis Island, contour map. (Source: Department of National Development Division of National Mapping. Deal Island Sheet SJ55-15: 8219.III.1965).

TABLE 1

Bass Strait Islands and Island Groups in order of depth of surrounding water and estimated time of isolation.

Island/Island Group	Location	Depth (metres)	Time of Isolation (Years Before Present)
(Minimum sea level)	-	100-150 m.	20,-18,000 y. B.P.
(King Island/Cape Otway)	W.Bass Strait	80 m.	14,750 y. B.P.
CURTIS ISLAND	E.Bass Strait	73 m.	14,000 y. B.P.
RODONDO ISLAND	E.Bass Strait	73 m.	14,000 y. B.P.
West Moncoeur Island	E.Bass Strait	64 m.	13,000 y. B.P.
East Moncoeur Island	E.Bass Strait	64 m.	13,000 y. B.P.
TASMANIA	E.Bass Strait	60 m.	12,750 y. B.P.
Albatross Island	W.Bass Strait	55 m.	12,000 y. B.P.
Hogan Group	E.Bass Strait	55 m.	12,000 y. B.P.
Kent Group	E.Bass Strait	50 m.	11,750 y. B.P.
King Island	W.Bass Strait	50 m.	11,750 y. B.P.
Furneaux Group	E.Bass Strait	32 m.	10,000 y. B.P.
(Present sea level)	-	0 m.	5,000 y. B.P.

must rely on environmental (external) factors for the maintenance of body temperature. All reptile species have innate (inherited) behaviour patterns which cause them to select the most suitable environmental conditions. When conditions are favourable, reptiles become active and select thermal zones which enable them to maintain relatively constant body temperatures. During the period of activity reptiles keep their body temperatures within well defined limits, (Brattstrom 1965). At the upper end of the scale lies the "Voluntary Maximum" temperature; if body temperature reaches this level the reptile actively seeks a cooler area. At the lower end of the scale lies the "Voluntary Minimum" temperature; if body temperature falls to this level the reptile either actively seeks a warmer area or retreats to its microenvironment and becomes inactive. The range of body temperatures between the Voluntary Maximum and Minimum is known as the "Normal Activity Range", and this is a characteristic of each species. Reptiles can be divided into two groups depending on the method they use for maintenance of body temperature during activity:

1. Heliotherms (basking reptiles) use the energy in solar radiation to elevate body temperature; thus they can remain active in low environmental temperatures if they have access to sunshine.
2. Thigmotherms (non-basking reptiles) simply select suitable temperatures in shaded situations; thus they are limited directly by ambient temperatures.

Heliotherms are pre-adapted to cold areas as they can maintain high body temperatures in low environmental temperatures.

When environmental conditions become unfavourable for activity (e.g. too hot or too cold) reptiles seek out a suitable "microenvironment", such as under a log or rock, and they may remain inactive in this moderated shelter for hours, days or months until conditions become favourable once more.

All living reptiles have descended from "oviparous" or egg-laying forms in which an egg shell is deposited around the egg after fertilization and the egg is laid almost immediately in a warm, well-aerated and humid site where embryonic development takes place. Oviparous reptiles, however, are at a disadvantage in many habitats as there are no suitable egg nest sites or the climate is too variable to allow development to proceed normally. Thus in many reptile species, especially those from the higher altitudes and latitudes(i.e. colder areas) there has been a tendency to abandon egg-laying and become live-bearing so the developing embryos are incubated within the body of the mother during her normal thermoregulation. The live-bearing condition was initially achieved by "ovovivipary" where the egg shell is deposited after fertilization, but the eggs are retained in the oviduct until the embryos have reached an advanced state and the eggs hatch soon after they are laid. The most advanced reptiles are fully "viviparous", no egg shell is deposited after fertilization, the egg is retained in the uterus and the chorion and allantois become attached to the uterine wall forming a "placenta" and allowing exchange of materials with the maternal blood stream. Thus a live-bearing mode of reproduction (especially vivipary) is another important adaptation of reptiles to cold climates as it eliminates the need for an egg nest site and allows active incubation of the embryos.

REPTILE FAUNA

Apart from navigational references in the "Australian Pilot Volume 2"(Ritchie 1969) and the "Sailing Directions for Victoria including Bass Strait" (Wagglen 1970) there is very little information on Curtis or Rodondo Islands. Several natural history articles on Rodondo Island were published after the first recorded landing in January 1947 (Anon 1947; Bechervaise 1947a, 1947b; Chisholm 1947; Willis 1947). Only two of these articles (Anon 1947; Bechervaise 1947a) contain any information about reptiles and neither author positively identifies the species discussed.

Data on the reptiles of Curtis Island have come from collections and observations made by the author and others during the visit of the McCoy Society from 8-15 February 1971. Limited collections from Rodondo Island were made by the Geelong College expeditions of January 1947 and December 1970. Additional information on the reptiles of Rodondo Island has been obtained from the natural history accounts mentioned above and observations of one member of the second expedition (J.B. Kirkpatrick).

In all, four species representing four genera and two families have been recorded from Curtis Island, and three species representing three genera and one family have been recorded from Rodondo Island. Further collecting is needed from Rodondo Island before the species list can be considered accurate and complete. However, it is considered that the list for Curtis Island is final. All species collected on the islands are fairly extensively distributed on other Bass Strait islands, Tasmania, and/or the southern Australian mainland. One species from Rodondo Island, *Sphenomorphus tympanum* (cool temperate form) belongs to a species complex which has been discussed in some detail elsewhere (Rawlinson 1969, 1971b).

In the following account of reptiles from Curtis and Rodondo Islands, data for each species are presented under five headings:

1. Specimens examined: Includes the registration numbers, localities and sexes (where possible) of all specimens catalogued in the collections of the University of Melbourne Zoology Department (MUZD) and the National Museum of Victoria (NMV).
2. Literature records: Includes all known literature records for Curtis and Rodondo Islands.
3. Habitat : Describes the island habitats utilized by the species during periods of activity and the microenvironments utilized for shelter during periods of inactivity.
4. Ecology : Describes the method of behavioural thermo-regulation employed by the species; the mode of reproduction; major food source; predators; and any interesting features. The Normal Activity Range (Voluntary Minimum to Voluntary Maximum) and mean activity body temperatures of all Curtis and Rodondo Island species are known from laboratory measurements made in a thermal gradient. Also the litter sizes of these species are known as a result of observations carried out over many years. These details are given in Table 2. However, it must be remembered that they only refer in part to Curtis and Rodondo Island specimens.
5. Distribution: Gives the general distribution of the species based on the authors collecting in south-eastern Australia, examinations of Museum collections and reliable literature records.

The reptiles of Curtis Island do not show any altitudinal stratification, specimens of all species were taken within 20 m of sea level on the northern end of the island and above 320 m on the highest peak at the southern end of the island. Presence or absence of a species at any locality appears to depend only on the availability of suitable habitat. Although there is no information on Rodondo Island, it would be reasonable to assume the situation is similar there.

The taxonomic scheme used here for the family Scincidae is the same as that adopted by Rawlinson (1971a, 1971b). McDowell (1967, 1968, 1969a, 1969b, 1970) has recently completed a world-wide generic revision of snakes belonging to the family Elapidae. His revisions resulted in many generic changes for Australian snakes and these are adopted here.

The generic changes for elapid snake species mentioned in this paper from those used previously by the author (e.g. Rawlinson 1971a, 1971b) are as follows:

Denisonia coronoides	becomes	*Drysdalia coronoides* (Gunther 1858)
Denisonia flagellum	"	*Suta flagellum* (McCoy 1878)
Denisonia nigrescens	"	*Cryptophis nigrescens* (Gunther 1862)
Denisonia superba	"	*Austrelaps superba* (Gunther 1858)
Demansia textilis	"	*Pseudonaja textilis* (Dumeril & Bibron 1854)

SQUAMATA

LACERTILIA

SCINCIDAE

LYGOSOMINAE

Leiolopisma Dumeril & Bibron 1839

Leiolopisma metallicum (O'Shaughnessy 1874)

Metallic skink

Specimens examined: (MUZD) Curtis Island: 29 adult males (Nos. 67/71 - 93/71, 111/71, 112/71); 17 adult females (Nos. 94/71 - 110/71) 110/71 is pregnant and contains two fully formed embryos; 9 sub-adults (Nos. 113/71 - 121/71); 4 recently born juveniles (Nos. 122/71 - 125/71); 7 adults sex not determined (Nos. 126/71 - 132/71: Rodondo Island: 1 adult female (No. 712/70) this specimen is pregnant and contains

TABLE 2.

THERMOREGULATION AND REPRODUCTION OF CURTIS AND RODONDO ISLAND REPTILE SPECIES

Species	Method of Thermo-regulation	Thermoregulation: Normal Activity Temperatures °C. Voluntary Minimum	Mean	Range of Body (Mean values) Voluntary Maximum	N*	Reproduction: Mode of Repro-duction	Litter Size Mean	Range	N*
L. metallicum	Shuttling Heliotherm	22.4	29.0	35.1	8	Viviparous	3.7	1-7	33
L. bougainvilli	Thigmotherm	21.6	30.7	38.0	4	"	2.7	2-4	10
S. tympanum	Shuttling Heliotherm	22.5	29.1	34.6	16	"	3.7	1-8	67
E. whitei	Posturing Heliotherm	29.5	33.6	37.3	12	"	2.8	1-5	27
D. coronoides	Shuttling Heliotherm	24.8	31.1	37.7	4	"	5.9	3-8	9

* N = Number of specimens examined.
Values from specimens collected outside Curtis and Rodondo Islands included.

six embryos in an early stage of development; 1 sub-adult (No. 713/70); these two specimens collected on 20/xii/70: (NMV) Rodondo Island: 2 adults sex not determined (Nos. D7878, D7972); these two specimens collected on ?/i/47.

Literature records: Rodondo Island (Bechervaise 1947a as *Leiolopisma* (prob. *metallicum*); Rodondo Island (Rawlinson 1971b).

Habitat: Most commonly found around rocky outcrops in well vegetated *Poa* and *Stipa* grasslands, *Disphyma* herbfields, *Melaleuca* low closed-forest and *Eucalyptus* open forest. In the latter two forest types fallen logs and the trunks and lower limbs of large trees are also utilized. During activity metallic skinks use the exposed surfaces of the logs and rocks for basking sites and the vegetation for foraging; when inactive they exploit microenvironments under rocks, logs or dense mats of rotting vegetation.

Ecology: Metallic skinks are shuttling heliotherms; when active in low ambient shade temperatures they spend most of the time basking; at intermediate ambient temperatures they shuttle between sun and shade, basking for a brief interval to elevate body temperature, then foraging in the shade until body temperature falls almost to the Voluntary Minimum forcing them to return to the basking site; in high ambient temperatures (above the Voluntary Minimum) they have no real need to bask and may forage continuously in the shade. The young are born alive in early to mid February and Weekes (1935) reported the presence of placentae in pregnant females proving the species to be viviparous. Soft bodied insects form the main part of the diet of metallic skinks although they are omnivorous and will eat suitable plant matter when it is available. White-lipped snakes (*D. coronoides*) are the main predators on Curtis Island (see later). It is known that adult White's skinks (*E. whitei*) eat juveniles. On Rodondo Island southern water skinks (*S. tympanum*) may also prey on adults and juveniles (see later).

Distribution: This species is found on almost every Bass Strait island, certainly it is known from all the islands where reptiles have been recorded. On Tasmania and the Tasmanian Islands it is the commonest and most widely distributed lizard. The distribution on the Australian mainland, however, is limited to southern Victoria and the species has only been found in West Gippsland, the eastern side of Port Phillip Bay, Mud Island and the Barwon Heads area.

Lerista Bell 1883
Lerista bougainvilli (Gray 1839)
Bougainvilles skink

Specimens examined: (MUZD) Curtis Island: 4 adult males (Nos. 133/71 - 137/71); 10 adult females (Nos. 138/71 - 147/71). 142/71, 143/71, 144/71, 145/71 and 146/71 are pregnant and contain four, two, three, two and two fully formed embryos respectively; 1 sub-adult (No. 148/71); all the above specimens collected between 8-14/ii/71.

Literature records: Nil.

Habitat: Found only in loose sandy soil under flat rocks, logs or mats of rotting vegetation. When active the lizards seek out suitable thermal zones in the soil or under cover, simultaneously foraging for food. During the currency of unfavourable environmental conditions they burrow deep into the loose soil under large flat rocks, large logs or thick mats of vegetation, and remain inactive in these micro-environments.

Ecology: Bougainvilles skinks are burrowing thigmotherms and they thermoregulate simply by following the optimal temperature zones in sub-surface layers, thus the species is limited directly by soil temperatures. Live young are produced from mid to late February and although the presence of a placenta has not yet been recorded, they are almost certainly viviparous as the embryos in the uterus are not surrounded by an egg shell. The food consists entirely of small soft bodied invertebrates. This species is probably only very rarely preyed upon for its cryptic habits would keep it well out of reach of the available predators most of the time.

Distribution: Widely distributed in eastern Bass Strait, having been recorded from islands in the Curtis, Kent and Furneaux Groups, and Swan and Waterhouse Islands off north-eastern Tasmania. The only known Tasmanian population is on Cape Portland in the north east. On the Australian mainland the species occurs in many disjunct southern localities between the 15 and 25 inch isohyets in south-eastern South Australia, Kangaroo Island and Victoria.

Sphenomorphus Fitzinger 1843
Sphenomorphus tympanum (Lonnberg & Andersson 1913)
(Cool Temperate Form)
Southern water skink

Specimens examined: (MUZD) Rodondo Island: 1 adult, sex not determined (No. 714/70); this specimen, collected on 20/xii/70, is a mummified corpse, thus the species record must be regarded as tentative until live specimens have been positively identified from the island. J.B. Kirkpatrick observed many lizards of similar size and colouration in the *Melaleuca* low closed-forest and *Eucalyptus* open-forest. It is probable these observations were of living specimens of *S. tympanum* as the other two Rodondo Island lizards differ in size or colouration; *L. metallicum* being much smaller; *E. whitei* is about the same size but has a very different colour pattern.

Literature records: Nil.

Habitat: As this species does not occur on Curtis Island and there must be some doubt about its presence on Rodondo Island, no reliable information can be given about island habitats. The species is extremely common on adjacent Wilson's Promontory where it occurs mainly in rocky or log strewn clearings in forested areas, even extending into the supra-littoral zone where the forests descend onto the coast. Like metallic skinks (see above) they use the exposed surface of logs and rocks for basking sites, and forage in the surrounding vegetation; when inactive they exploit microenvironments in and under decomposing logs, under rocks and in deep litter.

Ecology: Southern water skinks are shuttling heliotherms and their thermoregulatory behaviour resembles that of metallic skinks closely (see section above on the Ecology of *L. metallicum* for details). The young are born alive from mid February to mid March and Weekes (1927b) reported the presence of placentae in pregnant females proving the species to be viviparous. They are omnivorous and opportunistic in their feeding habits, but soft bodied insects form the main part of the diet. In the absence of white-lipped snakes, water skinks would not have a serious predator on Rodondo Island. Water skinks have an extremely aggressive nature, any lizard entering the territory of an adult is pursued; if the intruder is captured a fight ensues and this almost invariably results in the death of the intruder if it is smaller than the aggressor. The victim may be eaten if it is very small, and the discarded tails of larger victims are occasionally eaten.

Distribution: This species is not known from any other Bass Strait Island or Tasmania. It is widespread on the south-eastern Australian mainland, occurring in the highlands of southern New South Wales and Victoria from the Jenolan area, Blue Mountains (N.S.W.) southward. *S. tympanum* also occurs in the forested lowland areas of Victoria from Stradbroke (W. Gippsland) to Mt. Richmond (SW. Victoria).

SCINCINAE
Egernia Gray 1838
Egernia whitei (Lacepede 1804)
Whites skink

Specimens examined: (MUZD) Curtis Island: 5 adult males (Nos. 56/71 - 60/71); 8 adult females (Nos. 48/71 - 55/71), 48/71, 49/71, 50/71, 51/71, 52/71 and 53/71 are pregnant and contain three, three, two, three, two and three fully formed embryos respectively; 6 sub-adults (Nos. 61/71 - 66/71); all the above specimens collected between 8-15/ii/71.

Literature records: Rodondo Island, reference to *Egernia* sp. plus photograph of adult *Egernia whitei* taken on Rodondo Island (Bechervaise 1947a as *Egernia* sp.).

Habitat: Occur mainly in open rocky areas strewn with loose flat rocks (or sometimes logs) and surrounded by *Poa* or *Stipa* grasslands, *Melaleuca* low closed-forest or *Eucalyptus* open forest. When active, Whites skinks use the exposed rock surfaces for basking sites and forage for food over the rock surfaces, under rocks and in the surrounding vegetation; they construct tunnels in soil under loose rocks or logs and use these for microenvironments when inactive.

Ecology: White's skinks are posturing heliotherms; they maintain high body temperatures during activity (table 2) and do not emerge from shelter until ambient temperatures are fairly high; after emergence they thermoregulate by simple changes in body posture on the exposed basking site and they may forage about the rock surface; at high ambient temperatures (above mean body temperature) basking ceases and they forage in the shade under rocks or in vegetation. The young are born alive in mid to late February and Weekes (1927a, 1930) reported the presence of placentae in pregnant females proving the species to be viviparous. These large skinks are omnivorous but largely insectivorous, their powerful jaws and sharp cutting teeth enable them to crush hard bodied beetles, roaches etc. which shelter under the rocks. On Curtis Island white-lipped snakes *(D. coronoides)* prey on juveniles, the adults have no serious predators. Whites skinks are communal, each suitable area of rock having a small social group.

Distribution: Widely distributed in Bass Strait, having been recorded from: islands in the Curtis, Hogan, Kent and Furneaux Groups, Swan and Waterhouse Islands in eastern Bass Strait; King Island and islands in the Hunter Group in western Bass Strait. In Tasmania it is restricted to the north and east. On the south-eastern Australian mainland *E. whitei* is widely distributed in coastal and highland regions from Grafton (N.S.W.) to south-eastern South Australia, Kangaroo Island, and the Yorke and Eyre Peninsulas (S.A.).

OPHIDIA
ELAPIDAE
ELAPINAE
Drysdalia Worrell 1961
Drysdalia coronoides (Gunther 1858)
White-lipped snake

Specimens examined: (MUZD) Curtis Island: 3 adult males (Nos. 150/71 - 152/71); 2 adult females (Nos. 149/71, 153/71) both specimens are pregnant and they contain eight and six fully formed embryos respectively; 1 adult sex not determined (No. 154/71); all the above specimens collected between 8-15/ii/71.

Literature records: Nil. It is almost certain that the species is absent from

Rodondo Island as Bechervaise states "No snakes were seen, though a search was made for them" (in Anon. 1947).

Habitat: Specimens were observed in all vegetation types, but they were most abundant in *Poa* and *Stipa* grasslands around the margins of rocky outcrops and *Melaleuca* low closed-forests. During activity white-lipped snakes use grass tussocks for basking sites. When basking they coil up tightly on a tussock so all the body receives solar radiation, and this is how most of the specimens observed on the island were found. When foraging for food white-lipped snakes usually move around under the cover of dense vegetation or rocks, occasionally they venture into the open e.g. on *Disphyma* herbfields but this exposes them to predation by Pacific Gulls *(Larus pacificus)* and three specimens killed in this way were found during the visit of the McCoy Society. When inactive white-lipped snakes utilize microenvironments under dense layers of grass, deep litter or decomposing logs lying on the soil.

Ecology: White-lipped snakes are shuttling heliotherms (see section above on the ecology of *L. metallicum* for details); they do not emerge from shelter until ambient temperatures are fairly high (approaching the Voluntary Minimum); after emergence they thermoregulate by shuttling between sun and shade until ambient shade temperatures exceed mean body temperature when they forage for food in the shade. The young are born alive from late February to mid April and although the presence of a placenta has not yet been recorded, they are almost certainly viviparous as the embryos in the uterus are not surrounded by an egg shell. They are carnivorous and take only live food; metallic skinks form the main part of the diet although juvenile Whites skinks are also taken. As mentioned above, white-lipped snakes are preyed upon by pacific gulls (*Larus pacificus*)(and possibly silver gulls *Larus novae-hollandiae*) when they move across open ground.

Distribution: Widely distributed in Bass Strait, having been recorded from islands in the Curtis, Kent and Hogan Groups in eastern Bass Strait and King Island in western Bass Strait. Found all over Tasmania except in tall closed-forest. On the Australian mainland it is found in coastal and highland regions of the south-east from Sydney (N.S.W.) southwards to Mt. Gambier (S.A.).

DISCUSSION

It was stressed earlier that Curtis and Rodondo Islands are steep sided granite outcrops isolated by deeper water than Tasmania or any other island in Bass Strait. These facts are of great importance when considering the origins of the present terrestrial ecosystems because of climatic and sea level changes that occurred during the Pleistocene epoch.

Five major world-wide Pleistocene glacial phases (in order, the Nebraskan, Kansan, Illinoian, Early and Late Wisconsin) have been recognized (Ericson and Wollin 1968). During each glacial there was a lowering of surface temperatures around the world, polar ice caps and continental ice sheets expanded and the vast amount of water locked up in ice caused a eustatic drop in sea level. Sea level fell below minus 80 m in the Illinoian and Early and Late Wisconsin glacials (Fairbridge 1960, 1961; Jennings 1971). Thus Tasmania and the Bass Strait islands would have been connected to the Australian mainland at these times by an extensive landbridge (the "Bassian Isthmus") as nowhere in Bass Strait do depths exceed 80 m. Curtis and Rodondo Islands would have formed high and rugged granite hills on this landbridge and they would have been the first islands isolated as sea level rose at the end of each glacial phase.

Reptiles are the only completely terrestrial vertebrates known from Curtis and Rodondo Islands so the data presented above are considered to be important biogeographically. In the discussion below an attempt is made to reconstruct the major changes that occurred during and after the most recent glacial phase and show how these changes have affected reptiles and the terrestrial ecosystems (see also Rawlinson 1967, 1971b).

The palaeogeography of Curtis and Rodondo Islands

It is now recognized that there is evidence of only one really intense and extensive glacial phase in Australia and Tasmania, its effects possibly covering or

PLATE 1A - *Poa poiformis* tussock grassland on Curtis Island with some *Melaleuca armillaris* on ridges. All reptile species occur in the vegetation form, but are concentrated around the scattered rocky outcrops.

PLATE 1B - *Stipa teretifolia* tussocks with *Carpobrotus rossii* and bare rock near coast on north end of Curtis. The lack of continuous ground cover exposes white-lipped snakes to predation by Pacific Gulls *(Larus pacificus)*.

obliterating those of earlier phases (Costin 1971; Davies 1967; Galloway 1965, 1971; Jones 1968; Peterson 1968, 1971). The freshness of the glacial deposits in Australia and Tasmania, and carbon dates quoted by Costin (1971), Gill (1956) and Peterson (1968) prove this major phase to be the Late Wisconsin and indicate it started about 32,000 years B.P. and ended about 9,000 years B.P. Therefore here we need only consider changes during and after the most recent glaciation.

Sea level. The Late Wisconsin glacial eustatic lowering of sea level commenced about 40,000-35,000 years B.P. (Milliman and Emery 1968) and reached its peak 20,000-18,000 years B.P. when the sea lay 100-150 m below the present level (Jennings 1971). As the glacial ice melted, sea level rose rapidly from 17,000 to about 5,000 years B.P. when the present coastline was attained. Estimates are available for the rate of rise in sea level during this time (Fairbridge 1960, 1961, 1967; Godwin, Suggate and Willis 1958; Shepard 1964), from these it is possible to obtain a mean time for the isolation of each Bass Strait island or island group as the maximum depths separating the present Bass Strait land masses are known (table 1.). The most important estimates show that Curtis and Rodondo Islands were isolated about 14,000 years B.P. when sea level lay at minus 73 m and Tasmania was isolated about 12,750 years B.P. when sea level lay at minus 60 m. Jennings (1971) has discussed and estimated the times for the final drowning of three Bass Strait land links in some detail. He pointed out that physical processes may affect such estimates (e.g. tectonic activity, submarine erosion and deposition) but concludes these processes have been negligible in Bass Strait in recent times. Jennings prefers the use of ranges of dates and depths rather than means for indicating times of isolation, unfortunately he does not provide all the information needed here, but his figures (Victoria/Flinders Island 55-64 m, 12,000-13,000 years B.P.; King Island Tasmania 46-55 m, 10,000-12,500 years B.P.; Flinders Island/Tasmania 27-37 m, 8,500-10,000 years B.P.) are close to the estimates given in Table 1.

Milliman and Emery (1968) provide a time curve for the fall and rise in sea level over the last 35,000 years. This curve shows how long the sea lay below a certain level, making it possible to estimate the time of exposure of land links. From their results it appears Bass Strait was dry for about 7,000 years; Curtis and Rodondo Islands were land-locked for about 8,250 years; and Tasmania was linked to Australia for about 9,750 years. If these estimates are accurate, the land connections were only maintained while southern Australia was being subjected to a glacial climate.

Altitudinal stratification. The most important high altitude zones during glaciations would have been (after Costin 1959, 1971; Galloway 1965):

1. Glacial zone: above the permanent snow-line, ice covers surface all the year, no vegetation.
2. Periglacial zone: soil freezes in winter and thaws in summer, no vegetation.
3. Alpine zone: above the tree-line, ground continuously covered with snow for more than four months each year, vegetation low and stunted.
4. Sub-alpine zone: below the tree-line, ground continuously covered with snow for one to four months each year, vegetation woodland dominated by low, cold-tolerant trees such as *Eucalyptus pauciflora* or *E. coccifera* (Jackson 1965).
5. Montane zone: below the permanent winter snow-line, snow lies on ground for short periods only, vegetation variable, if precipitation is high enough tall open-forest forms.

Estimates are available for the altitudes of these zones in Tasmania during the Late Wisconsin (Davies 1967; Galloway 1965; Jones 1968; Peterson 1968). The glacial limit (which depends on snowfall and temperature) rose from 600 m in the south-west to 1,350 m in the north-east Periglacial zones (which depend only on temperature) were extensive, Davies (1967) summarizing the available data states "...... all the country above 600 metres was subjected to periglacial solifluction and this limit commonly fell to 450 metres and sometimes to 300 metres". The tree-line lay about 100 m below the periglacial limit (Galloway 1965), thus alpine limits lay at 500 to 200 m. Below the alpine zone, sub-alpine woodlands would have extended for the next 100 to 300 m (Costin 1959). Thus the montane zone, if it occurred, did not extend above 400 m, and sub-alpine woodlands may in places have descended to sea level (i.e. the glacial low sea level).

Galloway (1965) suggests the periglacial limits in Tasmania did not rise rapidly from south to north and he points out that in south and central New Zealand the limits fell from south to north. Jones (1968) quotes records of periglacial deposits down to (and possibly below) 300 m in north-eastern Tasmania. He states that the geologist who recorded these deposits calculated the tree-line in north-eastern Tasmania lay at 200 m. Curtis and Rodondo Islands both rise above 300 m, therefore it is likely the tops were in the periglacial zone and Mr. N. Rosengren (pers. comm.) found probable evidence of periglacial activity in a sheltered frost hollow just below the peak on Curtis Island. If the tops of Curtis and Rodondo Islands above 300 m lay in the periglacial zone, then the tree-line would have started at about 200 m. Arboreal vegetation occurring below this level would have been sub-alpine woodland (dominated by cold tolerant trees such as *Eucalyptus pauciflora* or *E. coccifera*) and this could have extended over the next 100 to 300 m i.e. right to the edge of the "plunging cliffs". The steepness of these cliffs would have prevented any extensive vegetation forms (especially forest or woodland) from becoming established above the present minus 65 to 70 m submarine contour (fig. 3).

If the above assessment is correct, it is unlikely that the present vegetation (especially the forest forms) could have occupied these areas during the glacial period, and the areas above the "plunging cliffs" must have been substantially or completely re-vegetated. Particular attention should be paid to the presence of *Melaleuca armillaris* low closed-forest on these islands. This sub-tropical form is otherwise restricted to east coastal areas of the Australian mainland, the nearest record being 312 km to the north-east (Kirkpatrick, Massey and Parsons this volume). Thus *M. armillaris* is most unlikely to be a glacial relict, and should be considered as a post-glacial intrusive. Similarly the *Eucalyptus* open-forest on Rodondo Island (composed of *Eucalyptus* aff. *globulus*) is probably a post-glacial intrusion.

Temperature. The decrease in mean air temperatures for southern Australia during the Late Wisconsin have been estimated by several workers: Galloway (1965) calculated mean temperatures were 9°C lower in the Snowy Mountains (N.S.W.) and 5°C Lower in Tasmania; Dury (1967) considers the depression was between 8° and 10°C in SE. Australia; Costin (1971) calculated mean temperatures were 8.3° to 11°C lower on the Monaro Tableland (N.S.W.). These values agree with the world-wide estimates of minimal temperature decreases (5° to 7°C, Littlejohn 1967). Thus it appears safe to assume that mean temperatures fell by at least 5°C near sea level and up to 11°C at the higher altitudes (above 1,500 metres).

RAINFALL AND WINDS. It was assumed that Australian glacial periods were pluvial periods until Galloway (1965) put forward the idea that glacial climates were cold and dry. The problem is still unresolved (see for example Littlejohn 1967 p. 165 and Galloway 1971 pp. 21-22). Carbon dated climatic sequences worked out for alluvial deposits from Keilor, southern Victoria (Bowler 1970) and the Riverine Plains of south-central New South Wales (Pels 1971) both suggest an arid period at the time of the glacial maximum (between 26,000 and 12,000 years B.P.). The sequence Bowler worked out for Keilor bears further consideration as it is the only one available for the Bass Strait area:

Pre 31,000 years B.P.	Low temperature - Low rainfall?
31,000-17,000 " "	Low temperature - Low evaporation
17,000-15,000 " "	Higher temperatures <u>and</u> Low rainfall
15,000-12,000 " "	High temperature <u>or</u> Low rainfall
12,000- 6,000 " "	Low temperature <u>or</u> High rainfall
6,000-Present " "	High temperature <u>or</u> High rainfall (as at present)

There is no evidence for a post-glacial drop in temperature from 12,000 to 6,000 years B.P.. Peterson (1968) reports that the high south-western Tasmanian glaciers were retreating (and therefore the climate was warming) by 9,000 years B.P.; thus the effects recorded by Bowler were most likely caused by high rainfall. Pollen diagrams prepared from carbon dated peat deposits on Wilson's Promontory reveal that the vegetation, and therefore the climate, of the areas has shown no major change over the last 6,000 years (Hope 1968; Howard and Hope 1970). This conclusion is in general agreement with the latter segment of Bowler's climatic sequence for Keilor. Wilson's Promontory is the western limit of several mesothermal plant species (Ashton 1969; Willis 1971) and some of these such as *Eugenia smithii* are mesic forms (Howard and Hope 1970) inferring invasion and colonization in a post-glacial period before 6,000 years B.P. The large disjunction of the *Melaleuca armillaris* stands on Curtis and Rodondo Islands from those in East Gippsland could also be explained in terms of an expansion of range in a post-glacial pluvial period followed by disjunction in a subsequent arid period.

Davies (1967) and Peterson (1968) have shown from estimates of the Late Wisconsin glacial snow-line that the present precipitation gradient in Tasmania was maintained. This gradient results from the prevailing westerly wind system, thus this system must have continued to influence Tasmania and the Bass Strait area throughout the glaciation and the glacial precipitation would have shown a winter maximum. Davies pointed out that the glacial snowline trends south-west to north-east while the present precipitation gradient trends north-west to south-east; he considered this may have been due to an increase in the north-westerly (rain bearing) winds and a decrease in the south-westerly (snow bearing) winds in the post-glacial period.

COMPARISON OF THE CURTIS AND RODONDO ISLAND REPTILE FAUNAS WITH THOSE OF THE OTHER BASS STRAIT ISLANDS, TASMANIA AND SOUTH-EASTERN AUSTRALIA.

The distribution of reptiles on the major Bass Strait island (excluding Curtis and Rodondo Islands) has been discussed previously (Rawlinson 1967, 1971b). The most important points to emerge from these discussions are:

1. The reptile faunas of the Bass Strait islands are apparently derived from the same source and they are closely allied to the present day Tasmanian reptile fauna. These reptiles are apparently relicts of the fauna occupying the "Bassian Isthmus" at the time Tasmania was isolated from Australia (12,750 years B.P.), i.e. the present Bass Strait island reptiles are considered to be glacial relicts.
2. In southern Victoria there are many reptiles not found on the Bass Strait islands or Tasmania. Seven of these species (*Anotis maccoyi, Leiolopisma guichenoti, L. mustelinum, L. weekesae* (?), *Sphenomorphus tympanum* cool temperate form, *Pseudemoia spenceri* and *Notechis scutatus*) are common in southern Victoria and all occur in the areas closest to the old landbridge (i.e. the Cape Otway and/or Wilson's Promontory areas). These species are considered to have moved into southern Victoria since the landbridge broke (12,750 years B.P.), i.e. they are post-glacial intrusives.

The distribution of Curtis and Rodondo Island reptile species on the Australian mainland, all the major Bass Strait islands or island groups and Tasmania is shown in Table 3. From the table it can be seen that one of the Rodondo Island species, *Sphenomorphus tympanum* (cool temperate form), does not occur on any other Bass Strait island or Tasmania. Thus it does not appear to be a glacial relict, and it is one of the seven southern Victorian species that has previously been described as a post-glacial intrusive (see above). *S. tympanum* is abundant on Wilson's Promontory only 9.8 km to the north where it occurs in forested areas right down to the coast. Logs are frequently used for shelters during periods of inactivity; thus the species is likely to disperse across the water gap in log "rafts" that wash out to sea. In addition the species is viviparous and females store sperm so there is the possibility of a single inseminated female making the crossing successfully and establishing a population.

The other four species found on Rodondo and/or Curtis Islands are fairly widespread on the Bass Strait islands and Tasmania (table 3) and they can be considered as glacial relicts. Three of these species, *Leiolopisma metallicum*, *Egernia whitei* and *Drysdalia coronoides*, are widespread on the Bass Strait islands, Tasmania and south-eastern Australia (including Wilson's Promontory). All three species occur in open habitats ranging from coastal grasslands to sub-alpine woodlands above 1,500 m, and all are viviparous heliotherms. Thus the present distributions and adaptations of these species indicate they could have survived the glacial conditions outlined above for Curtis and Rodondo Islands.

TABLE 3.
The Distribution of Curtis and Rodondo Island Reptile Species in the Bass Strait Area

Land Mass, Island or Island Group	*Leiolopisma metallicum*	*Lerista bougainvilli*	*Sphenomorphus tympanum*	*Egernia whitei*	*Drysdalia coronoides*
Southern Victoria	+	+	+	+	+
Wilson's Promontory	+	-	+	+	+
Curtis Island	+	+	-	+	+
Rodondo Island	+	-	+	+	-
Direction Group	+	-	-	-	-
Hogan Group	+	-	-	+	-
Kent Group	+	+	-	+	+
Furneaux Group	+	+	-	+	+
King Island	+	-	-	+	+
Albatross Island	+	-	-	-	-
Tasmania	+	+	-	+	+
Total	11	5	3	9	7

The fourth glacial relict species, *Lerista bougainvilli*, is widespread on eastern Bass Strait islands but it is only known from one locality in Tasmania. In south-eastern Australia the species has an extensive but disjunct distribution, populations being restricted to well-drained sandy habitats in areas receiving between 380 and 635 mm of rain per year. The known mainland localities range from central Gippsland and north-eastern Victoria to Kangaroo Island and the Eyre Peninsula in South Australia. *L. bougainvilli* is a burrowing skink and loose sandy soil is an essential habitat requirement, this fact helps explain the disjunct distribution. Bougainvilles skink has been found in suitable habitats from near sea level onto the highest mountains (above 900 m) in western Victoria (e.g. The Grampians). The species is only found in a few dry areas in eastern Victoria and it is absent from the Eastern Highlands (including the montane and sub-alpine areas) perhaps suggesting it could not tolerate a glacial climate. The western Victorian mountains, however, are relatively dry (rainfall only exceeds 1020 mm in a few areas) while the eastern Victorian mountains are very wet (rainfall commonly exceeds 1270 mm) (see rainfall map Rawlinson 1971a). The species is also missing from Wilson's Promontory where it would be expected, in all likely habitats the soil is too moist and compacted to allow burrowing. Wilson's Promontory receives an annual rainfall in excess of 1020 mm (the lighthouse receives 990 mm per year). The rainfall of Curtis Island is probably similar to that of Deal Island which receives 710 mm per year, only 72% of the figure for Wilson's Promontory. The absence of *L. bougainvilli* from the high altitudes in eastern Victoria and also from Wilson's Promontory might be taken to imply the species was not widely distributed in the Bass Strait area during the Late Wisconsin glaciation. However its occurrence on the drier mountain tops in western Victoria and the need for dry sandy soil suggests the species has been eliminated from many former localities in eastern Victoria by a post-glacial increase in rainfall (to levels above 635-760 mm). *L. bougainvilli* is viviparous but thigmothermic and specimens are therefore limited directly by soil temperatures. The species is active for about five months from about November to March and this suggests that during these months in late glacial times (14,000 years B.P.) soil temperatures must have frequently risen above the lizards' Voluntary Minimum of 21.6°C.

Curtis and Rodondo Islands were isolated about 14,000 years B.P. To the north-east and east lie the Hogan and Kent Groups isolated 12,000 and 11,750 years B.P. respectively. Two species of lizards, *Leiolopisma trilineatum* and *Tiliqua nigrolutea*, found on these two island groups do not occur on Curtis or Rodondo Islands. Both species are abundant in habitats that occur on Curtis and Rodondo Islands *(Poa* and *Stipa* grasslands and *Eucalyptus* open-forest). These species are heliothermic, but neither occurs in cold areas (i.e. montane or sub-alpine areas) in Victoria or Tasmania. The main factor which prevents *L. trilineatum* from invading cold areas is that it is oviparous; *Tiliqua nigrolutea* on the other hand is viviparous but it grows to a very large size and has a high Normal Activity Range. The occurrence of these mesothermal species on the Hogan and Kent Groups suggests that the climate may have moderated (warmed) significantly between 14,000 and 12,000 years B.P.

Tasmania was isolated from the Australian mainland about 12,750 years B.P. and seven of the southern Victorian reptile species are thought to be post-glacial intrusives (see above) i.e. they are absent from Tasmania and the Bass Strait islands (except for *S. tympanum* on Rodondo Island). Five of the species, *Anotis maccoyi*, *Leiolopisma mustelinum*, *L. weekesae* (?), *Sphenomorphus tympanum* and *Pseudemoia spenceri*, are forest dwelling forms. They presently occur only in areas where rainfall exceeds 760 mm per year and all have disjunct distributions (see cool temperate zone, map in Rawlinson 1971a). Thus it appears that the ranges of these species have expanded and subsequently contracted in the period after 12,750 years B.P. The remaining two southern Victorian post-glacial intrusive species, *Leiolopisma guichenoti* and *Notechis scutatus*, occur throughout southern Victoria in areas that receive more than 20 inches of rain per year and they show no disjunction (see warm and cool temperate zones, map in Rawlinson 1971a). These data are not inconsistent with the climatic sequence proposed by Bowler (1970) for Keilor and for Wilson's Promontory by Hope (1968) and Howard and Hope (1970), i.e. at the height of glaciation the climate was cold and dry, temperature moderated by 12,000 years B.P. and the climate was warm and wet until 6,000 years B.P. when the present climate was attained.

During the period from 12,000 to 6,000 years B.P. a broad flat coastal plain would have been open between Wilson's Promontory and East Gippsland (inside the 55 m submarine contour Fig. 1). If the period was warm and wet as outlined above, the plain (which would be cut by the 760 and 635 mm isohyets if present rainfall had prevailed) could have allowed the continuous dispersal of mesic and mesothermal plants such as *Melaleuca armillaris* and *Eugenia smithii*. It was shown above that Curtis and Rodondo Islands were unlikely to have carried arboreal vegetation at the time of isolation 14,000 years B.P. and the present trees (*Eucalyptus* aff. *globulus* and *Melaleuca armillaris)* probably became established in a post-glacial period. Thus it is proposed here that these trees became established on the islands in a post-glacial pluvial period which lasted from 12,000 to 6,000 years B.P. when the species ranges on the adjacent mainland were extensive. The mainland distributions have subsequently been broken up in a more arid phase since 6,000 years B.P.

CONCLUSIONS

1. All the Curtis and Rodondo Island reptile species except *Sphenomorphus tympanum* are relicts of the glacial Bassian Isthmus fauna of 14,000 years B.P.
2. The presence of two mesothermal reptile species on the Hogan and Kent Groups and their absence from Curtis and Rodondo Islands suggests a warming of climate between 14,000 and 12,000 years B.P.
3. The presence of seven probable post-glacial intrusive species on Wilson's Promontory and/or Cape Otway suggests a major change in climate since 12,750 years B.P. As five of the species occupy mesic habitats and they now have disjunct distributions, it is considered there was a post-glacial increase in rainfall followed by a decrease. This agrees with carbon dated climatic sequences established for Keilor (to 31,000 years B.P.) and Wilson's Promontory (to

6,000 years B.P.). From these data it is considered there was a cold dry period from 31,000 to 12,000 years B.P., followed by a warm wet period to 6,000 years B.P. and from that time the climate has been warm and dry, much as at present.

REFERENCES

Anon., 1947: Rodondo Adventure. *Wildlife* 9, 86-89.

Ashton, D.H., 1969: Botany of East Gippsland. *Proc. R. Soc. Vict.*, 82, 69-103.

Bechervaise,J., 1947a: Plant and Animal Life on Rodondo Island. *Wildlife* 9, 129-137.

__________, 1947b: The Rodondo Episode. *Vict. Nat.* 64, 18-20.

Bowler, J.M., 1970: Alluvial terraces in the Maribyrnong Valley near Keilor, Victoria. *Mem. Nat. Mus. Vict.*, 30, 15-58.

Brattstrom, B.H., 1965: Body Temperatures of Reptiles. *Am. Midland Naturalist*, 73, 376-422.

Chisholm, A.H., 1947: Comments on Rodondo Birds. *Vict. Nat.*, 64, 20.

Costin, A.B., 1957: The High Mountain Vegetation of Australia. *Aust. J. Bot.*, 5, 173-189.

__________, 1959: Vegetation of High Mountains in Australia in Relation to Land Use. Ch. 26 *in* Keast, A., R.L. Crocker and C.S. Christian (Eds.) *Biogeography and Ecology in Australia.* W. Junk. Den Haag, 427-451.

__________, 1971: Vegetation, Soils and Climate in Late Quaternary Southeastern Australia. Ch. 3 *in* Mulvaney, D.J. and J. Golson (Eds.) *Aboriginal Man and Environment in Australia.* ANU Press, Canberra, 26-37.

Davies, J.L., 1967: Tasmanian Landforms and Quaternary Climates. Ch. 1 *in* Jennings, J.N. and J.A. Mabbutt *Landform Studies from Australia and New Guinea.* ANU Press, Canberra, 1-25.

Dury, G.H., 1967: Climatic Change as a Geographical Backdrop. *Aust. Geogr.*, 10, 231-242.

Ericson, D.B. and Wollin, G., 1968: Pleistocene Climates and Chronology in Deep-sea Sediments. *Science*, 162, 1227-1234.

Fairbridge, R.W., 1960: The Changing Level of the Sea. *Sci. Amer.*, 202, 70-79.

__________, 1961: Eustatic Changes in Sea Level. *Physics Chem. Earth*, 4, 99-185.

__________, 1967: Coral Reefs of the Australian Region. *in* Jennings, J.N. and J.A. Mabbutt (Eds.) *Landform studies from Australia and New Guinea.* ANU Press, Canberra, 386-417.

Galloway, R.W., 1965: Late Quaternary Climates in Australia. *J. Geol.*, 73, 603-618.

__________, 1971: Evidence for Late Quaternary Climates. Ch. 2 *in* Mulvaney, D.J. and J. Golson (Eds.) *Aboriginal Man and Environment in Australia.* ANU Press, Canberra, 14-25.

Gill, E.D., 1956: Radiocarbon dating for glacial varves in Tasmania. *Aust. J. Sci.*, 19, 80.

Godwin, H., Suggate, R.P. and Willis, E.H., 1958: Radiocarbon Dating of the Eustatic Rise in Ocean Level. *Nature*, 181, 1518-1519.

Hope, G.S., 1968: *Pollen Studies at Wilsons Promontory*. Unpublished M. Sc. Thesis. University of Melbourne Botany Department, July 1968.

Howard, T.M. and Hope, G.S., 1970: The Present and Past Occurrence of Beech (*Nothofagus cunninghamii* Oerst.) at Wilsons Promontory, Victoria. *Proc. R. Soc. Vict.*, 83, 199-209.

Jackson, W.D., 1965: Vegetation. *in* Davies, J.L. (Ed.) *Atlas of Tasmania*. Government Printer, Hobart, 30-35.

Jennings, J.N., 1959: The Submarine Topography of Bass Strait. *Proc. R. Soc. Vict.*, 71, 49-72.

______________, 1971: Sea Level Changes and Land Links. Ch. 1 *in* Mulvaney, D.J. and J. Golson (Eds.) *Aboriginal Man and Environment in Australia*. ANU Press, Canberra, 1-13.

Jones, R., 1968: The Geographical Backdrop to the Arrival of Man in Australia and Tasmania. *Archaeol. & Phys. Anthrop. Oceania.*, 3, 186-215.

Kirkpatrick, J., Massey, J. and Parsons, R.F., 1973: Natural History of Curtis Island Bass Strait: 2. Soils and Vegetation with notes on Rodondo Island. *Pap. Proc. R. Soc. Tasm.*, 107, 131-144.

Littlejohn, M.J., 1967: Patterns of Zoogeography and Speciation in Southeastern Amphibia. Ch. 6 *in* Weatherley, A.H. (Ed.) *Australian Inland Waters and their Fauna*. ANU Press, Canberra, 150-174.

McDowell, S.B., 1967: *Aspidomorphus*, a genus of New Guinea snakes of the Family Elapidae with notes on related genera. *J. Zool. Lond.*, 151, 497-578.

______________, 1968: Affinities of the snakes usually called *Elaps lacteus* and *E. dorsalis*. *J. Linn. Soc. (Zool.)*, 47, 561-578

______________, 1969a: Notes on the Australian sea-snake *Ephalophis greyi* M. Smith (Serpentes: Elapidae, Hydrophiinae) and the origin and classification of sea-snakes. *Zool. J. Linn. Soc.*, 48, 333-349.

______________, 1969b: *Toxicocalamus*, a New Guinea of snakes of the Family Elapidae. *J. Zool. Lond.*, 159, 443-511.

______________, 1970: On the status and relationships of the Solomon Island elapid snakes. *J. Zool. Lond.*, 161, 145-190.

Milliman, J.D. and Emery, K.O., 1968: Sea Levels during the Past 35,000 Years. *Science*, 162, 1121-1123.

Pels, S., 1971: River Systems and Climatic Changes in Southeastern Australia. Ch. 4 *in* Mulvaney, D.J. and J. Golson (Eds.) *Aboriginal Man and Environment in Australia*. ANU Press, Canberra, 39-46.

Peterson, J.A., 1968: Cirque Morphology and Pleistocene Ice Formation Conditions in Southeastern Australia. *Aust. Geogrl. Stud.*, 6, 67-83.

______________, 1971: On the Status and Correlation of Pleistocene Glacial Episodes in South-eastern Australia. *Search*, 2, 285-288.

Rawlinson, P.A., 1967: The Vertebrate Fauna of the Bass Strait Islands: 2. The Reptilia of Flinders and King Islands. *Proc. R. Soc. Vict.*, 80, 211-224.

______________, 1969: The Reptiles of East Gippsland. *Proc. R. Soc. Vict.*, 82, 113-128.

______________, 1971a: Reptiles of Victoria. *in* Ch. 1. Arnold, V.H. (Ed.) *Victorian Year Book* 85, 11-36.

______________, 1971b: The Reptiles of West Gippsland. *Proc. R. Soc. Vict.*, 84, 37-51.

Ritchie, G.S. (Ed.), 1969: *Australian Pilot Volume 2. comprising the Southern and Eastern Coasts of Australia from Cape Northumberland to Port Jackson, including Bass Strait and Tasmania.* Fifth Edition. Navy, London, 161, 209, 210.

Shepard, F.P., 1964: Sea Level Changes in the Past 6,000 Years: Possible Archeological Significance. *Science*, 143, 574-576.

Wagglen, A.J. (Ed.) 1970: *Sailing Directions for Victoria Including Bass Strait.* Government Printer. Melbourne, 403, 408.

Weekes, H.C., 1927a: A note on reproductive phenomena in some lizards. *Proc. Linn. Soc. N.S.W.*, 52, 25-32.

____________, 1927b: Placentation and other phenomena in the scincid lizard *Lygosoma (Hinulia) quoyi*. *Ibid.* 52, 499-554.

Willis, J.H., 1947: Plants of Rodondo Island. *Vict. Nat.*, 64, 21-24.

____________, 1971: Flora of West Gippsland. *Proc. R. Soc. Vict.*, 84, 33-35.