LORD HOWE ISLAND

A summary of current and projected scientific and environmental activities

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LORD HOWE ISLAND

A Summary of Current and Projected Scientific and Environmental Activities

This publication is, in large part, a summary of a Symposium held at The Australian Museum 30 Nov.-1 Dec., 1979.

Edited by H.F. Recher and W.F. Ponder
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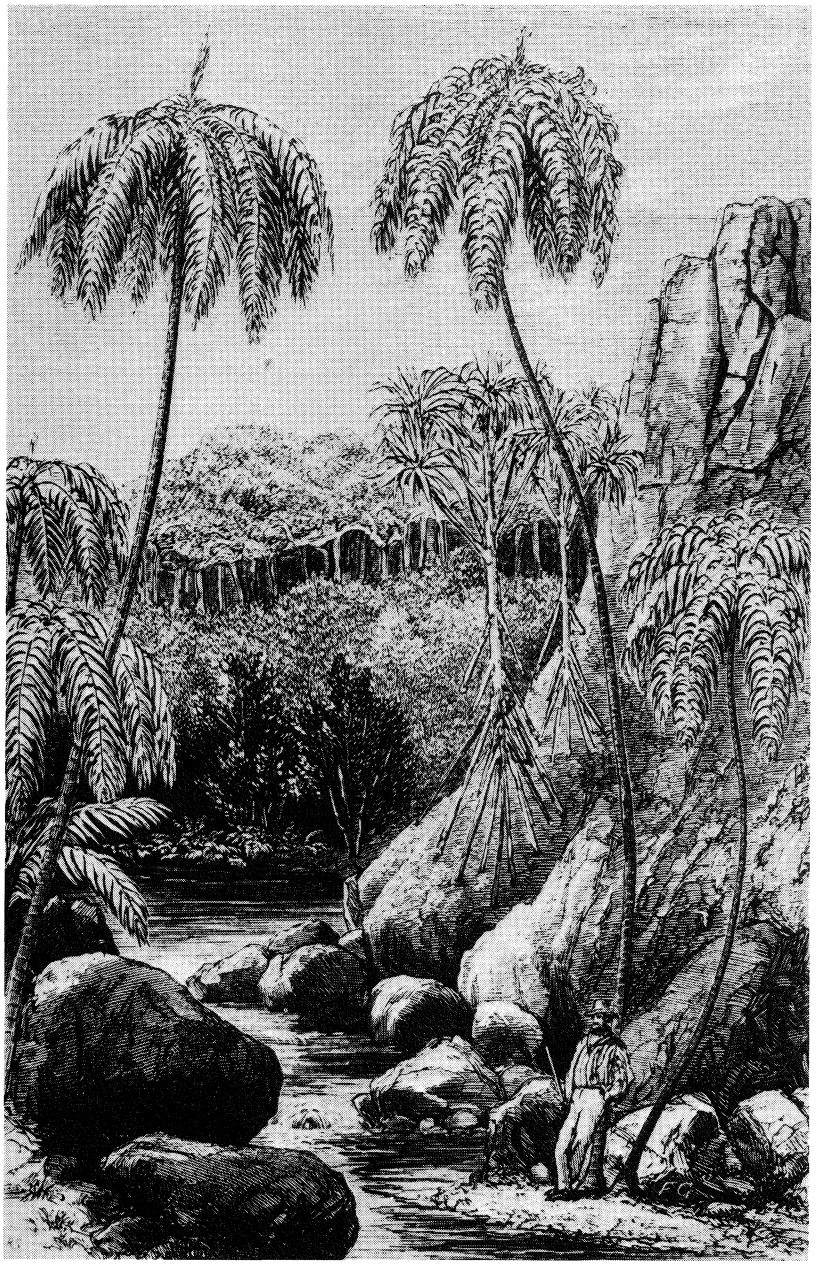

Lord Howe Island palms and Pandanus. From Mueller, Fragmenta Phytogeographiae Australiae (1869-1871)

INTRODUCTION

A Symposium concerning Lord Howe Island was held at The Australian Museum on 30 November to 1 December, 1979. The aim of the Symposium was to provide an opportunity for scientists engaged in research on Lord Howe Island to present their studies and discuss these with other scientists and with persons interested in research on the island.

Approximately 50 scientists attended the three scientific sessions and about 100 persons gathered at an open forum at the end of the Symposium. The forum was arranged to enable members of the public with an interest in the island, and the residents of Lord Howe Island present at the meeting, to discuss the island's future with the benefit of advice and information from scientists who have studied the island's geology, ecology and wildlife.

Twenty-four papers were presented in the scientific sessions. The Symposium represented the first occasion on which scientists engaged in research on the geology and biology of Lord Howe Island met and exchanged views about the evolution of the island's flora and fauna, its geological history, and the effects of human settlement on the landscape. Four papers (Dowden, Clark, Rooney and Pollard) dealt with issues of land management, tourism, and marine conservation. The summing up papers by Dr. J. Paxton and Dr. H. Recher focused on the need to make the results of scientific research available to persons responsible for the management of the island's natural resources. Because of the importance of Lord Howe Island and the diverse nature of the research conducted on the island a permanent record of the proceedings was considered desirable. The papers presented are summarized in the abstracts in this publication together with summaries obtained from scientists unable to attend the meeting.

A SUMMARY OF DISCUSSION

It was generally acknowledged that the terrestrial and marine environments of Lord Howe Island are a significant biological and scientific resource. In view of the considerable research which has taken place on Lord Howe Island over the past century, the island can be described as a great natural laboratory.

Lord Howe Island ranks among the important natural areas remaining in the world and has been listed by the Australian Heritage Commission in the Register of the National Estate. There is therefore an international obligation to manage the island in a way which would ensure the preservation of the island's flora and fauna. Several reasons can be advanced to explain why Lord Howe Island is important. These include the large number of endemic plants and animals, the relatively slight impact of European settlement when compared with most other sub-tropical islands (e.g. Norfolk Island, (Turner, Smithers and Hoogland, 1968)), accessibility which allows research to be carried out easily, and the probability that most other islands in Australasia will be radically altered by an expanding human population before the end of the century. Lord Howe Island is one island where sound management is possible and human pressures relatively light.

Management and the Environment

Excluding purely scientific matters, discussion at the scientific sessions was particularly concerned with the need to improve communication between scientists working on Lord Howe Island and island residents, the scientific and biological importance of Lord Howe Island, and applying the results of scientific study to problems of land management (conservation).

Throughout the scientific sessions there was active participation by the island residents attending the meetings. However, the best opportunity for an exchange of views came during the Open Forum. This session probably provided the first opportunity for concerned environmentalists (e.g. representatives of the Nature Conservation Council of N.S.W.), scientists and residents of Lord Howe Island to exchange views and discuss areas of seeming disagreement. In this the island was ably represented by the island representative of the Lord Howe Island Board, Mr. Bruce McFadgen.

In the past communication among these different groups has not been good. From discussion it was clear that there was a lack of knowledge on the part of residents about what the scientists were recommending and a similar ignorance by the scientists of the resident's concerns. Although there are many reasons for poor communication, it was clear that a major limitation on communication has resulted from the apparent failure of the Lord Howe Island Board to communicate scientific results and reports to residents.

Although there continues to be a need to correct previous mistakes in management (e.g. eradication of feral animals, eradication of noxious weeds, better management of the island's wastes and so on), it was agreed that existing use of the island (e.g. tourism, palm seed collecting, recreation fishing) was compatible with the conservation of the island's natural environment. An urgent necessity is for the adoption of controls on the introduction of plants, animals and soil to the island to prevent the introduction of potential weeds, pests and disease. At the present time there are no restrictions on introductions between the mainland and Lord Howe Island but there are between Norfolk Island and Lord Howe Island.

There was a general concern among the biologists present at the Symposium that insufficient use was made of the information available about the island's flora and fauna. The information is available to properly manage the island's marine and terrestrial environments. There is no area of comparable size in Australia which has been as intensively studied as Lord Howe Island. The lines of communication between scientists knowledgeable about Lord Howe Island and the persons responsible for the management of the island are inadequate. There is a need for a scientific advisory group with responsibility to ensure that all available scientific resources are used in making management decisions and that the recommendations and research of scientists are understood by the current management and the island's residents.[1]

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[1] An advisory group has since been established with representatives from the Australian Museum, National Parks, the National Herbarium, the island and other concerned groups.

The Concept of a Lord Howe Island National Park

There was a majority view that the natural environments of Lord Howe Island should be managed by the National Parks and Wildlife Service (N.S.W.) as the Government body with the greatest expertise in these areas and that a marine and terrestrial national park be established. There should, as with the present management, be a scientific advisory body to assist in planning. The scientists at the Symposium could find no major conflict between the concept of a National Park (or Nature Reserve) on Lord Howe Island and such existing activities as collecting palm seeds, recreation fishing or tourism.

Some scientists and conservationists consider island residents to be mis-informed about National Parks and the impact that a National Park would have on their current activities. As a result, many residents oppose a National Park on Lord Howe Island. This appears to be largely because of the view that it is 'their island'. Environmentalists, scientists and some residents consider the island a part of Australia belonging to all Australians. There was, however, a consensus that special consideration needed to be given to the islanders and their needs in planning the management of Lord Howe Island.

A number of specific conservation problems were discussed during the scientific sessions and Open Forum. A consensus was reached on the following issues:

The 'ownership' of Balls Pyramid needs to be resolved as a matter of urgency. Balls Pyramid should be included in any park or reserve dedicated on Lord Howe Island and access to the Pyramid closely controlled.

The mutton-bird (shearwater) colonies behind Neds Beach and at the Clear Place need protection and should be included in any park or reserve dedicated on Lord Howe Island. In particular it was felt that the Transit Hill area should be reserved and that unless it is formally protected, ultimately Transit Hill would be subdivided for residential or commercial purposes. Subdivision of Transit Hill would have a significant adverse impact on the island's flora and fauna. A reason advanced for the need to protect Transit Hill was its importance as the best and most extensive example of lower elevation plant communities. It is also the most logical area on which to establish a population of the Woodhen within easy viewing distance of residents, tourists and scientists. It is an area where feral animals and rats can be controlled and endangered populations of terrestrial invertebrates thereby protected.

The residents present at the Open Forum did not agree on the need to reserve Transit Hill from development. However, it was apparent that they had not been informed of the arguments advanced by scientists of the need to reserve Transit Hill nor had they properly considered the implications of an expanded human population in permanent residence on the island. Thus, while the desire for living space for one's children is understandable, the problems of employment for these persons and the provision of services (e.g. water, sewerage and energy) have not been properly assessed. The scientists argued that in view of the residents often expressed desire to preserve Lord Howe Island 'as it is', development of Transit Hill would have multiplying environmental effects, most of which residents would probably find objectionable.

Future Scientific Research on Lord Howe Island

Lord Howe Island provides a unique opportunity for research and there was considerable discussion of this during scientific sessions. This is particularly so for biologists not only because of its endemic fauna and flora but also because it is a small, largely natural area with a great diversity of habitats including the worlds southernmost coral reef. It is isolated from other land areas and yet is easily accessible. Considerable scientific activity has occurred on Lord Howe Island in the last 50 years and consequently a great deal is known about its biology, ecology and geology - probably more than any other comparable area in Australia. Much, however, remains to be done. Some more detailed comments on the areas lacking information are to be found in the abstracts but clearly the largest gap in our knowledge is information on many of the invertebrate groups, both marine and non-marine.

Much future work will no doubt be done by specialists concentrating on filling gaps in knowledge but marine environmental surveys appear to be a probable major activity in the near future. It is hoped that scientists planning such surveys adopt a multidisciplinarian approach as this appears to be the next logical phase for scientific work on Lord Howe Island. It is an ideal site for such an approach with excellent opportunities for experimental work in a system totally isolated from other shallow-water and terrestrial systems.

There are a number of disadvantages to working on the island. It is expensive to live there and airfares to the island are high. There are no laboratory facilities available and even basic equipment must be taken to the island. In order that a reasonable program of integrated research be possible a simple laboratory, to provide bench space, would have to be available. It has been suggested that space is available adjacent to the island's Museum for such a facility.

A major incentive to scientists would be a subsidy to assist with accommodation costs on approved research work. It is not recommended that separate accommodation be provided as this would only aggravate the existing shortage of building land. Another incentive would be for the Island Board to consider the allocation of funds for at least one annual grant for research.

If facilities and grants or subsidies were available and utilized, recipient scientists should be obliged to give a public lecture if requested and to provide a report intelligible to an educated layman. Copies of reports should be made available to some public institution (such as the island's Museum) so they are accessible to residents.

Much of the "once-off" biological work on Lord Howe Island involves basic or specialized collecting. Scientists wishing to be involved in this type of activity should be aware that good basic collections already exist in the Australian Museum and in the National Herbarium (N.S.W.).

CONCLUSION

Despite a few differences of opinion between scientists and conservationists and some residents the respective parties are remarkably close to agreement. All participants support the need to conserve Lord Howe Island, improve the level of environmental management and encourage continued research. Further open discussion and the communication of environmental and other information is required. Such discussion if

conducted in an atmosphere of mutual respect (as was the Symposium) would, in our view, lead to a consensus between islanders, environmentalists, scientists and management on the best ways to manage and conserve Lord Howe Island's unique flora and fauna.

SECTION A - GEOLOGY

The three papers included in this section deal with the origin, geology and geomorphology of Lord Howe Island. Earlier geologists believed Lord Howe Island to be older than current work indicates. These new facts have profound implications in the interpretation of biological phenomena and zoogeography.

ORIGIN AND EVOLUTION

I. McDougall, B.J.J. Embleton* and D.B. Stone**, Research School of Earth Sciences, Australian National University, Canberra, A.C.T.

Lord Howe Island is the eroded remnant of a large shield volcano. Tholeiitic lavas of the North Ridge Basalt comprise the main shield building phase and were erupted about 6.9 m.y. ago. The Rocky Point Breccia formed within the throat of the volcano, and it and the North Ridge Basalt are intruded by numerous basaltic dykes, which grade into a cone sheet complex near the main vent. Large scale collapse of the summit area of the volcano produced a caldera which was filled rapidly by lavas of the Mount Lidgbird Basalt some 6.4 m.y. ago, bringing to a close the volcanic history of Lord Howe Island. Thus the shield volcano was built during a short interval in the late Miocene.

Palaeomagnetic data show that the North Ridge Basalt and the Mount Lidgbird Basalt were erupted during periods when the geomagnetic field had normal polarity, and that their formation was separated by at least one interval of reversed polarity when the dykes and cone sheets were emplaced. The directions of magnetisation for the lavas and intrusives are such that no movement of Lord Howe Island is detected since its formation.

Lord Howe Island is the subaerial part of a large seamount which lies at the southern end of a northerly trending line of volcanic seamounts extending for more than 1,000 km. The Lord Howe seamount chain probably was produced by movement of the Australian lithospheric plate over a magma source or hot spot located below the plate within the upper mantle. Other data suggest that the Australian plate is moving north at about 6 cm/yr and from this it is predicted that the seamount underlying Nova Bank, at the northern end of the chain, was constructed by volcanic activity about 23 m.y. ago.

GEOLOGY

C.V.G. Phipps, Department of Geology & Geophysics, The University of Sydney, N.S.W.

Lord Howe Island is an erosional remnant of a volcanic peak of later Tertiary age which is in part covered by Pleistocene carbonate sands on the northern half.

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* Present address: Division of Mineral Physics, C.S.I.R.O., Minerals Research Laboratory, North Ryde, N.S.W.

** Present address: Geophysical Institute, University of Alaska, Fairbanks, Alaska, U.S.A.

Two ages of volcanics can be recognised, those north of Mount Lidgbird being the older and those making up Mount Lidgbird and Mount Gower, the younger. The former consist of thin flows of basalts with intercollated pyroclastics. In places such as Rabbit Island these rocks are intruded by dyke swamps making up as much as 50% of the surface outcrop. Dips on the older volcanics are generally slight, those making up cliffs at the northern end of the island suggest they originated from a centre in the area of the Admiralty Islands. It is probable that several centres of eruption account for this series of rocks. The overlying rocks of Mount Gower and Mount Lidgbird consist of essentially horizontal flows often several hundred feet thick with some interbedded pyroclastics. These rocks are more variable in composition ranging from trachytes to rocks containing abundant phenocrysts of pyroxene and olivine. Dykes are less numerous. It is suggested that these rocks filled an old caldera produced intially in a volcano made up of the older volcanics.

Pleistocene carbonate sandstones, mostly aeolianites, occur on the northern part of the island. These sands contain little volcanic material except on the flanks of Mount Lidgbird where volcanic grains can make up approximately 20% of the sediment. Studies by students at the University of Sydney show that cross bedding in the aeolianites indicates a predominantly south easterly wind stream at their time of formation. Associated with the aeolianites are lenticular soil horizons interpreted as swales between the dune deposits.

The lower sections of the sandstones outcropping at Neds Beach and Middle Beach show a cobble beach at Neds Beach and thinly bedded sands suggestive of upper beach and berm deposition. Dating of coral from this beach gave a C^{14} age greater than 35,000 years B.P. and probably relate to the last interglacial around 12,000 years B.P. Aeolianites occurring off-shore from Neds Beach at a lower level than the old beach at Neds may have been deposited when sea level dropped after the last interglacial. The sandstones contain Halimeda fragments which have not been found in the modern sands of the lagoon. This indicates a cooler present environment than at the time the sandstones were formed.

The lagoon and reef of Lord Howe have been extensively studied. There is evidence from sections cut by surge channels that coral growth in the past was far more extensive than at present. A similar situation has been found at Elizabeth and Middleton Reefs to the north.

Rubble banks on the reef and the lack of extensive coral growth at present give rise to some question as to the origin of the reef bank. Coralline algae appear to be the principal stabilising organism on the present reef. Fifty seven species of 33 genera of hermatypic scleractinian corals have been recognised and described by Veron and Done (1979).

The lagoon is filled with medium to fine sands over an irregular basement. Several channels, extension of onshore drainage developed at low sea level stands, have been defined by shallow seismic profiles and on aerial photos. Comets Hole is a remnant of one of these channels so far not completely filled.

Offshore the bathymetry suggests an old submerged reef or bank offshore which almost surrounded the island. In a time of lower sea level this would have formed a barrier with a lagoon shorewards and an opening to the north. Diving on these offshore banks shows them to be composed on the surface of limestone rubble with a covering of brown algae and a little coral. The intervening valleys are filled with a coarse brown rippled sand. Further studies of these features are planned.

Work planned for the 1979/80 summer consists principally of drilling on a series of transects across the reef to determine the nature of the Pleistocene basement, reef composition and rate of growth. A similar program is planned for Elizabeth and Middleton Reefs.

It is also planned to drill some holes in the calcarinite to ascertain the processes of cementation and diagenesis. The location of these holes has not been determined.

THE CAVES AT NORTH HEAD

L.S. Hall, H. Shannon and R. Shannon, Department of Anatomy, University of Queensland, St. Lucia, Qld.

Names

The most widely accepted local names have been adopted, i.e. Gooseberry, Banyan and Big caves. Detailed maps of the caves have been prepared.

Tourist Potential

Due to their ease of location, Gooseberry and Banyan caves are frequently visited by tourists. Gooseberry Cave is a single chamber entered by a steep rubble slope. Most of the chamber can be traversed without the aid of artificial light and the floor is relatively even. The entrance to Banyan Cave is small and the ceiling of the cave in most places is only 1 to 1.5 m high. Lighting is required to reach the chamber at the back of the cave where the wall and ceiling are decorated with small galleries of stalactites and flourstone. Big Cave is entered via a 5 m drop and a light source is required for further progress. This cave contains several chambers, decorations, and a stream passage. The structure of the cave and the loose nature of the rock make this cave unsuitable for tourists.

Geology and Geomorphology

Information has been collected but was not available for this summary.

Sub-fossils

Collections of bones have been made in the three caves on several occasions. Gooseberry Cave is the type locality of *Nyctophilus howensis* McKean, 1975. Most of the skeletal material is from birds, but a species list is not yet available.

SECTION B - INVERTEBRATES

Work on the invertebrates of Lord Howe Island has been limited. Apart from an early (and incomplete) list (Etheridge, 1889) no comprehensive account has been published. There is information available on hard corals, earthworms, a few groups of marine molluscs, land and freshwater snails, terrestrial crustaceans, a few insect groups, spiders, and echinoderms but other groups are poorly known. The bibliography gives reasonable coverage of the literature available on various invertebrate groups, but does not include all work on marine invertebrates.

The abstracts presented here cover most of the work currently underway on Lord Howe Island invertebrates, but is not complete. Several scientists (including some probably unknown to us), are working on Lord Howe material as a small part of projects of much wider scope. Their work is omitted from this account.

CORALS AND CORAL COMMUNITIES

J.E.N. Veron* and T.J. Done**

Fifty-seven species of 33 genera of hermatypic Scleractinia are found at Lord Howe Island, the southernmost coral reef of the Pacific. All except two undescribed species are known from the Great Barrier Reef. The families Fungiidae, Merulinidae, Caryophyllidae and Oculinidae are absent from the island and the Mussidae are represented by two genera only. Coral communities are mapped from survey data and aerial photography. Lagoon and reef communities defined using a polythetic agglomerative procedure are shown to have an ordered distribution relative to their hydrodynamic regime. These communities differ substantially from their tropical equivalents due to growth form deviations of dominant species and depauperate species composition. Available surface circulation and temperature data suggest existing coral communities are the result of a balance between periodic denudation by cold, subantarctic currents and recolonization by larvae from tropical currents. Low temperatures per se appear to have little effect on coral growth but may affect growth form responses to light regimes. (Published in Aust. J. Mar. Freshwater Res. 30: 203-236 (1979)).

NON-MARINE ANNELIDS

P. Hutchings, Australian Museum, Sydney, N.S.W.

This account summarises the data of Jamieson (1977) and Richardson (1969).

The majority of the earthworms are restricted to the subfamily Megascolecinae, with 6 genera containing 10 endemic species. In addition there are a widely distributed oriental species Amynthas diffringens and lumbricids, all of which are recently introduced species.

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* Australian Institute of Marine Science, Townsville, Qld.

** Department of Marine Biology, School of Biological Sciences, James Cook University of North Queensland, Townsville, Qld.

The ten indigenous species are more closely related to the Australian fauna than to any other fauna. Of the 6 genera, 3 genera (Paraplutellus, Pericryptodrilus and Eastoniella) are known only from Lord Howe. Paraplutellus is closely related to Plutellus sensu stricto which has 3 species, one of which is endemic to Lord Howe. Jamieson suggests that evolution of the 2 endemic species Plutellus hutchingsae and Paraplutellus insularis was from a common ancestor. Alternatively, speciation occurred on Lord Howe of one of these species from an isolated population of the other species. Jamieson suggests that the separate invasion by each species or 2 distinct ancestral species is unlikely. Similarly the 4 endemic species of the subgenus Austroscolex are considered to have evolved from a single ancestral species.

Of the species for which sufficient distributional data are available, 5 species are restricted to the vicinity of the summit of Mount Gower. Another species is restricted to Mount Gower and Mount Lidgbird.

Lord Howe has a single endemic leech, Quantenobdella howensis, belonging to an endemic genus. Richardson suggests that the leeches on South Pacific Islands have been separated for some time because it is possible to divide the leech fauna at a generic level into provincial faunas.

MARINE MOLLUSCA

W.F. Ponder, Australian Museum, Sydney, N.S.W.

To date no synoptic account of the marine mollusca of Lord Howe Island has appeared. Iredale (1937), Iredale (1940) and Iredale and Allen (1940) have provided the only zoogeographic accounts of Lord Howe Island and its close neighbours, Middleton and Elizabeth Reefs. There are, in contrast to the fishes (see Paxton and Hoese herein), a number of endemic species of marine molluscs although many species (e.g. all of the cones (Conidae), cowries (Cypraeidae) and most bivalves) are common Indo-west Pacific species. Of the common intertidal molluscs the most conspicuous is Turbo cepoides Smith, a species endemic to Lord Howe Island and Middleton and Elizabeth Reefs. The common limpet (Cellana howensis Iredale) and the Siphonaria limpets are other endemics.

The intertidal fauna, in general, is similar to that found in New South Wales, the tropical Indo-west Pacific elements being mostly inconspicuous and often sublittoral.

Substantial collections of marine molluscs from the shelf and the intertidal zone of Lord Howe Island have been made recently and as groups are revised more information about the relationships of the fauna will be available.

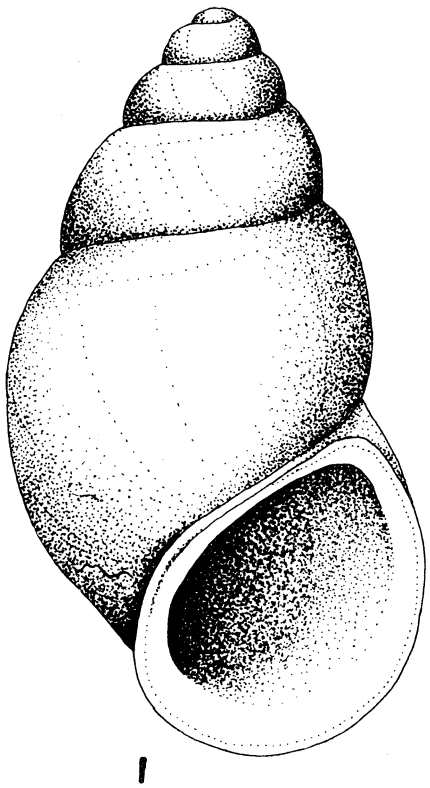
FRESHWATER SNAILS

W.F. Ponder, Australian Museum, Sydney, N.S.W.

Small freshwater gastropods (family Hydrobiidae) were first reported by Etheridge (1889) and then by Iredale (1944). They are common in the numerous streams on the island. Three genera and nine species are recognised (Ponder, in press). Three species have subspeciated, two into two subspecies and one into five subspecies. The total number of species group taxa is 15, more than is known on the eastern Australian mainland. It is probable that this fauna is the result of 3 separate colonisations during the Pliocene and/or Pleistocene. Most of the species live in small streams but one is adapted to living on waterfalls and another is subterranean in habit.

One introduction was probably from eastern Australia and this group (Hemistomia Crosse) contains 6 species, one of which (H. whiteleggei (Brazier)) has recently become extinct. Two others are restricted to the summit of Mount Gower and one has become subterranean in habit. Fluviopupa Pilsbry, an introduction from the north, has developed into 2 species which live sympatrically in some localities. The remaining genus group, tentatively referred to as Potamopyrgus Stimpson, contains only one species. It is found living on waterfalls around the southern mountains.

A previously unrecorded freshwater gastropod, a species of the Ancylidae (freshwater limpets) is found in the Erskine Valley.



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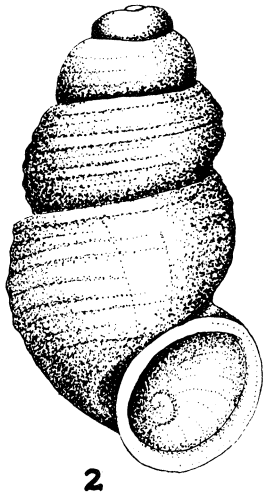

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Freshwater snails from Lord Howe Island. Fig.1. Fluviopupa ramsayi (Brazier). Fig.2. Hemistomia whiteleggei (Brazier).

LAND MOLLUSCA

J. Stanisic, Queensland Museum, Brisbane, Qld.

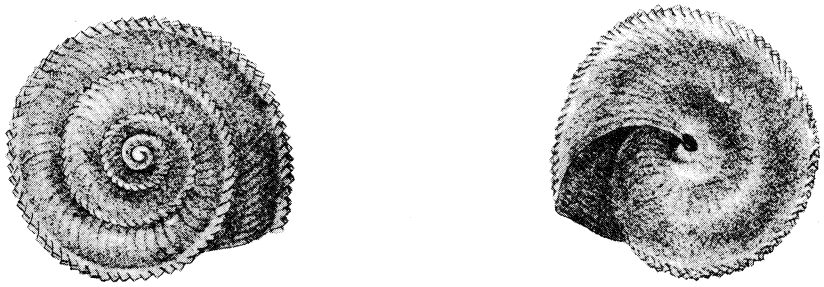
The Lord Howe Island land snail fauna is remarkable for both its size and its diverse affinities.

Iredale (1944) lists 79 species and 9 subspecies belonging to 30 genera. Iredale's view of classification has been criticised by both Solem (1959) and Burch (1976). His tendency to emphasise differences rather than draw together related elements when erecting generic taxa and his "over-splitting" at the specific level, have resulted in a distorted view of faunal composition. A more reasonable assessment of species numbers (Solem, 1974, p.244) puts the number at 51. Nevertheless, this is high for such a small area when it is compared with some of the larger Pacific islands. Reasons for these differences must await a more detailed analysis of the fauna.

Lack of comparative studies on the soft parts of the Lord Howe Island land snails, makes the task of establishing extra-limital relationships arbitrary. However, it is possible to make a number of broad approximations based on conchological characters. Basically three broad faunal elements are represented. Following Solem (1959), these can be characterised as Pacific Island, Palaeo-Oriental and Southern Relict. The island also possesses a number of recent introductions which are related to patterns of human activity.

The omphalotropid genera, Limborelia and Opinorelia together with the "microcystids" may be considered Pacific Island elements. The orthurethran groups of Elasmias, Tornelasmias and Imputegla can tentatively be considered recent introductions of widespread forms.

Palaeo-Oriental groups are represented by Palaina and the larger helicarionids. Although Baker (1941, pp.264-265) considered that Epiglypta howeinsulae (Cox) was most closely related to Helicarion s.s., lack of comparable anatomical studies of Howearion spp. and Parmellops australis (Reeve) makes the position of the Lord Howe helicarionids problematic.



Epiglypta howinsulae (Cox), a land snail from Lord Howe Island which is probably extinct.

The Lord Howe Island Placostylus and the various endodonts make up the Southern Relict element. Solem (1959) considered that both groups are related to New Zealand forms. The presence of Hedleyoconcha on Lord Howe Island must be regarded as doubtful. The Lord Howe species, Hedleyoconcha addita (Iredale), is known only from the two syntypes present in the Australian Museum collections.

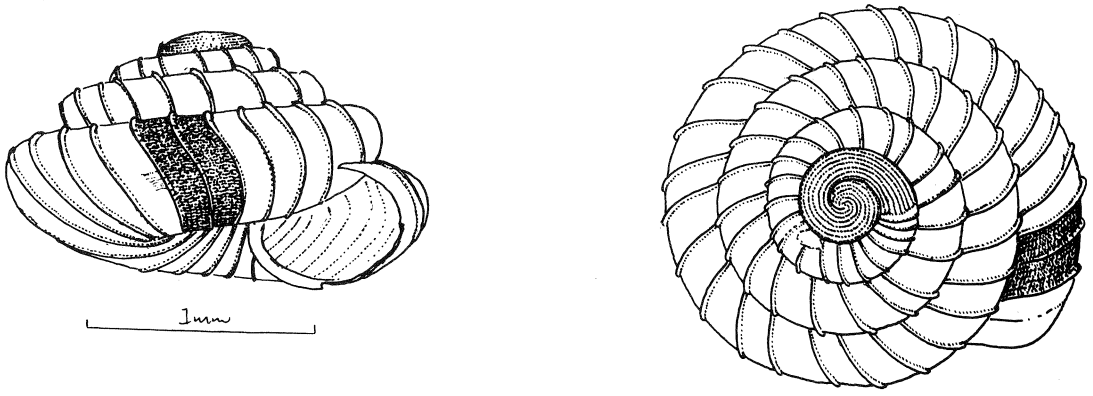
In considering the origins of the Lord Howe Island land Mollusca, it is possible to postulate derivation from Melanesia by means of wind or rafting. The small size of the species present (more than 75% less than 10 mm), when viewed in terms of the arguments of Vagvolgyi (1975), suggest that aerial dispersal has been important.

Much information regarding insular speciation trends and colonisation patterns remains to be acquired. However, a number of species are already restricted in distribution and in danger of extinction.

PUNCTIDAE - MINUTE LAND SNAILS

F.M. Climo, National Museum, Wellington, New Zealand

A major revision of this large family of minute, litter-dwelling snails is in progress. The Lord Howe Island fauna is an interesting one which consists of 9 genera and 15 species; several of these taxa are undescribed. There are relationships with New Zealand, eastern Australia, Norfolk Island and the Kermadec Islands.



Pernastela gnoma Iredale, Mount Lidgbird, Lord Howe Island.

TERRESTRIAL AND FRESHWATER CRUSTACEA

J.K. Lowry, Australian Museum, Sydney, N.S.W.

The terrestrial and freshwater crustaceans of Lord Howe Island are not well known. Etheridge (1889) first reported a freshwater crab, Hymenicus sp., from the "water-carrying gullies" behind the Old Settlement. Chilton (1915) correctly identified Etheridge's species as Halicarcinus lacustris in collections from a stream on top of Mount Gower. Roux (1926) described the freshwater prawn Paratya (Xiphatyoida) howensis from Big Creek. Vandel (1973) reported the isopod Ligia australiensis colonising the interior of the island to altitudes of 250 m. In the same paper

Vandel described 3 new genera and 5 new species of terrestrial isopods from Lord Howe Island. Bousfield (1976) recently described a new species of talitrid amphipod from the top of Mount Gower. These are all of the terrestrial and freshwater crustaceans presently known from Lord Howe Island.

Recent collections by Dr. Tim Kingston, and Dr. Winston Ponder, Australian Museum, have provided terrestrial and freshwater crustacean material from many parts of the island. The material contains at least 8 species of isopods of which only one is identifiable with the species described by Vandel (1973). Dr. Susan Kingston is studying these collections (see below). There are 3 species of amphipods among the material, two of which have not been reported from the island and are presently being studied by the writer. One specimen of what appears to be a terrestrial ostracod is being studied by Dr. De Deckker, University of Adelaide.

Nominate Crustacea of Lord Howe Island

Isopoda

Ligiidae

Ligia australiensis Dana, 1853

Philosciidae

Australophiloscia nichollsi Vandel, 1973

Armadillidae

Australiodillo insularis Vandel, 1973
Australiodillo primitivus Vandel, 1973
Orthodillo chiltoni Vandel, 1973

Incertae Sedis

Tasmanoniscus evansi Vandel, 1973

Amphipoda

Talitridae

Parorchestia gowerensis Bousfield, 1976

Caridae

Atyidae

Paratya (*Xiphatyoida*) *howensis* Roux, 1926

Brachyura

Hymenosomatidae

Amarinus lacustris (Chilton, 1882)

AMARINUS LACUSTRIS (CHILTON), A FRESHWATER CRAB (FAMILY HYMENOSOMATIDAE)

J.S. Lucas, Zoology Department, James Cook University, Townsville, Qld.

Amarinus lacustris has a wide distribution in south-eastern Australasia, occurring in freshwater and low salinity habitats in Victoria, South Australia, King Island, Tasmania, Lord Howe Island, Norfolk Island and the Northland of North Island, New Zealand. It has no larval or resistant egg stages to act as a dispersal mechanism. To further complicate considerations of the origins of this distribution, Australian specimens of A. lacustris are genetically compatible with a brackish water species, A. paralacustris, which occurs in eastern mainland Australia. The various isolated populations of A. lacustris are morphologically similar and the main difference between the two species is in their modes of development. Walker (1969) and Lucas (1970) interpret these data as A. lacustris having recently evolved from a brackish water ancestor in Australia and subsequently dispersing to other land masses. Walker suggested rafting and Lucas suggested transport by water fowl for the trans-Tasman crossing.

The hypothesis of a recent dispersal of A. lacustris is being tested by attempting crosses in the laboratory between specimens of A. lacustris from Victoria, Lord Howe Island and New Zealand and A. paralacustris to find what level of genetic compatibility exists between these populations. Juvenile crabs are reared from hatching and juvenile females isolated and then exposed to appropriate males at their pubertal moult. Results are inconclusive and difficulties have arisen through early prepubertal matings and females discarding viable eggs.

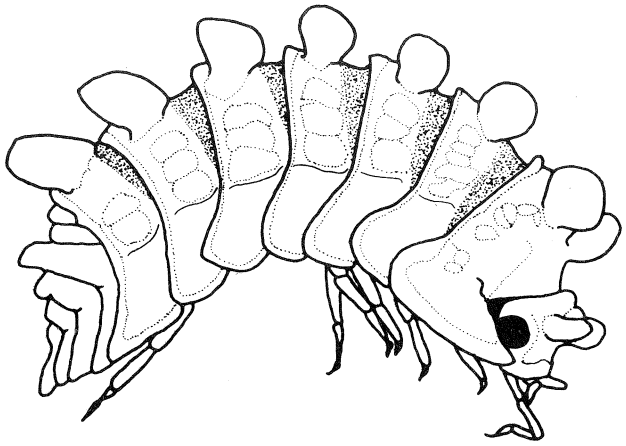
The specimens of A. lacustris from Lord Howe Island were collected in November 1978. The freshwater crab was found to be ubiquitous in freshwater streams and seeps on the island, except in unshaded streams at sea-level.

TERRESTRIAL ISOPODS OF LORD HOWE ISLAND

T.J. Kingston and S.C. Kingston, Australian Museum, Sydney, N.S.W.

Lord Howe Island possesses an abundant and diverse terrestrial isopod fauna. Preliminary examination of material derived from an intensive invertebrate sampling program has revealed at least 30 species or species-groups. In the only previous study of Lord Howe Island terrestrial isopods (Vandel, 1974) six species were recorded of which five were newly described, two being assigned to two new endemic genera (Orthodillo and Tasmanoniscus). The 30 species presently recognised comprise the following: two introduced species (Porcellio laevis Latreille and Metoponorthus pruinosus (Brandt): family Porcellionidae); four of Vandel's (1974) five endemic species (Tasmanoniscus evansi (incertae sedis), Australophiloscia nichollsi: family Philosciidae, Australiodillo insularis and A. primitivus: family Armadillidae), a Ligia species, the relationship of which to the mainland L. australiensis Dana and the New Zealand L. novazealandiae Dana remains unclear; a member of the family Sphaeromatidae, a predominantly marine group which, although it has some freshwater and littoral forms has none previously recorded from a strictly terrestrial habitat. The remaining 22 species are predominantly of the family Armadillidae with a few representatives of the families Styloniscidae and Philoscidae. These are being described and studied.

The phylogenetic and biogeographic affinities of the Lord Howe Island isopod fauna are being studied. From Vandel's (1974) study it appears likely that a large proportion of the newly recognised taxa is endemic. In addition, comparison of the Lord Howe Island fauna with the terrestrial isopod faunas of Australia, New Zealand and Indo-Pacific island groups may indicate the degree to which these neighbouring geographic regions have contributed to the Lord Howe Island fauna.



One of the undescribed isopods from Lord Howe Island.

Terrestrial isopods are found throughout Lord Howe Island and on some of the offshore islands at densities that frequently exceed 1,000/m^2. The species collected include some that are restricted to particular habitats (for example the base of palm fronds) and to narrow geographical ranges (for example Mount Lidgbird or Ball's Pyramid). Others are widespread in both habitat and geographical range. The degree to which geographic and habitat specialisation reduces competition between the numerous species present on Lord Howe Island is being studied. The high numbers of closely related taxa, particularly within the family Armadillidae, is at variance with the generally accepted view that small oceanic islands possess low numbers of co-existing closely related taxa.

SPIDERS

M.R. Gray, Australian Museum, Sydney, N.S.W.

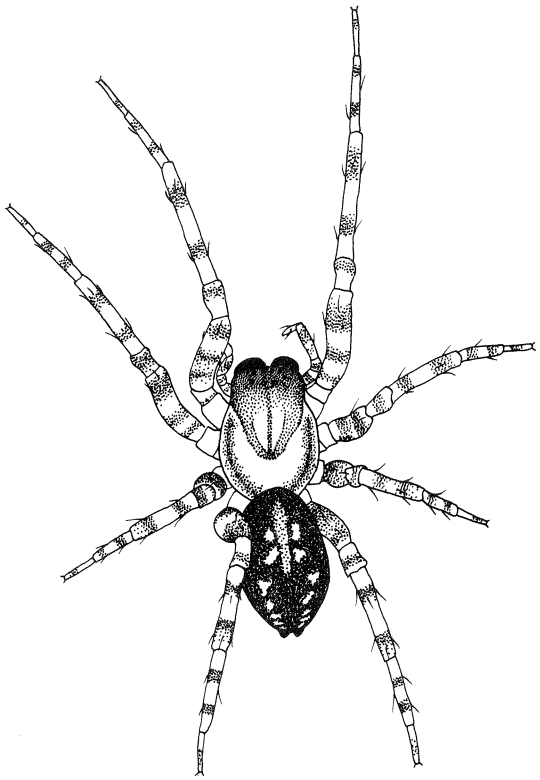
Three projects involving Lord Howe Island spider fauna are under way or proposed:

1. Revision of the amaurobioidid genus Forsterina. This widespread group of spiders occurs in Australia, New Zealand, New Caledonia and Lord Howe Island. Only two species occur on Lord Howe Island but they are of particular interest in consisting of a cribellate - acribellate sister species pair.

2. Investigation of the relationship between a common lowland theridiid spider Achaearanea mundula and another small theridiid which parasitises the adult female and eggs.

3. Analysis of the litter dwelling spider fauna - a joint project with T. Kingston.

A more detailed account of the spiders is given in Gray (1974).



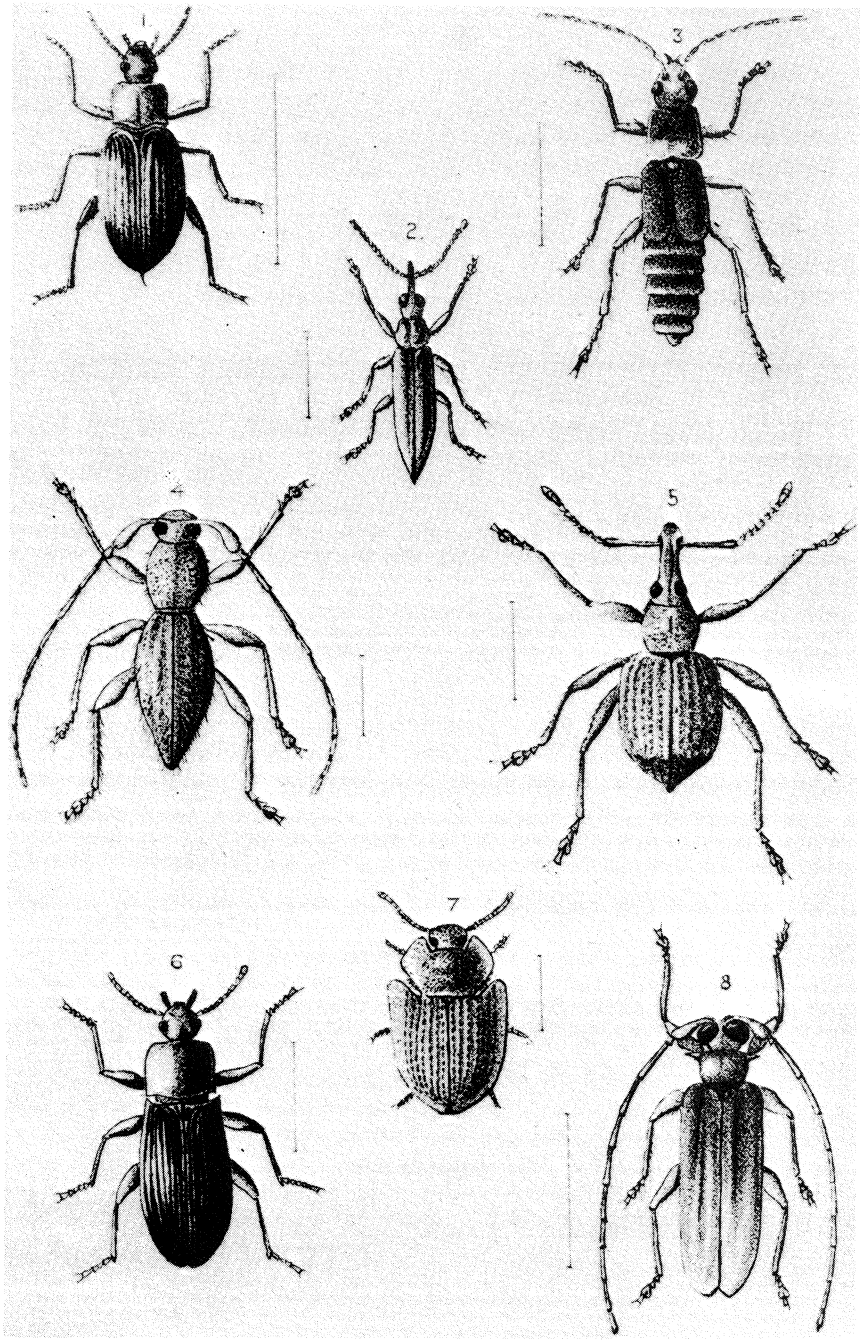
Forsterina frequens (Rainbow) Lord Howe Island

INSECTS

C.N. Smithers, Australian Museum, Sydney, N.S.W.

Perusal of titles of papers which include mention of insects from Lord Howe Island might suggest that the fauna has been well studied. This is not so, as many of the papers provide only a few descriptions or records; papers dealing with entire groups for the island are few. For example, a mere handful of small lepidopterans are recorded from Lord Howe Island whereas from a program of trapping by Jowett and Holloway on Norfolk Island more than two hundred species are known and additional species are regularly being taken. As Lord Howe Island is more diverse it would be expected to have larger fauna. There has been an increase in collecting in recent years but most of this has been done by general collectors, not specialists, and there is ample evidence in entomology to show that for full investigation specialist attention is necessary.

Some beetles from Lord Howe Island: (1) Promethis sterrha (Olliff). (2) Belus acrobeles (Olliff). (3) Chanliognathus apterus (Olliff). (4) Somatidia pulchella (Olliff). (5) Leptopius etheridgei (Olliff). (6) Meneristes vulgaris (Olliff). (7) "Ostoma" pudicum (Olliff). (8) Howea angulata (Olliff). From Plate VI of Aust. Mus. Mem. 1, 1889. The names of these insects have been updated by Dr. J. Lawrence, C.S.I.R.O.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There is no published list of species from the island. A progressive step would be the preparation of such a list.

Groups which are well known are the ants, butterflies and psocids. I feel competent to consider only the two last groups.

Butterflies

There are 24 recorded species. Of these seven have been taken only once and are casual invading species which are probably not established. All species recorded are Australian. Thirteen are migrants and only one has developed a recognisable island form; this species is not recognised as a migrant species on the mainland. Anaphaeis java peristhene, the New Caledonian form of the caper white butterfly, has been recorded but is not established. Flights of A. j. teutonia, the Australian form, have been observed arriving at a time when massive migrations have been taking place in eastern Australia. This form is not able to establish itself because suitable larval host plants are not available.

Similar invasions of Norfolk Island by Vanessa kershawi (painted lady butterfly) and of New Zealand by a variety of species are described in the literature. A. j. peristhene has re-established itself on Norfolk Island after an absence of several decades.

Arrival of Australian species on Lord Howe is a common occurrence and easily achieved by strong fliers with or without wind assistance. Establishment is less common.

Psocoptera

Ten species of Psocoptera are known from Lord Howe Island but there are probably more. One of the species is known from Australia; the others are not yet recorded from elsewhere but this need not necessarily indicate endemicity. The faunas of likely source areas are only now being studied. Their affinities are in the main with the Australian fauna except for one species which can be placed in a group of South Pacific species and another which has affinities with species from New Zealand, Micronesia and the Oriental Region.

There is evidence from aerial sampling and meteorological data that movement of Psocoptera from the direction of Australia would be easily achieved, sometimes at high altitudes.

So far as butterflies and psocids are concerned invasion of Lord Howe poses no great problems but subsequent establishment might be difficult. The faunas of these groups as presently known do not need postulation of land connections to explain their presence. On the other hand, some other insect groups, e.g. peloridiids (order Hemiptera) have distributions which appear to warrant such postulation.

Zoogeographical generalisations based on the insects as a whole should, at present, be regarded as tentative hypotheses. The insects are diverse as a group, ecologically, morphologically and historically and generalisation is only possible on the basis of those few groups which have been well studied on the island and other areas.

THE PATTERNS OF DISTRIBUTION OF SOME HEMIPTERA (INSECTA)

J.W. Evans, 47 Bundarra Rd, Bellevue Hill, N.S.W.

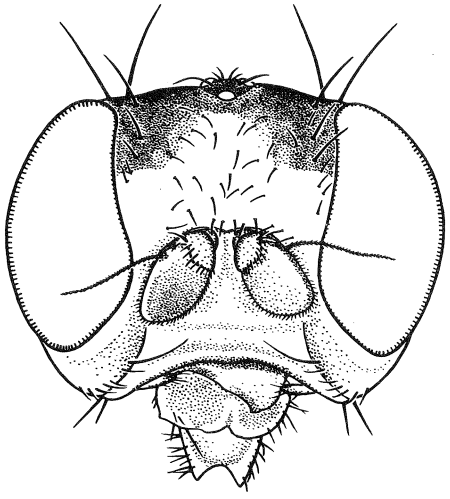
The distribution of insects belonging to three groups of Hemiptera (sucking bugs) are considered. These are the Fulgoroidea, Cercopoidea (spittle bugs) and Peloridoidea. The fulgoroidea delphacia, Notuchus monticola, belongs to a genus represented elsewhere only in New Caledonia, while the cercopoids (Carystoterpa fasciata and C. pallida, family Aphrophoridae) belong to a genus represented only in New Zealand.

The three species of Peloridoidea described (Evans, 1959, 1968) from Lord Howe Island (Howeria kingsmilli, H. payteni, H. coggeri) seem more closely related to an Australian species, Hemiodoecus leai, which may itself have been differentiated in Antarctica, than to ones occurring in either New Zealand or New Caledonia. The occurrence in the same restricted environment of three closely related species raises some ecological problems as do the zoogeographic implications (discussed in part by Evans, 1973).

ACALYTRATE FLIES

D.K. McAlpine, Australian Museum, Sydney, N.S.W.

Lord Howe Island has a depauperate Diptera-fauna but this includes endemic species some of which are of extreme interest. The closest relationships of the fauna are undoubtedly with eastern Australia and some flies are barely specifically distinct from Australian species. A few of the endemics are not congeneric with Australian flies. Among these may be cited an undescribed species of the platystomatid genus Guamomyia, which is associated with Pandanus. The genus has otherwise only one species in Guam and one in the New Guinea highlands. Naupoda insularis Paramonov is an endemic platystomatid fly of a genus occurring as close as tropical northern Queensland and Fiji, but not otherwise present in temperate Australia. A strange, undescribed fly of the family Asteiidae seems closest to the Oligocene fossil genus Succinasteia. The lauxaniid genus Poecilohetaerus has a distinctive species living on the summit area of Mount Gower. The genus is represented in New Zealand, temperate Australia and Norfolk Island.



Head of an unnamed asteriid fly from Lord Howe Island.

WASPS

G. Holloway, Australian Museum, Sydney, N.S.W.

Excluding the bees and ants, there are three species of hymenopterans belonging to the suborder Apocrita, recorded from Lord Howe Island. Over 300 species of both parasitic and predacious wasps have been collected from the island; the majority of these are Australian in origin.

In this paper I shall attempt to outline some of the obvious absences and possible reasons for these absences from the Lord Howe Island wasp fauna as well as species present in both Australia and Lord Howe yet noticeably absent from New Zealand. For example, the paper nest wasp genera, Polistes and Ropalidia are absent from Lord Howe Island and New Zealand. Another strong flyer, Sphex fulligonosa is found throughout eastern Australia and Lord Howe Island, with a subspecies recorded from each of New Caledonia and New Hebrides. The genus is not found in New Zealand. There are one hundred and eleven recognised species of Sphex and their distribution is as follows: Palearctic 15, Nearctic 12, Neotropical 28, Ethiopean 22, Oriental 19, and Australian 21. Island endemics are found in the West Indies, Madagascar, the Seychelles and New Guinea and on several islands of Melanesia and Indonesia. A few species have extensive distributions, for example, Sphex argentatus is found from India to Japan and Australia. Sphex is limited on Lord Howe Island by its host specificity in that they prey on specific tettigoniids, of which the fauna is limited to only a few species.

The Lord Howe Island wasp fauna tends to be unbalanced in its composition, containing fewer varieties of predators than similar areas on the mainland and even similar-sized islands. The first wasps to successfully inhabit Lord Howe Island were most probably those that have their hosts inhabiting rotting logs and secondly those that are egg parasites, such as the ensign wasp, Evania appendigaster, which oviposits in cockroach ootheca.

Since a species' success and survival are the only measures of its degree of adaptation to its island environment, the fact that a species has become extinct also demonstrates that it is not well enough adapted; with wasps it is also necessary for the host species to become adapted. The adaptation to the Lord Howe Island environment is an unusually difficult one for a species to make. Firstly, the immigrant individuals are for the most part, originally part of the Australian population and were adapted to the mainland environment. They cannot, therefore, already be adapted to the different conditions of Lord Howe Island. Secondly, the colonists were probably few in number and therefore include only a small part of the genetic variation that provided the mainland population with the flexibility to cope with environmental change. Finally, small populations are also far more susceptible to random non-adaptive changes in their genetic makeup. Since it is less likely to be closely adapted to the Lord Howe Island environment, a small population is more likely liable to chance extinction.

A wasp species which can make use of a wide range of hosts or prey, for example, Netelia producta, is at a decided advantage on an island for its maximum possible population size will be greater than that of a species with more restricted food preferences.

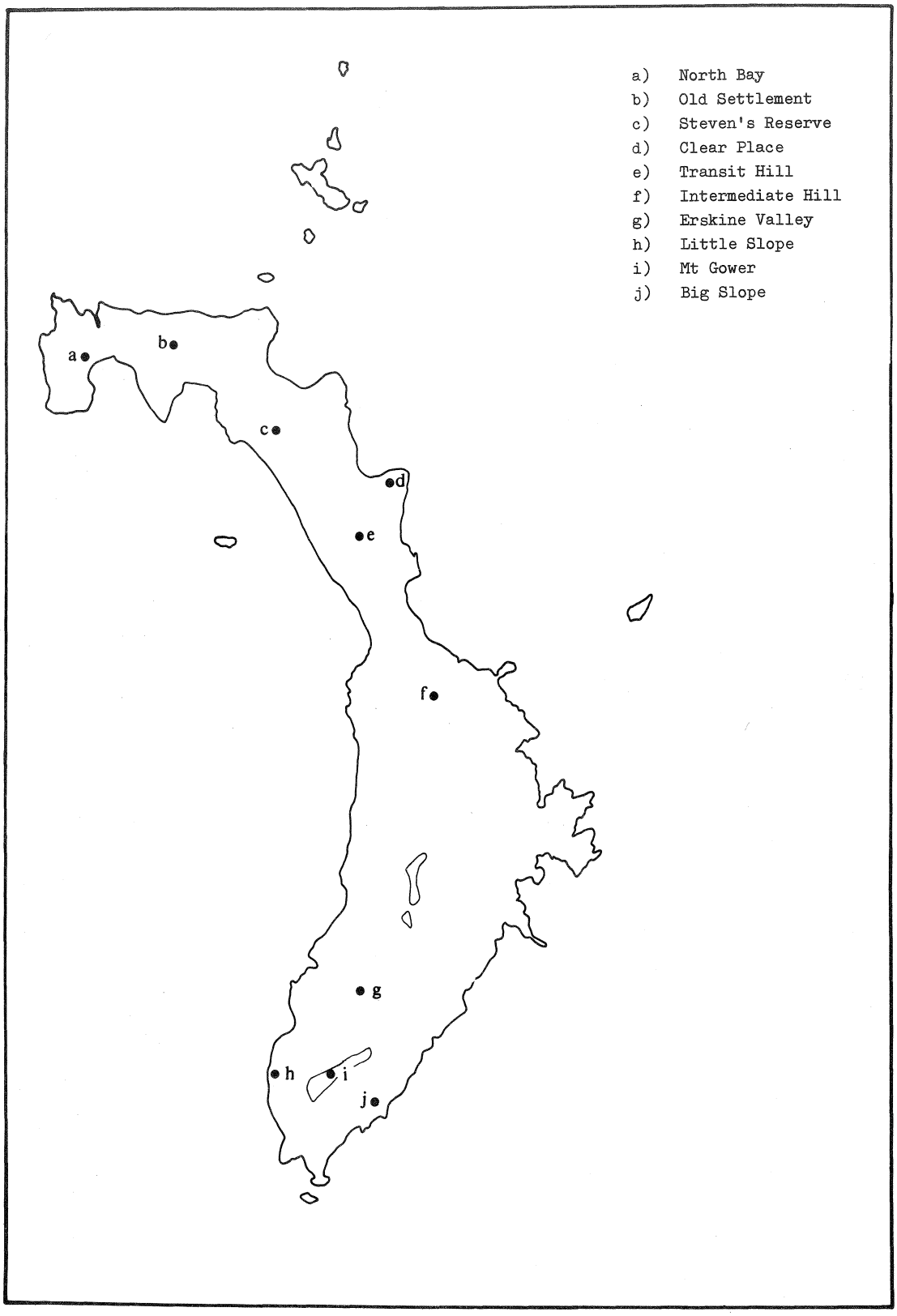
Chance extinction is also a particular danger for both parasitic and predaceous wasps, since their numbers must always be lower than those of the species upon which they prey.

ABUNDANCE OF INVERTEBRATES AT POTENTIAL WOODHEN RELEASE SITES

T.J. Kingston, Australian Museum, Sydney, N.S.W.

Ten areas of Lord Howe Island have been selected for consideration as potential Woodhen release sites. The leaf litter and soil fauna of these ten areas, and of Mount Gower, which have been sampled to assess invertebrates at each potential release site, is compared with that found on Mount Gower, and the quality of each site, in terms of food available for the Woodhen, is assessed.

Mount Lidgebird and Mount Gower seen from Settlement Beach.



A map of Lord Howe Island showing the study sites used in the invertebrate survey.

SECTION C - VERTEBRATES

Work on the vertebrates of Lord Howe Island has been the main focus of scientific attention. Much of the present scientific activity (in terms of money expended and manpower) concerns research into a single species of bird, the Lord Howe Island Woodhen. These studies, however, have had numerous "spin-offs", for example, the discovery of a large endemic terrestrial isopod fauna as a result of Dr. Kingston's work on litter invertebrates (see previous section). Kingston's work was initiated to determine the abundance of litter invertebrates at potential Woodhen release sites.

Of the vertebrate groups, birds have the prime place of interest for aesthetic, faunistic and zoogeographic reasons. Fish have been relatively well studied (see Paxton and Hoese herein) as have the only two reptiles. The only native mammals are bats which may occur on Lord Howe Island only accidently.

The greatest threat to the native fauna is introduced mammals, in particular the Black Rat (Rattus rattus). Feral goats and pigs have been reduced to a level where extermination is possible. Cats and the introduced Masked Owl are also problems. Several species of invertebrates and some birds are assumed to have been exterminated by noxious animals and more will follow unless control of exotics is achieved.

FISH

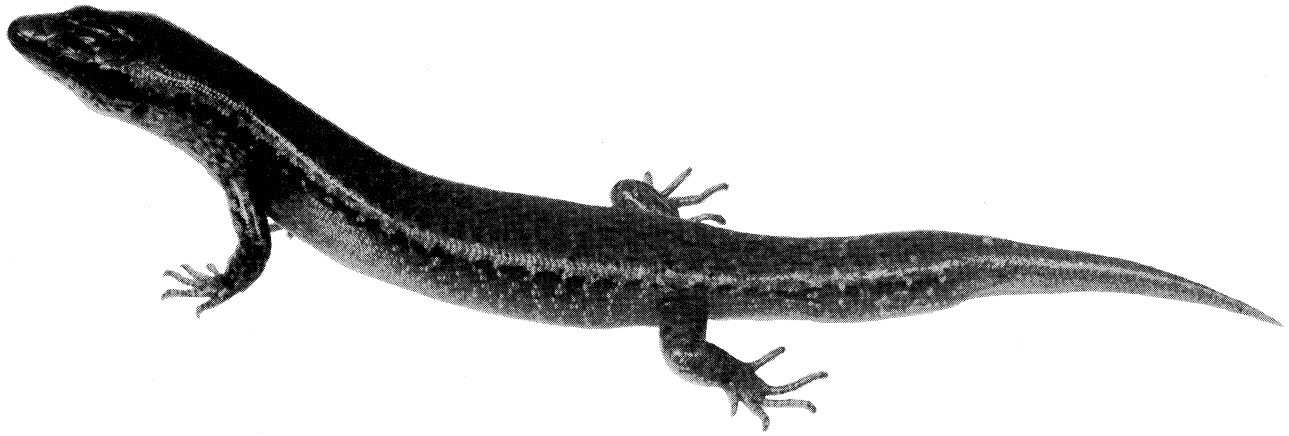
J.R. Paxton and D.F. Hoese, Australian Museum, Sydney, N.S.W.

Although the first fishes from Lord Howe Island were collected in 1853, a month long Australian Museum expedition to Lord Howe in 1973 collected 208 new records, bringing the fish total of 447 species in 107 families (Paxton et. al., 1976). The relatively depauperate fauna consists primarily of tropical Indo-Pacific species (42% of the inshore species) oceanic and southern temperate species and other important components. Thirteen species are endemic to Lord Howe (and Norfolk-Middleton Reef areas). Of the species collected in 1973, a surprising number were represented by few individuals and there were indications of annual fluctuations in the presence or absence of some species like snapper. The island would make an excellent study site for a project on expatriation and the role of oceanic currents on distribution. If fluctuations are common, further collecting could add substantially to the number of tropical species recorded from the island. There are only 3 species of freshwater fishes recorded from the island, none of which is endemic.

REPTILES

H.G. Cogger, Australian Museum, Sydney, N.S.W.

Studies on the terrestrial reptiles of Lord Howe Island in 1966 indicated that the two lizards which were once abundant on the main island - the endemic skink Leiolopisma lichenigera and the gecko Phyllodactylus guentheri - were confined to geographically restricted and specialised habitats, and were nearing extinction on the main island. Both species were abundant on the offshore islands, including Ball's Pyramid (Cogger, 1971). The gecko is known elsewhere only from Norfolk Island, where it was considered the sole terrestrial reptile.



Leiolopisma lichenigera (O'Shaughnessy), from Lord Howe Island.

In 1978, the Lord Howe Island skink was discovered on Philip Island, in the Norfolk complex, and a survey of the latter discovered that these two lizards are now extinct on Norfolk Island itself (Cogger, 1971). However, they are relatively abundant on Norfolk's offshore islands.

The factors which might have led to the reduction or extinction of these two lizards on Lord Howe and Norfolk Islands are being examined, as are conservation measures which might be essential to their survival on the offshore islands.

PHYLOGENY AND BIOGEOGRAPHY OF MEIOLANIID TURTLES

E.S. Gaffney, Department of Vertebrate Palaeontology,
American Museum of Natural History, New York

The extinct chelonian family Meiolaniidae consists of five named species (see Table 1 for generic distribution) united by the following derived or advanced characters: 1) well developed squamosal horns, and 2) a slit or pocket formed ventral to the basisphenoid by the pterygoid. Although records of the family occur widely throughout the southern hemisphere, most of the specimens are fragmentary. It is only the Ned's Beach calcarenite of Lord Howe Island that has yielded sufficient numbers of well preserved skeletons of Meiolania platyceps to allow extensive morphological comparisons with other turtle groups.

Dorsal views of two skulls of Meiolania platyceps.

The relationships of Meiolania have been the subject of controversy since the original identification of Meiolania as a lizard by Owen in 1881. After Huxley recognised that Meiolania was a turtle, its affinities within the group became the subject of debate; some authorities arguing that it was a pleurodire, others that it was a cryptodire. Anderson, in 1925, made the first detailed study of the skull of Meiolania and concluded that it belonged to a group termed the Amphichelydia, which was supposed to include the most primitive turtles. More recent work has shown that the "Amphichelydia" is a waste-basket taxon of fossil forms that lack certain distinct features of recent groups. Detailed morphologic study of "Amphichelydia" cranial material has resulted in the identification of most of the included taxa as either cryptodires or pleurodires. Although Meiolania has well developed, free cervical ribs and a tail club, features which occur only in the most primitive turtles (the Triassic Proganochelydia), many features of the braincase in Meiolania are advanced characters found only in true cryptodirans. Therefore, I conclude that Meiolania is a cryptodire that has retained some primitive chelonian characters lost in most other turtles. The relationships of Meiolania within the Cryptodira are still under study, but it should be noted that the Cryptodira is an ancient group; most of its subdivisions appear by the Jurassic.

Table 1

The Species of Meiolaniidae

	Meiolania platyceps	*Meiolania mackayi*	*Meiolania oweni*	*Niolamia argentina*	*Crossochelys corniger*
1. Geographic Distribution	Lord Howe Island	Walpole Island, New Caledonia	Darling Downs, Queensland Coolah, New South Wales	Argentina	Argentina
2. Age	Pleistocene	Pleistocene	Pleistocene	Pre-Oligocene	Eocene
3. Available Material	Hundreds of separate elements, including partial skeletons and five skulls	Horn cores and miscellaneous fragments	One skull and tail club, tail club fragments	One skull and tail ring	One partial skull
4. Skull horns	Cow-like horns with no frill	Cow-like horns, presumably no frill	Flat horns, developed into frill	Flat horns, developed into frill	Flat horns, developed into frill
5. Tail club	Long, narrow	Unknown	Short, squat	Unknown	Unknown
6. Estimated relative size (*Meiolania platyceps* = 1.0)	1.0	0.7	1.5 - 2.0	1.0	0.5 - 0.3

Among the many specimens of Meiolania from Lord Howe Island are a series of nearly a dozen partial skulls, five nearly complete skulls and over fifty squamosal horns. These specimens show a great deal of variation in size and it has been suggested that perhaps males and females can be recognised by horn size or shape. However, measurements of the horns and comparisons by means of simple height/width ratios show no signs of a bimodal distribution.

The oldest Australian meiolaniids are indeterminant Meiolaniidae fragments from the Miocene of Lake Pinpa, South Australia and Miocene (?) of Gulgong, New South Wales.

BIRDS

H.F. Recher, Australian Museum, Sydney, N.S.W.

The birds of Lord Howe Island are relatively well known, being comprehensively dealt with by Hindwood (1940) and Fullagar et. al. (1974). When discovered by Europeans, Lord Howe Island had a terrestrial avifauna of fifteen species. Fourteen were forms endemic to Lord Howe Island. Of the fifteen, nine are extinct and two others (the woodhen and the currawong) should be considered endangered. The twelve or so species of seabird which nest on the Lord Howe group of islands have been less affected by European settlement, but numbers of some species on the main island have been greatly reduced. Ignoring the colonisation of Lord Howe Island by a number of species which have found the human environment favourable, the impact of Europeans on the avifauna of Lord Howe Island has been entirely adverse. Recently, efforts have been made to conserve the woodhen and recommendations put forward to protect other terrestrial species and seabirds. If asked why these birds should be conserved, we can no doubt provide some moral justification based on years of neglect. The avifauna of Lord Howe Island is also a major biological resource and the woodhen could well be a symbol of conservation and enlightened management, if not for all of Australia, then certainly for Lord Howe Island.

FOSSIL, SUB-FOSSIL AND EARLY HISTORIC BIRDS OF LORD HOWE AND NORFOLK ISLANDS

G.F. van Tets*, P.V. Rich", P.J. Fullagar* and P.M. Davidson+

Cave and sand deposits on Lord Howe Island and sand deposits on Norfolk Island have yielded a wealth of bird bones. Most of these bones are of marine birds that still breed on the islands, but others are of marine birds that have not otherwise been recorded there. These include

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* Division of Wildlife Research, CSIRO, Lyneham, A.C.T.

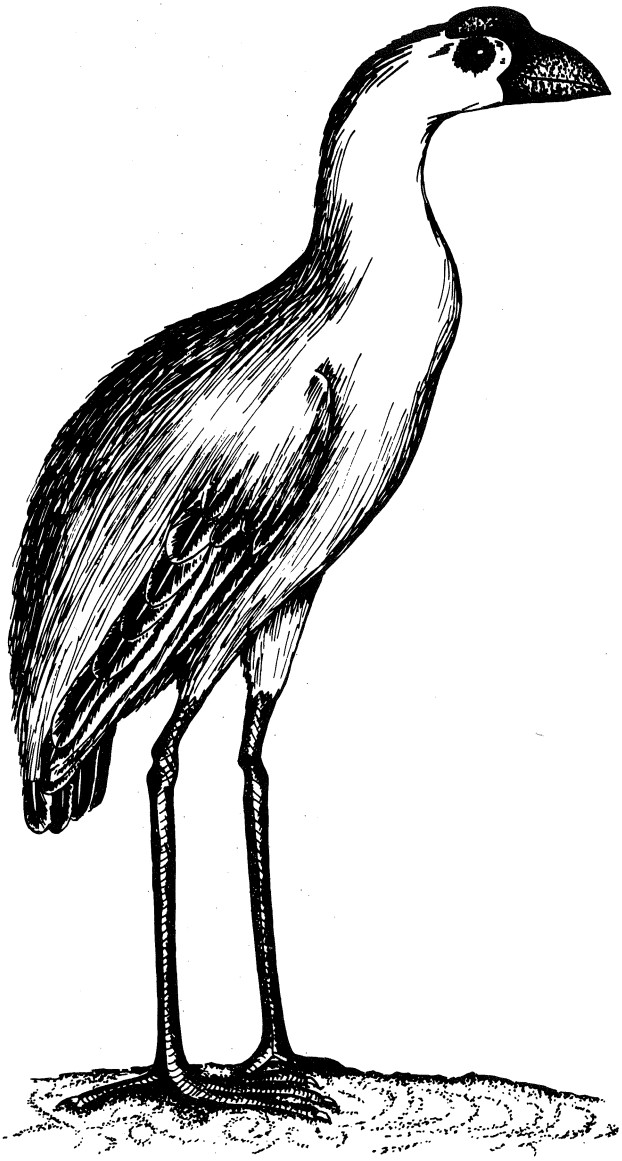
" Dept. of Earth Sciences, Monash University, Clayton, Victoria.

+ 23 Huelin Circuit, Flynn, A.C.T.

the White-faced Storm-Petrel, Pelagodroma marina on both islands and the Little Penguin, Eudyptula minor on Lord Howe Island.

Two species, a giant booby, Sula, and a pigmy gadfly petrel, Pterodroma, with chick and fully-grown material on both islands, may be new species and appear to differ in size and shape from congeners that now breed on the islands.

So far, no material has been found on Norfolk Island of the Bird of Providence, Pterodroma solandri, that was exterminated soon after European settlement. Until it is found, there will remain an element of doubt about its identity with the Brown-headed Petrel or Big Hill Muttonbird of Lord Howe Island. Presumably we will have to wait until an inland cave deposit is found on Norfolk Island or there is an archaeological excavation around the area of first settlement by Europeans.



The White Gallinule or Swamp Hen (Notornis alba), one of the extinct birds of Lord Howe Island.

Among the less plentiful remains of landbirds are those of the Woodhen, Tricholimnas sylvestris, and the White Gallinule, Notornis alba, on Lord Howe Island and of a smaller woodhen, probably a new species, on Norfolk Island. Remains of large pigeons were found on both islands, and are presumably those of Columba vitiensis godmanae on Lord Howe Island and of Columba norfolciensis on Norfolk Island. Bones of a large parrot on Norfolk Island appear to be of the endemic Kaka, Nestor productus. Except for the Lord Howe Island Woodhen, all large landbirds died out shortly after European settlement.

The early extinctions of birds on Lord Howe and Norfolk Islands may be attributed to habitat changes following: the post-Pleistocene rise in sea level and consequent massive reduction in island sizes; the pre-historic presence of Polynesians and their introduction of rats on Norfolk Island; and the introduction by Europeans of pigs, goats and dogs to both islands, combined with an over-harvesting of birds for food and feathers.

STUDIES ON THE FLESHY-FOOTED SHEARWATERS, PUFFINUS CARNEIPES

P.J. Fullagar, CSIRO, Division of Wildlife Research,
Lyneham, A.C.T.

and

H.J. de S. Disney, Australian Museum, Sydney, N.S.W.

Almost all of the Fleshy-footed Shearwaters on Lord Howe Island nest within the intensively settled lowland regions (Fullagar et. al., 1974). Their numbers on Lord Howe Island have been greatly reduced by human settlement and there is concern for the long term survival of the colony (Recher and Clark, 1974; Fullagar et. al., 1974). When time permitted during our Woodhen studies we tried to determine the distribution of the colonies and count the number of burrows to obtain an estimate of the size of the breeding population.

Colonies were mapped from stereo aerial photographs. Several discrete colonies exist and occupy an area of 46 hectares (cf 70 acres (28 ha) in Fullagar et. al., 1974; a figure based on the first and less thorough survey). A small (1.2 ha) and apparently declining colony occurs in palm forest along the eastern shore of Hunter Bay. This is the only colony on the lagoon or western side of the island. The principal colonies at the present time extend from Neds Beach to the Clear Place, along the eastern side of the island. These colonies are more or less broken into four sections. The northernmost, of about 3.4 ha, occurs on the "Common" at the back of Neds Beach. Much of it is located in palm forest, the remainder in lowland rain forest. This northern colony is linked to a large (about 15.8 ha), but patchy section that follows the cliff tops round Stevens Point. It nowhere extends inland beyond Anderson Road. Although some of it is located in palm forest, most is within lowland rain forest. Several clearings adjacent to and within this section are no longer occupied by shearwaters. In one paddock of about 0.7 ha (on portion 80) burrows were still in use in recent years. To the south of the Stevens Point colonies there are large areas of cliff slopes that have been cleared of coastal forest. Remnant colonies persist on about 4.3 ha in paddocks east of the Radar and Weather Station, above Jims Point. Another large colony section (about 9.1 ha) occurs in the lowland rain forest and palm forest above Middle Beach. An extensive

colony (10.0 ha) occurs in palm forests in the Valley of the Shadows. A small colony (1.1 ha) is situated in palm forests east of Transit Hill; an area known as the "Little Mutton-Bird Grounds".

Estimates of burrow density have been obtained in two ways. All burrows were counted within 15 x 15 m plots positioned at random throughout most colonies. Forty such plots were counted. An alternative approach was to use a plotless sampling technique. A point-centred quarter method was used at randomly located sampling sites on 24 transects, which ran through the colonies more or less perpendicular to their shoreline edges. In each quarter surrounding a sample point the distance to the nearest burrow was measured. More than 500 sample points were examined. In theory (Cottam et. al., 1953; Morista, 1954) the mean value of all point to burrow distances equals the square root of the mean area surrounding a burrow. Hence, the density of burrows can be estimated from any set of point sampled data. The PCQ procedure in this simple form assumes that the burrows are not clumped. Unfortunately, we suspect that such an assumption does not hold for the pattern of burrow distribution in this shearwater. Some correction is therefore needed. Nevertheless, we gain knowledge of relative density changes throughout the colonies from this more extensive technique. For example, there seems to be no correlation between burrow density and distance from nearest shoreline.

Provisional calculations suggest an average burrow density of about 870 per hectare using the PCQ method. Plot counts gave about twice this figure. Therefore, estimates of 40,000 to 79,000 burrows within the colonies as a whole would be given by these calculations respectively. Although we counted only usable burrows, the number actually occupied by breeding birds was not readily obtainable and may vary from year to year. Probably not more than half of the burrows would be used by breeding pairs. So, we are looking at a current population of 20,000 to 40,000 breeding pairs of Fleshy-footed Shearwaters on Lord Howe Island (cf Fullagar et. al., 1974).

STUDIES ON THE WOODHEN, TRICHOLIMNAS SYLVESTRIS

H.J. de S. Disney, Australian Museum, Sydney, N.S.W.

and

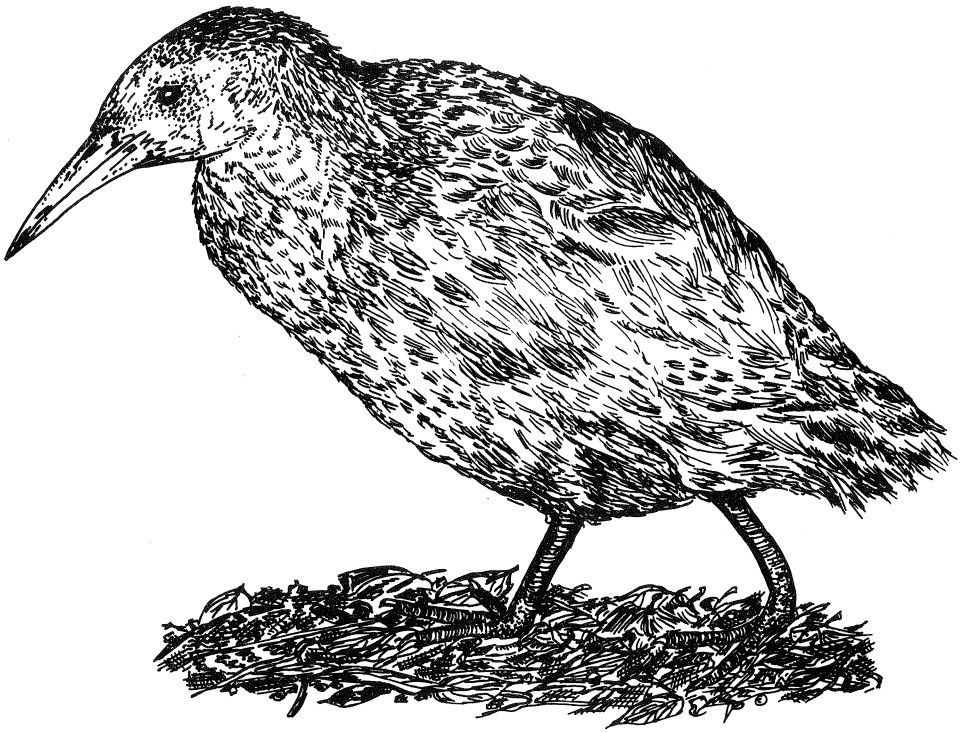
P.J. Fullagar, CSIRO, Division of Wildlife Research, Lyneham, A.C.T.

Disney first visited the island in 1969 with Dr. C.N. Smithers of the Australian Museum (Disney and Smithers, 1972). During this visit two nights were spent on Mount Gower and six woodhens were captured and banded. A study of the woodhen was started in 1971 during the Environmental Survey of Lord Howe Island (Disney, 1974 a, b). Work continued with visits in 1972, 1974 and 1975. In December 1975 the summit was gridded and a vegetation survey made with the help of John Pickard, National Herbarium, N.S.W.

Recommendations for further research (Disney et. al. 1976) were followed by a request from the Lord Howe Island Board for a research and management program. This was submitted in 1977 (Disney, 1977). The reports have been acted upon by the Board in association with the New South Wales National Parks and Wildlife Service.

Dr. B. Miller was appointed by the National Parks and Wildlife Service as resident biologist in 1977. His brief was to implement our recommendations and particularly to initiate a captive breeding program for the Woodhen. Since Dr. Miller's appointment we have acted as consultants and maintained our interest in Woodhens.

This abstract has been prepared to supplement our previous accounts of work on the Woodhen.



The Lord Howe Island Woodhen.

The Woodhen Population of Mount Gower

Forty-one visits were made to Mount Gower between 1971 and 1979 to study the Woodhen. Visits were less frequent but longer in the earlier years. Thirty-one visits have been made since 1976. There was no survey in 1973.

Starting from February 1971 an effort has been made to colour-band all Woodhens on Mount Gower. There are few unmarked adults and it is now necessary only to band young birds.

The number of Woodhens banded on Lord Howe Island between September 1969 and November 1979 is eighty. Seventy-six were colour banded. One

Woodhen was colour banded on Mount Lidgbird in 1975; another on Big Slope in 1978, and a third at Salmon Beach in late 1979. This leaves 73 colour banded Woodhens marked on Mount Gower in nine years. Of those reliably sexed, 24 were males and 27 were females.

The maximum number of marked Woodhens known to be alive has varied from 15 in 1976 and 1977 to 23 in 1975. In four other years (1971, 1974, 1978 and 1979) 19-21 birds were present. That portion of the population on Mount Gower using the Little and Thatch pockets was not discovered until 1978. Six Woodhens were marked in these pockets in 1978 and four in 1979. The number of Woodhens seen during any visit has varied from 6 in 1977 and 8 in 1976 to 18 or 19 in 1971, 1974, 1975 and 1979.

Thirty-three Woodhens were marked as chicks (still accompanied by parent birds) or were sufficiently immature to classify to a particular breeding season. The number marked each year from 1970/71 to 1978/79 were 3; 0; 2; 5; 6; 3; 3; 4 and 7. Not counting the last season, which includes 4 chicks reared in the newly discovered pocket areas, half of the young Woodhens did not survive to one year of age. Five (2 males and 3 females) of the 10 young marked during the first four seasons survived between 2 and 5 years (2, 3, 4, 4 and 5 years).

The natal territory of twenty-seven chicks was known. In a classification that divides Mount Gower into 12 territories, 15 chicks were reared in three territories and 7 others were produced in three other territories. No young have been reared in four territories. Five chicks were reared in the two pocket territories discovered in 1978.

The data on survival of Woodhens marked as adults, and therefore of unknown age, are of limited value. However, twenty-three Woodhens banded when adult survived from less than a year to 8 years; numbers per year class from 1 year to 8 years are 4; 6; 3; 4; 2; 1; 0; 2 and 1. Fourteen other Woodhens banded as adults are possibly still alive. However, only one has survived more than a year and was banded 8 years ago.

In summary, the greatest number of Woodhens recorded by us on Mount Gower has been 23, but usually the number is 17 or less. When the few birds that are possibly overlooked are added and with the odd Woodhen on Big Slope, Mount Lidgbird and Salmon Beach, the population probably has not exceeded 30 birds during the last 10 years.

SECTION D - PLANTS

This section deals with current research on the taxonomy, biology and ecology of plants. One paper has immediate economic application as it deals with the harvesting of palm seeds.

Several titles were received by Dr. J. Pickard of the Antarctic Division, Melbourne (formerly of the National Herbarium, Sydney) which indicate aspects of work carried out by Dr. Pickard. Some are presented below as abstracts but others in preparation include:

1. Vegetation of Lord Howe Island
2. Handbook to the ferns
3. Plant invasions and extinctions
4. Caudex formation of Asplenium australasicum
5. Rare and endangered vascular plants
6. Introduced fauna and vegetation
7. Vegetation of Mount Gower
8. Sampling for vegetation survey
9. Annotated botanical bibliography II
10. Off-shore islets
11. Fossil Araucaria
12. Effect of settlement on vegetation
13. Five years after the Biological Survey
14. Vegetation maps - one thing for all users?
15. Palm seed industry
16. Landslides
17. Historical data for determining invasion/extinction rates
18. Essential oils of some Lord Howe Island plants
19. Phytogeography of Lord Howe Island.

AN ANNOTATED BOTANICAL BIBLIOGRAPHY

J. Pickard, Antarctic Division, Melbourne, Vic.

One hundred and fifteen papers, books, articles and pamphlets dealing either directly or indirectly with the botany of Lord Howe Island are listed. The papers are classified into 14 categories to facilitate entry into the bibliography.

Published in: Contrib. N.S.W. natn. Herb. 4: 470-498 (1973).

KEYS TO VEGETATION

J. Pickard, Antarctic Division, Melbourne, Vic.

Most vegetation maps suffer from the fault that the only entry to the descriptions is via the map. Keys provide independent entry to the descriptions and avoid the problems of inclusions - patches of different communities that are too small to map.

I compare two keys to the vegetation of Lord Howe Island using data in Pickard (1978 and ms). One key is subjective and the other is prepared using a key-generating computer program. The program allows weighing of both characters and units so that specific keys can be prepared easily.

The keys are particularly valuable to users of vegetation maps who do not have the accumulated (and usually unpublished) experience of the mapper.

MARINE ALGAE

G.T. Kraft, Botany Department, University of Melbourne
Parkville, Vic.

Our survey of the Lord Howe Island benthic marine algae began in February 1976 and is based on the 4 trips completed to December 1978. Aims of the project have been to 1) make extensive collections intertidally and subtidally (using SCUBA) in as many habitats and seasons of the year as possible with the goal of eventually publishing a flora of the island's green, brown and red seaweeds; 2) study the distributions of individual species as they may change through the course of the year and as they differ in habitat and depth "preferences"; 3) compare the components of the flora with those of mainland Australia (both southwards to the southern coasts of the continent and northwards along the Great Barrier Reef), New Zealand to the east, and more northerly islands in the same general region (such as Norfolk Island) in an attempt to show trends in the biogeography and perhaps direction of dispersal of particular genera and species; and 4) to concentrate on particularly interesting items of the flora for detailed anatomical and taxonomic work.

With about half of the collections curated, we have identified about 40 species of green algae, 32 species of brown algae (of which 22 belong to the order Dictyotales), and 163 species of red algae. Endemism appears to be high, but lack of knowledge of the Australian mainland coast north of Sydney makes a reliable estimate of endemic species difficult. At present we recognise 3 endemic species of green algae (2 undescribed), 6 endemic species of browns (5 undescribed), and 19 endemic species of reds (2 genera and 16 species undescribed). Affinities of the flora are mostly tropical, but a few distinctive species are related to endemic New Zealand forms, while others show southern Australian affinities.

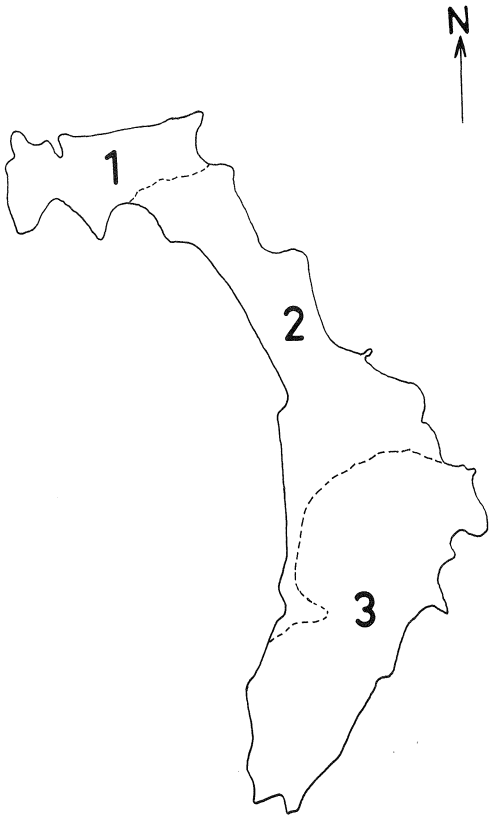
BRYOPHYTES

H.P. Ramsay, School of Botany,
University of New South Wales, Kensington, N.S.W.

Almost all the information available on the bryophytes of Lord Howe Island comes from collections made by Rev. W.W. Watts in July-August 1911. His collections are housed in the New South Wales National Herbarium in Sydney. Watts published a list of mosses (1915) incorporating all previous work on mosses while Stephani & Watts (1914) described species of hepatics from Lord Howe Island in their Hepaticae Australes (1914). Few specimens have been added to these original collections since then.

Some 102 (and 8 doubtful) taxa from 31 families of mosses have been recorded of which 18 are endemic. According to Stephani and Watts, the hepatic flora consists of 32 taxa including 5 new species. A check list of moss species incorporating present knowledge of distributional details is nearing completion. No similar work on hepatics has yet been envisaged or attempted. Of the 22 new moss species and 2 new varieties described by Watts six have now been reduced to synonomy.

Mass distribution data based on areas 1, 2 and 3 indicated on the map (see figure) give the number of species recorded in each area.



Area	1	2	3
No. species	27	56	55
	28	56	54

In area 3 covering Mount Gower and Mount Lidgbird respectively, there are 36 and 8 species reported. This area is almost certainly under-collected. Twelve species occur in areas 1 and 2 while 16 species are reported only from the mountains. There are 31 records for which no locality details are available. A notable absence from the species list is the Polytrichales although a single specimen has been reported of Atrichum androgynum and Dawsonia polytrichoides in the Polytrichaceae. Details on where the specimens were collected are lacking. The record for Dawsonia is doubtful.

The bryoflora includes subtropical as well as temperate species plus some endemics making Lord Howe Island an interesting environment for studying bryophyte species with various climatic requirements and origins.

The bryophytes, both mosses and liverworts, of Lord Howe Island require further investigation. The following suggestions are put forward for consideration.

1. As no significant collections have been made for the New South Wales National Herbarium since 1911 (the only other specimens being earlier: a few 1887, T. Whitelegge and 1898, J.H. Maiden) and these represent only a few months of the year, a series of collections covering several periods of the year should be undertaken to ensure that species present over the whole range of seasons are detected.

2. Many species are represented by a single specimen. Further collections should be sought to determine the frequency and range of distribution.

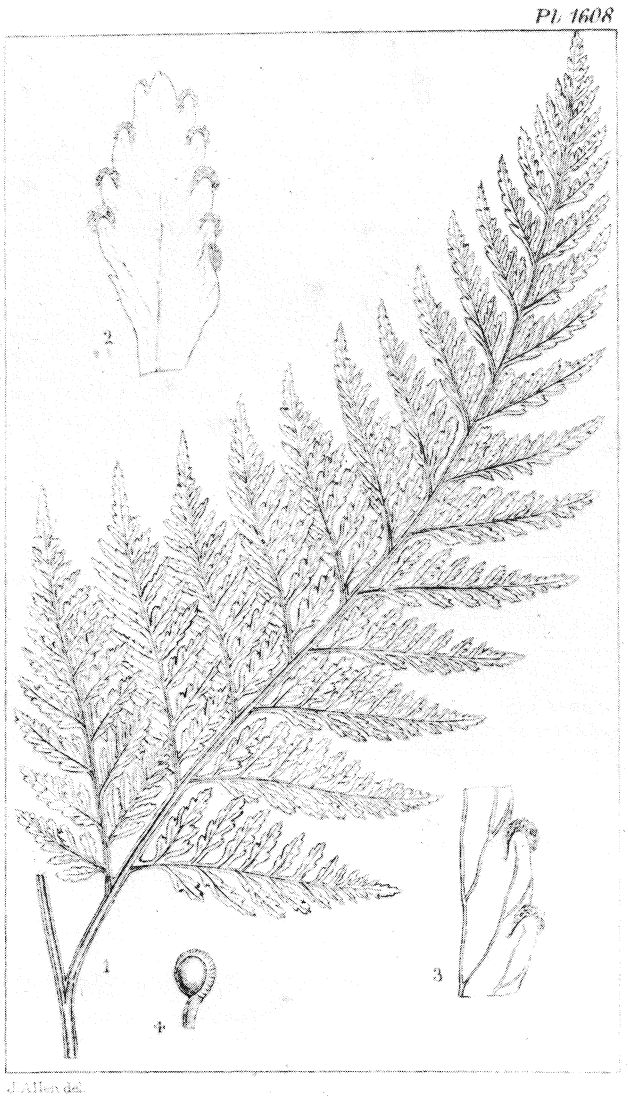
3. Intensive collecting to determine distribution patterns should highlight endangered species, particularly those which are endemic.

4. A record of the names and institutions from which collectors visiting the island come and their interests (if not already done) would make it possible to contact them for information regarding distribution of specimens located in herbaria outside Australia.

HANDBOOK TO THE FERNS

J. Pickard, Antarctic Division, Melbourne, Vic.

The 45 species of ferns on Lord Howe Island are described using a standard format. Keys for identification are provided; these use reproductive and vegetative characters together and singly. The distribution of each species is mapped and herbarium specimens are distinguished from field records on the maps. Each species is illustrated by photos. Wherever possible the handbook has been prepared using computer methods.



Lastreopsis nephrodioides (Baker), a Lord Howe Island fern.

Draft keys are available but they are being revised. Distribution maps are prepared but are being revised to separate specimen records from field records. All information (descriptions, synonomy and distribution) is stored on computer files.

Plantago hedleyi Maiden, an endemic plant from Lord Howe Island.

KEY TO THE ANGIOSPERMS

J. Pickard, Antarctic Division, Melbourne, Vic.

and

A.N. Rodd, Sydney, N.S.W.

Keys to the angiosperms of Lord Howe Island are in preparation. The keys are designed to be used in the field and may not work on specimens. Wherever possible, vegetative characters are used instead of reproductive characters.

PANDANUS

B.C. Stone, University of Malaya, Kuala Lumpur

and

J. Pickard, Antarctic Division, Melbourne, Vic.

The taxonomic status of Pandanus on Lord Howe Island is clarified. There are two species on the island. One, Pandanus forsteri C. Moore and F. Muell. is endemic and widely distributed. The second, P. tectorius, was represented by a single plant on the calcareous sand dune at North Beach. Apparently it grew from a drift seed about 1930 but was killed in a cyclone in 1975.

The distribution and ecology of both species is briefly described.

SOME ASPECTS OF THE PROBLEM OF PALM SEED YIELDS

H. Dowden, Forestry Commission of N.S.W.,
West Pennant Hills, N.S.W.

Although palm seed yields, as judged by sales from the island, are said to have declined recently, the sales were greater from 1960 to 1976 than they were from 1939 to 1959. However, recent sales were less than they had been between 1906 and 1914 and from 1936 to 1939.

Air photo interpretation indicated that palms have been cleared from at least 25% of the area of the lower and more accessible parts of the island.

Deforestation, nutrition, weeds and animals were considered as other factors which may affect seed yields.

There are two main types of soil on the island: these are derived from volcanic (mainly basaltic) rocks and calcareous sandstones. Data from plots and transects showed that although trees were generally healthy and numbers of trees per hectare were similar, yields were less on sandy soils than on basaltic ones. On sandy soils many trees produced few or no seeds while few trees produced many seeds but on basalts fewer trees produced little or no seed and more trees produced a higher yield.

Chemical analysis of seeds indicated that they have a higher content of potassium than of any other non-volatile element. Soil analyses showed

that although both types are rich in nutrients, the sandy soils have a very high calcium content. The uptake of potassium by plants may be affected by a high soil calcium content. This possible cause of reduced seed yield by palms could be investigated experimentally. Weed competition and animal effects are other possible causes of reduced yield which are amenable to experimental studies.

This work suggests that if seed yield has declined, possible remedies may be the re-establishment of palms on deforested areas, together with use of fertilisers and protection of existing palm trees.

VEGETATION CHANGE: A HISTORICAL PERSPECTIVE WITH THE AID OF POLLEN ANALYSIS

J.R. Dodson, School of Geography, University of N.S.W., Kensington, N.S.W.

A study of the pollen representation of the various vegetation formations on Lord Howe Island was made from moss and surface sample collections. These are used to establish the level of precision likely for the identification of vegetation types and their species composition from fossil pollen assemblages.

Three short organic matter sections from near the Airport and Old Settlement Beach were analysed for their pollen content. These data suggest that the wetland site at the Airport is essentially a man-made feature. At Old Settlement Beach there was a vegetation shift from Cryptocaria rainforest to Howea palm forest thence to open grassland after European settlement. The swamp behind the foredune at this beach probably extended considerably after European settlement as a result of a land-slip at the northern end and this has contributed to marginal conditions for the lone surviving Avicennia marina mangrove stand on Lord Howe Island.

CATASTROPHIC DISTURBANCE ON LITTLE SLOPE

J. Pickard, Antarctic Division, Melbourne, Vic.

Little Slope is a series of debris avalanche deposits below basalt cliffs 700 m high at the southern end of Lord Howe Island (31°35'S 159°05'E). There are five distinct physiographic areas on the slope, each separated by sharp boundaries most corresponding to boundaries between features on the cliffs above. The physiography is a consequence of a series of landslides of different but unknown ages. A model of the physiographic history is presented.

Each physiographic area supports a different vegetation community, also separated by sharp boundaries. The present structure of two communities, Melaleuca howeana scrub and Howea forsterana forest, is a consequence of damage by feral animals. Melaleuca scrub has replaced Cyperus lucidus Sedgeland destroyed by goats (Capra hircus) browsing from 1914 until their extermination in 1955. Howea forest has a markedly unimodal age distribution with very few small individuals of the dominant palms. This is a result of the combined effects of browsing by goats on small palms and seed predation by Black Rats (Rattus rattus) from the 1920's preventing regeneration.

Unless rat numbers are periodically reduced to reduce seed predation, regeneration will be insufficient to guarantee long-term survival of the Howea forest. Present rat-poisoning programs are ineffectual.

SECTION E - CONSERVATION

Papers in this section are principally concerned with environmental issues and nature conservation. Significantly each of these proposed to manage the natural areas of Lord Howe Island with respect for the needs and aspirations of the island's residents. Yet each paper recognised the limits to the growth of the island's resident and tourist populations. It was the expression of these limits that led to considerable discussion and some debate between island residents, scientists and environmentalists at the symposium. As the residents of Lord Howe Island were unable to present papers at the symposium, we (Recher and Ponder) asked through one of their representatives on the Island Committee and the Lord Howe Island Board, for a paper to be prepared for inclusion in this section. Unfortunately at the time of these abstracts going to press no statement has been received.

PROPOSAL FOR MARINE RESERVES

D.A. Pollard, N.S.W. State Fisheries, Sydney, N.S.W.

Lord Howe Island, at a latitude of 31.5°S, supports the southernmost coral reef in the world and has been described as the South Pacific's counterpart of Bermuda in the North Atlantic. Because of its zoogeographic uniqueness in this respect, little further justification is required for the protection and preservation of this coral reef environment as a marine reserve. To this end a survey of the aquatic environments around the island was carried out by the author early in 1975 in order to complement the earlier terrestrial environmental survey carried out by the Australian Museum (Recher and Clark, 1974). A brief outline of the results of this survey was presented at the International Conference on Marine Parks and Reserves in Tokyo in May 1975 (Pollard, 1977) and subsequently an outline plan for marine reserves in the island's waters was proposed.

In summary form, this proposal is for the creation of two reserves under the provisions of recently passed Aquatic Reserves legislation in the Fisheries and Oyster Farms (Amendment) Act, 1979, comprising the waters of the lagoon and its fringing reef and those adjacent to Neds Beach (i.e. the two most important coral reef areas). In the case of the former (lagoon and fringing reef) it is proposed that the southern part of this area (i.e. south-east of a line passing through the summit of Transit Hill and the southernmost point of Rabbit Island) be declared a protected area in which the capture or removal of fish or other marine life would be prohibited. To the north-west of the above line all marine life would be similarly protected, with the exception of fish taken for food by means of angling or scoop net (garfish). In the case of the latter area (Neds Beach), the entire area south of a line between the two outermost headlands would be protected in a similar manner to the southern sector of the lagoon and its fringing reef. Permits could be issued by N.S.W. State Fisheries allowing collecting in these areas (with the possible exception of the southern lagoon) for scientific purposes. The capture of butterfly cod (and possibly also other fish species of particular scientific or visual interest) would be prohibited in all island waters except as authorised by such a scientific collecting permit.

It should be stressed: that at this stage the above proposals are suggested management strategies for these areas and that they may be modified according to comments received from affected and interested parties such as local residents and fishermen's representatives, conservation groups, etc., and the results of a comprehensive marine ecological survey of the area.

CONSERVATION OF MARINE ENVIRONMENTS AS AFFECTED BY DEVELOPMENT ALTERNATIVES

W.S. Rooney, Dames & Moore,
17 Myrtle Street, Crows Nest, N.S.W.

A proposal has been submitted to the World Wildlife Fund to assess future development alternatives for Lord Howe Island. The major purpose of the project is to provide information on the implications of different future courses of development for marine and terrestrial environments. The project would require 18 months to complete. This paper describes the proposal for the marine environments, and complements a paper by S.S. Clark on the objectives of the terrestrial and socio-economic aspects of the project.

The principal objectives of the marine survey are to:-

(1) characterise the marine environments present in the vicinity of the island, using techniques described in a report on marine conservation prepared for the Australian National Parks and Wildlife Service by the Centre for Environmental Studies at Macquarie University (Rooney et al., 1978).

(2) to evaluate these marine environments in terms of their significance in the wider Australian context (again applying guidelines developed in the Macquarie University report), and

(3) to assess the vulnerability of the marine environments to the different scenarios of proposed terrestrial development.

The method of approach will include the application of the selection criteria developed by Ray (1976) for the marine environment and discuss the suitability of the resource in terms of each of these criteria.

Before selection criteria can be applied to any area, certain essential information must be known about the area so as to judge its representativeness or uniqueness of habitat. Although it is appreciated that no two ecosystems are exactly the same, some generalised means of classifying the observable habitats would be of great value in speeding up the process of survey, description, comparison and selection. A habitat classification scheme has been produced by the Environmental Studies Centre at Macquarie University which incorporates concepts of biogeography and geomorphology. It is intended to apply this scheme and to expand on it in the form of a well structured site evaluation, such as that proposed by Wright (1977). It is further intended to construct a scientifically detailed data matrix, necessary to develop precise guidelines for management and monitoring. This includes seasonal physio-

chemical and basic productivity data in the water column, and biological information on the benthic macroinvertebrates to accompany the fish survey conducted by the Australian Museum in 1973.

An initial survey and definition of habitat types present will be carried out using aerial photography. Once habitats are delineated, detailed observations and sampling will be carried out along transects in each of the major habitat types (e.g. sandy bottom, rocky bottom, fore reef, back reef, reef crest, intertidal, deep holes, sheltered areas, exposed areas). Seasonal variation will also be investigated.

It is also intended to define the requirements of marine conservation at Lord Howe Island, i.e. what types of reserves and zonation requirements are appropriate, compatible where possible with the social and economic requirements, present and future.

Finally it is proposed to consider the impacts on the marine environment of the proposed development scenarios. This would include consideration of conflicts in usage and in values. Both marine and shore based activities may affect water quality, and coastal morphology. When considering the impact of various activities, the latent but pervasive impacts must be weighed against the conspicuous. Examples of shore based activities which could have serious implications are the discharge or leaching of sewage and septic overflow, or the leaching of persistent and toxic pesticides/herbicides into the lagoon.

The Lord Howe Island Board has recently complained of large increases in the number of sharks in the lagoon. Verification, identification of species and probable causes would be welcomed by the local residents and visitors alike.

CONSERVATION OF TERRESTRIAL AND MARINE ENVIRONMENTS AS AFFECTED BY DEVELOPMENT ALTERNATIVES

S. Clark, Centre for Environmental Studies
Macquarie University, North Ryde, N.S.W.

The conservation of Lord Howe Island is important. The island has a rich fauna and flora, high endemism (plants 30%), rare endemic birds, and is an important sea-bird breeding area. It has the southernmost coral reef in the world and a marine fauna also with many endemics. It has been recommended for inclusion in the World Heritage list by the Australian Conservation Foundation.

But these values are under threat. It is considered that present land use on the island, and feral animals, pose threats to the integrity of the fauna and flora in the long term. State planning authorities have recommended that tourism could be increased (Ashton and McKenzie, 1975), but the concomitant increased support population as well as the visitors numbers will have an impact on the terrestrial and marine ecosystems that has not yet been fully evaluated. This project therefore proposes a study of the changes to the island town that would occur with four different population levels (including the present level) and the impact that these would have on the conservation of fauna and flora, terrestrial and marine, of the island.

The authors are fully cognisant of the importance of the project and its difficulty. They nevertheless feel certain that the task can and must be tackled if this superb conservation area is not to be degraded. It is also considered that the project will provide information of a case study kind for other island communities, because of its integrated approach to a society's impact on valuable and fragile marine and terrestrial island ecosystems.

There are two major objectives of the proposed project; one terrestrial in its focus and the other marine.

(1) On the terrestrial side a major purpose of the project is to develop alternative scenarios for island development in the future concomitant with the conservation of the fauna and flora. It will then be possible to assess the implications of these development scenarios for the island residents in economic and social terms and also for the natural ecosystems of the island in physical and biological terms.

(2) On the marine side our major purpose is to characterise the marine environments present in the vicinity of the island. These environments will also be evaluated in terms of their significance in the wider Australian context. The vulnerability of the environments to the different types of proposed terrestrial development will then be assessed.

The over-riding objective of the study is to provide information to decision makers on how the choice of a course for the future development of the island affects the island's ecosystems, flora and fauna.

CONSERVING AN ENDANGERED SPECIES, THE LORD HOWE ISLAND WOODHEN (TRICHOLIMNAS SYLVESTRIS)

B. Miller, N.S.W. National Parks and Wildlife Service.

The progressive demise of a once flourishing Woodhen population is well documented. Regular censuses and ecological studies since 1969 by Mr. H.J. de S. Disney have focused international attention on the plight of the species (and genus). His recommendations on Woodhen conservation form the basis of my two year appointment to the island by the National Parks Foundation. Objectives of the study are the following:

1. Documentation of distribution, population dynamics, and ecology.

2. Determination of factors confining the population to its present relict distribution.

3. Assessment of possible re-introduction sites on the island. (Discussed by T.J. Kingston).

4. Investigation of the feasibility of a capture, captive breeding, release program.

The Woodhen population is found on Mount Gower Summit (7 stable territories), eastern slopes (4) and Mount Lidgbird Summit (2). In the 1978/79 breeding season, chicks were reared in only 3 of 11 territories studied, due to a lack of females to make up mated pairs, and apparent

sterility. Overall, recruitment balanced mortality. However, on Mount Gower Summit there was a net loss of 4 birds. Six of 7 deaths to September 1979 were in the 4 coldest months.

Circumstantial evidence strongly points to feral pig Sus scrofa as the major factor preventing spread of Woodhen, through predation and habitat destruction. Black rats R. rattus, feral cats Felis catus, feral goats Capra hircus, introduced owls Tyto novaehollandiae and Man are not significant limiting factors. Pig eradication is being attempted by island hunters, in response to a bounty offered by the Lord Howe Island Board.

Captive propagation of the species will commence on the island in early 1980. These pairs of Woodhen will be homed separately in large free-range pens. Artificial rearing of eggs and young will be employed to supplement natural productivity. The program will run for five years after which time it is hoped that sufficient progeny will be available to re-stock additional suitable sites.

THE ENERGY CRISIS

G.J. Bowden, School of Physics, University of New South Wales, Kensington, N.S.W.

The experts tell us that Australia will experience an 'oil crisis' towards the latter half of the 1980's unless substantial new reserves are discovered. To avoid sudden changes in lifestyle therefore, I believe that the 250 people on Lord Howe Island should take a hard look at the alternatives to oil. At the moment the island's electricity is supplied by four diesel oil driven generators, with a maximum capacity of 291 kilo-Watt. The cost of shipping diesel fuel to Lord Howe means that the cost of supplying electricity on the island is approximately 500% more than that in Metropolitan Sydney: perhaps the most expensive electricity in Australia. In this abstract, I examine the role that could be played by windturbines in providing at least a partial solution to the energy needs of the island.

There is one other reason why the islanders should switch to windgenerators. There are 9,000 empty 44 gallon oil drums on the island, quietly rusting away underneath the trees. This number will continue to increase. It would cost $17.50 a drum to return the drums to the Mainland, a total of $152,500. The presence and disposal of these drums therefore constitutes a real and continuing problem for the island. Under the circumstances, a pollution free renewable energy source such as the wind, makes a great deal of common sense.

Windgenerators

In the past few years, both the design and availability of windgenerators in the 100 to 1,000 kilo-Watt range has changed dramatically. Some examples of windgenerators may be seen in figures 1 and 2. The generator in figure 1 has been installed on Cuttyhunk Island 14 miles off the coast of Massachusetts. The island has an average population of approximately 200 people rising to a peak of 500 or so in the summer months. The electricity was originally supplied by diesel generators. In one year the windgenerator cut the annual fuel bill by 60%. Problems of interfacing the windmill to the existing diesel grid were non-existent.

The frequency and the voltage variations of the A/C power produced by the windturbine were within acceptable limits.

Another development in windgenerator design is the Vertical Axis Darrieus rotor shown in figure 2. For US$200,000 it is possible to purchase an off the shelf 300 kw ALCOA windgenerator, which starts up in wind speeds of greater than 19.0 km/hr and produces its maximum output of 300 kw in a 51 km/hr wind. The generator itself resembles a giant egg beater aimed towards the sky. The blade diameter is 26 m, the overall height 37.5 m and the aerofoil blade cross section 0.74 m. This style of windgenerator possesses advantages over propeller-machines. The Darrieus rotor is omnidirectional and does not have to be turned into the wind. The tower and blades cast practically no shadow and the generator is located at the base of the windmill. Servicing the generator of a Darrieus rotor is therefore easier than servicing the generator of a propeller turbine high above the ground. The ALCOA 300 kw machine can survive hurricane force winds of up to 100 mph and wind gusts of up to 150 mph in the parked condition. It does possess one drawback; is not self-starting. Thus the existence of another energy supply such as a battery system is vital.

The most reasonable location for a windgenerator is near the settlement on high ground. The summit of Transit Hill, or more reasonably, on Malabar should be considered as possible sites.

Electric Vehicles

If a decision is made to install a windgenerator on Lord Howe Island, there are further options, which should be explored. At the moment there are 106 vehicles together with a similar number of motor-cycles on the island. Since the range of the electric vehicle is typically between 100-150 km, Lord Howe Island is ideal for the electric car. The batteries of the electric cars could be recharged when excess power is being generated by the windturbine, perhaps overnight. It is worth noting that the electric vehicle industry should welcome an opportunity to test their products on Lord Howe Island. The resulting publicity and practical experience, would benefit the industry and the island. If this option is exercised then the capacity of the windgenerator installed on Lord Howe should be increased to perhaps 750-1,000 kw.

Solar Energy

It is customary (especially in Sydney) to talk in terms of solar energy options. Informed sources believe that electricity generated by solar devices should be about $10 per Watt, which is to be compared with a figure of $1 per Watt for the windturbines discussed above. On cost alone therefore, windturbines are well in the lead at the present time. However, there is another reason why the wind-energy option is to be preferred for Lord Howe Island. Solar devices require plenty of space - because they employ large numbers of mirrors to capture the Sun's rays. At Alice Springs a 100 m x 100 m installation presents no problem, but on Lord Howe Island space is at a premium.

Most homes on Lord Howe Island have been sited underneath the trees. As a result many householders would not benefit from the installation of water heating panels, such as Solarhart, on their roofs. It might be possible to circumvent this difficulty with a 'Condominium solution' in which one large installation is used to provide hot water for say ten

homes. Problems associated with insulating and transporting hot water over a distance of say 50 metres would have to be overcome.

Conclusion

A preliminary investigation of Lord Howe Island's energy needs, suggests that a windgenerator could be used to reduce the island's dependence on diesel oil by as much as 50%. This would at least half the oil drum problem and constitute a step in the direction of self-sufficiency. The transport needs of the island could also be solved at the same time, by the use of electric cars. No dramatically new technology would be required. The overall capital cost of such a transformation would be in excess of one million dollars. However, the practical lessons which could be learned are considerable and would benefit Australia as a whole. Therefore it would be reasonable to expect government support. From the islander's point of view every effort should be made now to make Lord Howe Island immune from future oil shortages.

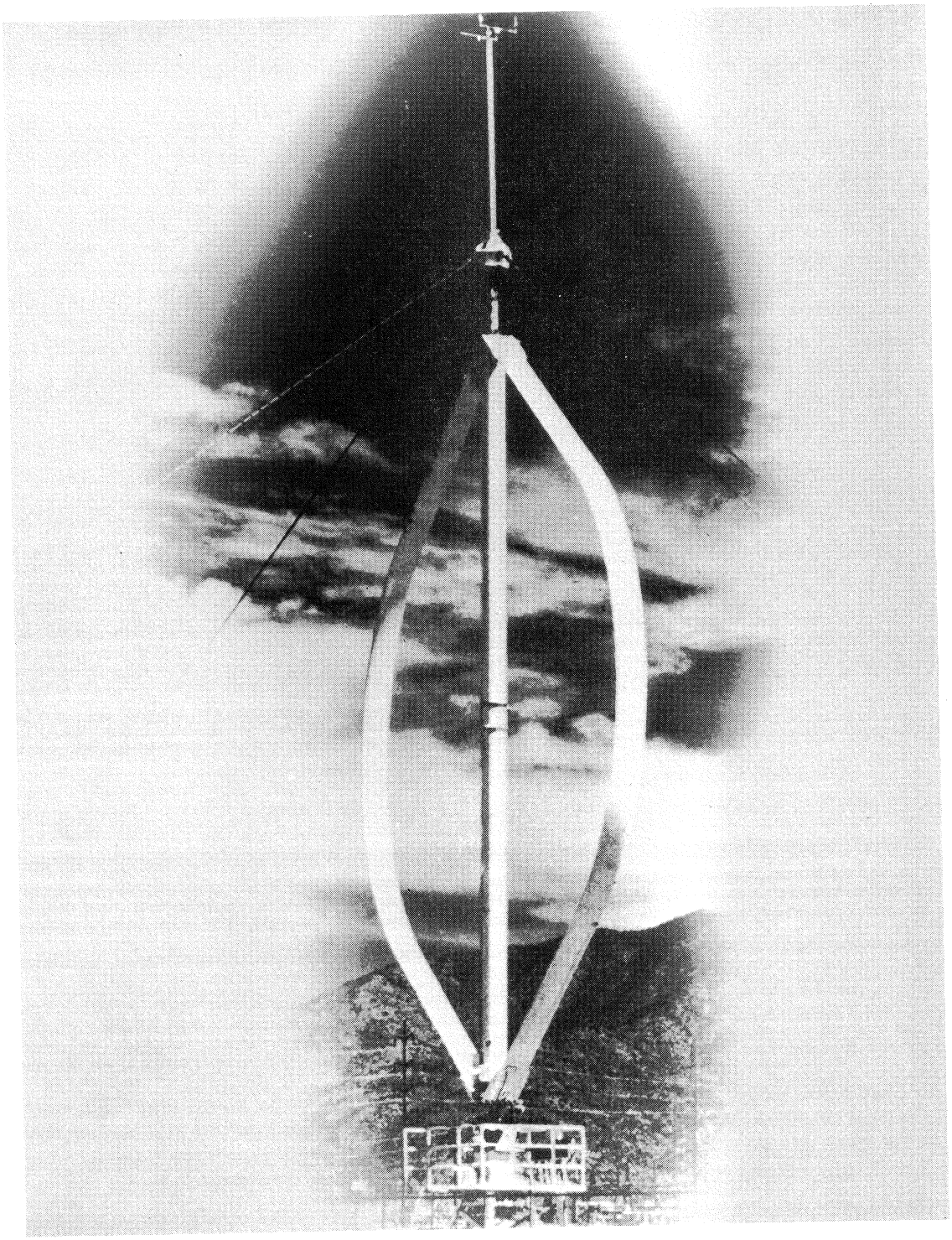


Figure 1. The WTG 200 kw Windgenerator, Cuttyhunk Island, Massachusetts, USA.

Figure 2. The ALCOA 300 kw Vertical Axis Darrieus Rotor, Albuquerque, New Mexico, USA.

SECTION F - GENERAL

In this section a brief summary of the biogeography of Lord Howe Island is presented and two projects of general interest and of considerable usefulness to anyone pursuing research on Lord Howe Island are outlined.

BIOGEOGRAPHY OF THE NON-MARINE FAUNA AND FLORA

W.F. Ponder, Australian Museum, Sydney, N.S.W.

The major geological facts that must be considered when looking at the biogeography of Lord Howe Island are that it is an island of reasonably recent volcanic origin, perhaps only 6 million years old, and that there has never been any form of land bridge or large land-mass connected to, or part of the island. Thus, except in the case of birds and some insects various dispersal agents were required to transport the biota to Lord Howe Island. An analysis of the wind patterns and oceanic currents shows that these impinge on the island from opposite directions at different times of the year. In addition migrating birds could arrive from several adjacent land areas (primarily eastern Australia, New Caledonia and New Zealand). Thus the dispersal agents available to organisms are diverse in relation to the direction on which they act on the island and, probably because of this, the biota is heterogeneous in its composition. The confused composition of the biota has caused some divergence of opinion amongst biogeographers who have variously grouped Lord Howe Island biogeographically along with New Zealand, eastern Australia or New Caledonia.

An analysis of the plants and the well-worked groups of animals indicates that the fauna and flora of Lord Howe Island has much more in common with Australia than with New Zealand or New Caledonia. This is perhaps to be expected considering the proximity of eastern Australia and the size of its land-mass.

As might be expected the groups showing a lower ability to disperse have a higher rate of endemism than those that disperse easily.

The high rate of endemism, at the generic as well as species level, amongst the biota might indicate a greater antiquity for the island than the geological evidence would suggest. There may be two explanations to account for this anomaly. Firstly, the island may be a refuge for Australian organisms that were exterminated with the onset of aridity in the late Tertiary. It is also possible that an element of the biota may have evolved separately, and in a sequential way, during the Miocene on the chain of seamounts to the north of Lord Howe Island. If this is so then Lord Howe Island is the last refuge of this unique assemblage of plants and animals.

GEOGRAPHICAL PLACE NAMES

J. Pickard, Antarctic Division, Melbourne, Vic.

The current synonymous and obsolete geographical place names of Lord Howe Island (31°35'S 159°05'E) are listed. Their locality and origin are noted.

CARTOGRAPHY

J. Pickard, Antarctic Division, Melbourne, Vic.

Twenty five maps and charts of Lord Howe Island are listed and described. Dates of Publication, scale and contents are listed. The first map, by Ball in 1798, was superseded by a well drawn and accurate chart by Denham in 1853. Denham's chart formed the base of all subsequent maps until Standard drew a sketch map in 1963 using air photos. In 1965 a new nautical chart was published. This is based on recent hydrographic surveys and air photos.

Topographic maps at 1: 15840 were first published by the Lands Department of New South Wales in 1909, using Denham's chart as a base. Editions 2 to 5 record changes in cadastral boundaries but the topographic base is identical. Edition 6 was drawn in 1966 using photogrammetric methods on 1966 air photos.

Air photo coverage is also listed. At least 11 sets of air photos and two photomosaics are available.

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