THE SUBANTARCTIC ISLANDS: PAST, PRESENT AND FUTURE*

G. A. KNOX

Department of Zoology, University of Canterbury, Christchurch, New Zealand.

Contributors to this symposium have outlined the present status of our scientific knowledge of what is one of the most fascinating regions on this globe, the Subantarctic Islands of New Zealand. No completely satisfactory definition of this region exists. It may be defined as those islands which lie within the Subantarctic zone of surface waters, bounded to the north by the Subtropical Convergence zone and to the south by the Subantarctic Convergence (Knox 1960).

As these limits are broader in narrower zones of surface waters that fluctuate in position seasonally, and from year to year, it is to be expected that there are island groups to the north and south that may or may not be included in the area according to the point of view of the investigator. Macquarie I., depending on the season, may lie north or south of the Antarctic Convergence and being most isolated and with the severest climate it has, as expected, an impoverished flora and fauna. To the north the Snares Is., the southern part of Stewart I. and the Chatham Is., with milder climates and closer links with the main land mass of New Zealand, have much greater floristic and faunistic affinity with New Zealand. Gressitt (1964) regards Stewart I. and the Chatham Is. as integral parts of the New Zealand faunal area but includes the Snares in the subantarctic. These subantarctic islands, apart from the southern tip of South America, represent the most extensive land area in the great belt of subantarctic waters encircling the globe. They are characterised by their isolation and prevailing oceanic climate with strong winds, low insolation, relatively even low temperatures and many rain days.

As outlined by Falla (1965) and Dawson (1965) there has been a long history of scientific effort in the subantarctic islands, covering four main periods. First, the early collections and observations made during the great exploring and scientific expeditions from 1840 to 1874. Secondly, the magnificent 1907 expedition organised by the Philosophical Institute of Canterbury, followed particularly on the marine side by the 1914-1916 Mortensen Pacific Expedition. Thirdly, the wartime efforts of the Cape Expedition. And fourthly, the modern period commencing with the D.S.I.R. expedition to Enderby and Rose Is. in the northern part of the Auckland Is.; followed by the 1960 expedition led by Dr. E. Godley to Campbell I.; intensive collections of terrestrial arthropods by Dr. L. J. Gressitt and Mr. K. Wise in Campbell I. in 1961 and 1963 (Gressitt 1964); and the December 1962 to January 1963 comprehensive expedition to the northern half of the Auckland Is., organised by the Dominion Museum and the D.S.I.R. Thus in spite of their isolation and difficult access these New Zealand outliers have not been neglected scientifically.

Contributors to this symposium have outlined the state of knowledge in their respective fields and a brief integrated summary follows under subject headings.

BOTANY

Species lists of seed plants are probably complete for all island groups except perhaps the Antipodes. The lower plants, however, have not been studied so intensively and much taxonomic work remains to be done. The recent Auckland Islands Expedition included a lichenologist, and for the first time a comprehensive collection of lichens was made. Initial vegetation surveys have now been completed for the Snares Is. (Fineran 1964a), Campbell I. and the northern portion of the Auckland Is.

TERRESTRIAL INVERTEBRATES

Campbell I. is probably the only island with a reasonably complete list of terrestrial invertebrates (Gressitt 1964). Recent intensive work

* This paper concluded and summarised the symposium on "The Ecology of the Subantarctic Islands of New Zealand" at the Society's Conference at Lincoln College, Canterbury.

in Campbell I. and the northern part of the Auckland Is. has added considerably to our knowledge of this group. Below are listed estimates of the arthropod fauna of the subantarctic islands from Gressitt and Weber (1959) compared with more recent estimates (Gressitt 1964).

	Campbell	Auckland	Antipodes	Bounty	Snares
1959	107	151	20	8	18
1964	381	600	–	–	–

Thus, in the space of a short five years and in spite of considerable collecting over a period of more than 100 years prior to 1959, the described arthropod fauna has been more than trebled. The estimate of 600 species for the Auckland Is. is based on published records combined with estimates of numbers in unstudied collections to hand; and is likely to increase following a further projected expedition to the southern half of the group.

Of the other groups the Bounty Is., being devoid of terrestrial vegetation, are likely to have a limited invertebrate fauna, while the Antipodes Is. are the least studied group, no scientists having spent more than a few days ashore. The Snares Is. still require considerable collecting before we have a complete picture of the fauna, although collections made by the recent University of Canterbury expedition (Fineran 1964b) largely remain to be examined. Kuschel (1964) described the weevil fauna and the number of species recorded for the Snares has been increased from two to eight.

BIRDS

Falla (1965) has given a comprehensive survey of the present state of knowledge concerning the birds of the islands. By and large their distribution is well-known and some detailed biological, life-history and population studies have been carried out at Campbell I. in particular, largely as a result of the Cape Expedition (Bailey & Sorenson 1962).

MARINE MAMMALS

The general distribution of the fur seals, sea elephants and sea lions is now known and some preliminary biological studies have been carried out.

MARINE FLORA AND FAUNA

Dawson has given an excellent review, based on recent extensive surveys by the New Zealand Oceanographic Institute, of the distribution of the bottom fauna of the region. There is evidence of the widespread distribution in this region of the common, deep-water, archibenthal fauna of the New Zealand mainland and of the incursion of subtropical species, especially among the echinoderms, on to the Campbell Plateau. The results of these investigations highlight the previous paucity of knowledge concerning the distribution of the marine fauna of the region. A few years ago I found it impossible to get any reliable information about the occurrence of barnacles on the Auckland Is. However, as a result of the recent expedition the detailed zonation and distribution of the plants and animals on the rocky shores of the northern coast have been worked out. A preliminary survey of the rocky shores of Campbell I. and the Snares Is. has been carried out but the results have not yet been published. There is very little information, however, available concerning the Bounty and Antipodes Is. The taxonomy of only a few groups, such as the mollusca, is complete and we do not even have a check-list for the marine algae of these islands.

Most of the work to date has been concerned with floral and faunal surveys, the compiling of species lists and the establishment of the broad patterns of distribution. To summarise briefly, the present state of knowledge concerning each of the island groups in turn is as follows.

Campbell Island

This is the best known group as well as the most modified through the activities of introduced animals and of man. It is the only island, apart from the main island of the Snares group, for which we have an adequate vegetation map. The list of terrestrial invertebrates is relatively complete and a start has been made on the biology of some groups. More is known of the birds and mammals of this island than of any other.

Auckland Islands

Only the northern part of the group has been studied in detail and a further comprehensive expedition to the southern part should have first priority on a list of desirable scientific projects in order to complete the basic taxonomy of the flora and fauna and the preliminary mapping of the vegetation. The Auckland Is. group, having the largest land area, has been in part subjected to a greater number of

mammalian introductions than the other islands. This mammalian fauna comprises pigs, goats, cattle, rabbits of two varieties, mice and cats. Fortunately the comparatively large Adams I. retains its primitive condition, being free from such introductions. Enderby I. in the north with an area of some 2000 acres has a herd of about sixty cattle as well as innumerable rabbits. An interesting balance appears to have been struck between the introduced species and the native flora and fauna. While many scientists and others would advocate the destruction of the introduced species on Enderby, I would urge that they be retained as the island at present could form an excellent natural laboratory for the study of the interaction of the introduced and native species.

Antipodes Islands

This is the least known group of subantarctic islands and we do not have more than partial species lists for most groups. A comprehensive expedition to fill this gap in our knowledge would have second priority on the list of desirable scientific activities.

Bounty Islands

While the teeming marine bird-life of these islands would make a fascinating study, there is no vegetation and the invertebrate fauna is probably very limited. The group would, however, well repay visiting in conjunction with an expedition to the Antipodes Is.

Snares Islands

The vegetation of this group is now adequately known (Fineran 1964a) and a start has been made on a study of the invertebrate fauna and the biology of the very interesting marine and terrestrial bird fauna. The Snares group is unique in that it is perhaps the only one of its size in the New Zealand area which still retains its virgin state and is entirely free from all introduced mammals. In a simplified island ecosystem such as the Snares it is possible to study the interaction of the component species in a situation that has not been interfered with in any way. The University of Canterbury Zoology Department has established a base on the island and intends to carry out a long-term programme of biological research (Fineran 1964b).

What then of the future of these interesting islands? First, there is an urgent need to complete initial surveys, particularly on the projected second Auckland Islands Expedition to the southern part of the group and on another in the not too distant future to the least known of the islands, the Antipodes and the Bounties.

For the scientist these islands have many points of intrinsic interest, notably concerning the biogeographical problems of the region and their relationship to southern biogeography in general (Knox 1963). These isolated islands could hold the key to some of the fascinating distribution problems of the southern land areas. On the basis of the distribution and relationships of the weevil fauna Kuschel (1964) considers that the present day fauna of the subantarctic islands has been derived from two main sources of different ages, postglacial colonizers that have reached the islands in the past 15,000 years, and an ancient element, comprising endemic species, that was already established in the region before the Ice Ages. It is of interest that Godley (1965) recognises in the north of the Auckland Is. a distinctive group of plant species characteristic of and confined to the higher altitudes, including many endemic species of the subantarctic islands. These then would correspond to Kuschel's ancient element. This hypothesis receives further support from recent studies of the Plecoptera (stoneflies) of Campbell and Auckland Is. (Illies 1963, 1964). Stoneflies as a group do not readily disperse across extensive sea barriers and are missing from oceanic islands in general.

The winged *Aucklandobius complementarius* End. is endemic to both Auckland and Campbell Is. and, in addition, the completely wingless genus *Apteroperla* Wisley is represented by two endemic species on Campbell I. and one on the Auckland Is. This latter genus is endemic to the New Zealand region, being represented on the mainland by two species. Illies considers that the genus could have evolved in the "Mesozoic territory which included New Zealand and its later isolated subantarctic islands", i.e. the species were distributed across land connections. Another group which apparently requires land connections for dispersal is the land slugs, represented not only by endemic species but also by the endemic genus *Pallipodex* on Auckland I. (Burton 1962). It appears firstly that the land area in the subantarctic was once considerably more extensive than at present and secondly that considerable ice-free refuges must have existed, such as the well known extensive ice-

free area which existed in Alaska at the height of the glaciations. Illies considers that favourable conditions for the terrestrial larvae of one of the flightless stoneflies, i.e. a cool and wet climate, must have lasted continuously in at least some places on Campbell I. since Mesozoic times, and that permanent, running fresh water environments must have lasted at least since the breakdown of land connections, to allow the continued existence of the obligatory aquatic larvae of other flightless species.

Gressitt (1964) considers that the arthropod fauna of Campbell and the Auckland Is. may be classed as a depauperized fragment of an ancient subcontinental fauna with overseas recolonization, and believes that much of Campbell's fauna represents recent post-glacial overseas dispersal. Before a final answer to the problem of the origin and relationships of the fauna can be given we need to have more information on the geological history of the region.

These subantarctic islands with their climate, isolation and interesting flora and fauna are of great evolutionary interest and in fact could be ideal open-air laboratories of evolution. The most conspicuous feature of the Insecta of these islands is their high proportion of flightless species (Gressitt 1964). Some of the apterous insects on Campbell I. are the only known wingless species in their respective groups and Gressitt suggests that ". . . evolution on such an island is very rapid, and that apterism may not be an indication of lengthy isolation. Among the evidence is the frequent non-use of wings by winged species, the variation in wing size of some of the brachypterous species, and the general indications of great plasticity and intraspecific variation. The morphological variation appears to correlate with great ecological plasticity, perhaps both being influenced by scarcity of predators and competitors. Because of the great influence of the adverse climate, selection favoring loss of wings and the development of habits better attuned to the local environment is probably proceeding at a rapid rate". Detailed study of such problems could add much to our knowledge of evolutionary processes.

The paramount scientific interest of these islands, however, lies in the fact that they represent, in part at least, some of the few remaining island areas that have avoided the destructive activities of man. As such we have both a national and international obligation to maintain and preserve them intact. This entails not just passive preservation but the development of a positive attitude, recognising the need to intensify our research into their biology and ecology. It is only when we have an adequate background of basic research that we will be able to devise a sound management programme for these islands.

We may hope that the initial surveys will be rapidly completed and that the second phase will be embarked upon, namely the more detailed study of the biology and ecology of the flora and fauna of the islands.

REFERENCES

BAILEY, A. F., and SORENSON, J. H., 1962. Subantarctic Campbell Island. *Denver Mus. Nat. Hist. Proc.* 10: 1–305.

BURTON, D. W., 1962. A revision of the New Zealand and Subantarctic Athoracophoridae. *Trans. Roy. Soc. N.Z., Zool.* 3: 47–75.

DAWSON, E. W., 1965. Oceanography and marine zoology of the New Zealand Subantarctic. *Proc. N.Z. Ecol. Soc.* 12: 44–57.

FALLA, R. A., 1965. Birds and mammals of the Subantarctic Islands. *Proc. N.Z. Ecol. Soc.* 12: 63–68.

FINERAN, B. A., 1964a. An outline of the vegetation of the Snares Islands. *Trans. Roy. Soc. N.Z., Bot.* 17: 229–235.

FINERAN, B. A., 1964b. A note on the 1961 Snares Islands expedition. *Trans. Roy. Soc. N.Z., Bot.* 17: 236.

GODLEY, E. J., 1965. Notes on the vegetation of the Auckland Islands. *Proc. N.Z. Ecol. Soc.* 12: 57–63.

GRESSITT, J. L., 1964. Insects of Campbell Island. *Pacific Insects Monograph* 7: 3–33, 531–600.

GRESSITT, J. L., and WEBER, N. A., 1959. Bibliographic introduction to Antarctic-Subantarctic entomology. *Pacific Insects* 1: 441–467.

ILLIES, J., 1963. The Plecoptera of the Auckland and Campbell Islands. *Cape Exped. Ser. No.* 26 *Rec. Dominion Mus.* 4: 225–265.

ILLIES, J., 1964. Insects of Campbell Island. Plecoptera. *Pacific Insects Monograph* 7: 208–217.

KNOX, G. A., 1960. Littoral ecology and biogeography of the southern oceans. *Proc. Roy. Soc., Lond. B.* 152: 577–624.

KNOX, G. A., 1963. Antarctic relationships in Pacific biogeography. In Gressitt, *Pacific Basin Biogeography*. Bishop Museum, pp. 465–474.

KUSCHEL, G., 1964. Insects of Campbell Island. Coleoptera: Curculionidae. *Pacific Insects Monograph* 7: 416–493.