Entomological Research in the Marquesas Islands

By Dr. HUGH SCOTT

THE Marquesas are the first islands chosen for intensive study by the Pacific Entomological Survey, which is being conducted jointly by the Bernice P. Bishop Museum, Honolulu, the Hawaiian Sugar Planters' Association, and other bodies. A preliminary general account of results by E. P. Mumford, director of the Survey, and A. M. Adamson, entitled "Entomological Researches in the Marquesas Islands", was prepared for the fifth International Congress of Entomology, in Paris in July 1932, and a few typewritten copies have been distributed.

Field-work was carried on by these two writers and others during the three years, 1929-31. Collections were formed of all terrestrial animals except birds (which were already fairly well known), all fresh-water animals, and plants (the last on account of their association with the insect fauna). Records were made of geographical, meteorological and other observations. Previous entomological work, the most important of which is based on the collections made by the *St. George* expedition, is being taken into consideration. The publication by the Bernice P. Bishop Museum of an extensive series of systematic reports has been begun, and an introduction is being prepared by Messrs. Mumford and Adamson.

The Marquesas are among the most isolated islands in the world, and are actually farther from continental land than any other comparable archipelago. Situated in 7°-11° S. lat. and 138°-141° W. long., they extend from north-west to south-east (the same direction as the Hawaiian and other Pacific groups) over some 230 miles. Their total area is about 500 square miles (that is, roughly one-fourteenth that of the Hawaiian Islands). All are high volcanic islands, almost entirely devoid of fringing coral reefs. The six larger islands reach an altitude of 3000-4000 ft.

Since the advent of Europeans, great changes have taken place, and are still rapidly happening, in the endemic flora and fauna. The familiar melancholy tale has to be told. Deforestation and denudation, for which sheep and other domestic animals are largely responsible, are far advanced. In the lower islands, the very interesting insect fauna seems doomed to extinction. In the higher islands, deforestation has affected much less the cloud zone above 2000 ft., where the moisture of the trade winds is precipitated as a heavy rainfall. But, even at these altitudes, the leeward slopes are relatively dry, and semi-arid *terres désertes*, denuded by grazing animals, occur. Moreover, the high forests are being invaded by a recently imported grass (*Paspalum conjugatum*), and a now cosmopolitan marauding ant, *Pheidole megacephala*, is an active agent of destruction.

The insect fauna has all the characters associated with isolated oceanic islands, *inter alia*, pre-

dominance of small size, dull colouring and obscure habitat; absence of many families and superfamilies, and of some entire orders; and disproportionate development of a few genera. Aquatic groups of insects and other fresh-water animals (as well as fresh-water plants) are poorly represented.

Groups entirely absent comprise the orders Plecoptera, Trichoptera, Ephemeroptera and Mecoptera (the first three of which are aquatic in their early stages); all the aquatic Hemiptera-Heteroptera constituting the sub-order Cryptocerata; among Hemiptera-Homoptera, the Cicadidæ, Cercopidæ, Membracidæ, aphids, and many families of Fulgoroidea; most families of Neuroptera, many great families of Coleoptera (for example, the entire lamellicorn series), many families of Diptera; and, in Hymenoptera, the sub-order Symphyta (sawflies, etc.) and most families of aculeates.

The authors regard these gaps in the fauna as strong evidence against the existence in past ages of extensive land areas in the Pacific. On the whole, this conclusion is probably right, but it may be pointed out that some of these groups are also absent from the faunas of islands not of volcanic and purely oceanic origin. Plecoptera, Mecoptera and Hymenoptera Symphyta are absent from the fauna of the Seychelles,* an ancient granitic archipelago, believed to be the remains of a much larger land, even if not of definitely continental origin. These groups are also, so far as is known, very poorly represented in Ceylon. Allowance must be made for their being apparently weakly developed in the tropics as a whole, both continents and islands, as compared with their much richer development in temperate latitudes.

Other features mentioned above, namely predominance of small size and dull colouring and weak representation of aquatic groups, are also characteristic of the fauna of the Seychelles. But disproportionately developed genera are much more numerous in the volcanic archipelagoes, and only of exceptional occurrence in the Seychelles.

Among the components of the Marquesan fauna one of the most interesting is the genus *Proterhinus* (Coleoptera, Rhynchophora). Originally discovered in the Hawaiian Islands, where more than 150 endemic species exist, it was made the sole genus of a new family. Afterwards a single species was found in Samoa and one in the Phoenix Islands, and two in the Marquesas must now be added. The genus most closely related to *Proterhinus* is *Aglycyderes*, of which one species in the Canary Islands and two in New Zealand are known†.

* See an abstract of "Summary and General Conclusions Regarding the Insect-Fauna of the Seychelles and Adjacent Islands", by Hugh Scott, (*Proc. Linn. Soc.*, Session 144, pp. 136-140, 1931-32).

† In several textbooks New Caledonia is included in the range of *Aglycyderes*, but I cannot trace any published description of a species in that country.

These two genera are now considered to form a single family. The distribution of *Proterhinus*, centred in Hawaii and with outlying species in other Pacific islands, is comprehensible, as is also the occurrence of related forms in New Zealand. But no explanation suggests itself for the existence of another relative in the Canaries, when no representative of the family has come to light in any other part of the world—even where the fauna has been intensively collected.

The degree of endemism is very high. Excluding wide-ranging forms, few or no species are common to the Marquesas and Hawaii or Samoa, the nearest high islands of which the fauna is well enough known for comparison. Among species the degree of endemism is probably lower than in Hawaii, but of the same order (that is, approaching 80 per cent); among genera it is much lower.

The proportion of endemic species restricted to a single island is apparently higher than in Samoa and of the same order as in Hawaii. For example, there is, as in many remote islands, a great development of endemic Curculionidæ, and, in the otiorhynchine section, the number and diversity of species, each restricted to a single island, indicate that the archipelago is of considerable age. Like phenomena are noted among the Hemiptera-Homoptera, while, on the other hand, in one family of Hemiptera-Heteroptera a genus has developed into many closely allied endemic species, some of which range over several islands. Possibly these latter forms originated too recently to have

diverged into separate species. It is too early to state whether any evidence is forthcoming of an increase in the habitable age of the islands from south-east to north-west, like that of which there is some indication in the Hawaiian archipelago.

Nor are generalisations as to the origin of the fauna yet possible; for, some groups of animals exhibit close relationships with the fauna of Hawaii, others with that of the south central Pacific islands lying to the south-west. Among the former are the Hemiptera-Homoptera, among the latter the Hemiptera-Heteroptera, and the endemic birds and land snails, which have little in common with those of Hawaii. Botanists have stressed the existence of important, though secondary, affinities between the Marquesan and Hawaiian floras.

Deductions bearing on past land connexions in the Pacific are also left until the fauna has been fully worked out. While the almost entire absence of coral reefs has been attributed to rapid subsidence, alternating elevation and subsidence have also been postulated. In either case, the number of species restricted to a single island indicates that the individual islands have been separated for a long period, if time be regarded in terms of what is needed for the formation of species.

The sections on association of endemic insects and plants, and the bearing of the investigation on agricultural and medical problems, cannot be discussed here. Enough has been written to show the nature of the questions discussed. The Survey may be congratulated on an excellent start.

Some Problems of Food Preservation

THE problems involved in the freezing, storage and transport of New Zealand lamb have recently been examined by the Food Investigation Board, in co-operation with the Empire Marketing Board, the New Zealand Department of Scientific and Industrial Research, the New Zealand Meat Producers' Board and the New Zealand Tonnage Committee representing the shipping lines trading between Great Britain and New Zealand.¹ The investigation involved an analysis of the physical conditions in the various storage chambers through which the meat passed and an examination of the effects of the environment on the quality and appearance of the carcasses, as estimated from the loss of 'bloom'. Bloom is the freshly-killed appearance of the meat and is dependent upon the appearance of the superficial tissues, the exposed muscle, fat and connective tissue. It is affected by the following factors: the rate of cooling and freezing, which determines the opacity of the superficial connective tissue and, indirectly, the colour of the visible muscle; the amount of drying, excessive desiccation producing marked loss of colour in the muscle; the formation of methæmoglobin from hæmoglobin on prolonged storage, that conversion being hastened by sweating; and finally, excessive sweating, which also results in swelling of the

connective tissue fibres with increase in their opacity.

When meat is frozen, the structure of the muscle is changed, so that on thawing it is not so resilient and there is a leakage of free fluid, usually referred to as 'drip'. Freezing probably denatures certain of the proteins so that they lose some of their power to hold water. At a temperature constantly below -8°C . other changes, such as those due to autolysis, microbial growth or hydrolysis and oxidation of the fat, are only slight. It is therefore the alterations in the physical properties of the meat which are of the most importance. They are indicated by loss of weight as well as by loss of bloom.

The survey has shown that there is no need for radical alterations of technique, although improvements at each stage of the chain of treatment are possible. It has been found that bloom is affected not only by the immediate ante-mortem treatment of the sheep but also by such factors as breed, diet, age at killing, etc. Southdown crosses were found to have a good initial bloom and that was correlated with a higher concentration of hæmoglobin in the superficial muscle; older animals had a better bloom than younger of the same breed. Starvation prior to slaughter had