

NON-MARINE INVERTEBRATE FAUNA
OF THE MARQUESAS
(EXCLUSIVE OF INSECTS)

By

A. M. ADAMSON

BERNICE P. BISHOP MUSEUM
OCCASIONAL PAPERS
VOLUME XI, NUMBER 10

HONOLULU, HAWAII
PUBLISHED BY THE MUSEUM
1935

NON-MARINE INVERTEBRATE FAUNA
OF THE MARQUESAS
(EXCLUSIVE OF INSECTS)

By

A. M. ADAMSON

INTRODUCTION

In this review of the Marquesan terrestrial and fresh-water invertebrate fauna, exclusive of insects, I have summarized the results of the specialists who have studied the collections made in the Marquesas by the Pacific Entomological Survey. I have given special attention to the facts that concern problems of distribution, and to supplementing the taxonomic reports with observations made in the field.¹ It has not been possible, at present, to attempt to list all the species in each group of animals, because a fair number of additions will be made when all the collections have been determined. I have omitted, as far as possible, details that are to be found in systematic reports already published. The opinions expressed in these pages regarding the absence of records of any group of animals from oceanic² islands in the Pacific are based on an extensive, but not exhaustive, review of the literature; these opinions are therefore to be taken with the reservations that I have made at appropriate places in the text. The manuscript was written in 1933; it has been revised before going to press, but I have probably neglected not a few important papers on Pacific island faunas published since 1933.

I am indebted to Monsieur L. J. Bouge, Governor of the Etablissements français de l'Océanie at the time of my visit, for permission to work in the islands, and to Monsieur A. Aumont, then Administrator in the Marquesas, and his successor, Monsieur le Docteur

¹As a member of the Pacific Entomological Survey Mr. A. M. Adamson resided in the Marquesas from January 21, 1929, to April 10, 1930. During this period he made collections on the islands of Hatutu, Eiao, Nukuhiva, Uahuka, Uapou, Hivaoa, and Moorea. Enroute to the Marquesas Mr. Adamson collected insects on Tahiti and Moorea which have been described by specialists in a series of 31 papers (B. P. Bishop Mus., Bull. 113). The scope and activities of the Pacific Entomological Survey are recorded in the Reports of the Director of Bernice P. Bishop Museum for the years 1926-33.—Editor.

²The term "oceanic" is used in this paper to designate islands within the Pacific Depression, without reference to their origin.

Louis Rollin, for the hospitality and assistance graciously extended by them.

I am indebted also to Marquesans and other residents in the islands for information received from them, particularly regarding native names of animals. I wish to thank especially Père Siméon Delmas, Monsieur Zacharie Touahafeuu, Monsieur Timo Vahatetua, Monsieur Stanislas Taupotini, Mr. Robert MacKittrick, and most of all Monsieur G. LeBronnec. In preparing this review I have received much advice from Mr. O. H. Swezey, Dr. F. X. Williams, Dr. C. H. Edmondson, and Mr. R. H. Van Zwaluwenburg, and, concerning the Mollusca, from Dr. C. Montague Cooke, Jr., and Dr. H. A. Pilsbry.

GENERAL REMARKS

In the Marquesan non-marine fauna there are only two phyla, the Arthropoda and Mollusca, in which large numbers of endemic species are known. The Protozoa and the Trochelmintes of these islands have received scarcely any attention; it is possible that both phyla are represented by few, if any, endemic free-living species. The Porifera, Coelenterata, and Molluscoidea may be entirely unrepresented; an exhaustive search for them was not made, but fresh-water sponges and polyzoans, if at all common, would probably have been found. Hydra, if present, may easily have escaped notice. A few free-living terrestrial Platyhelminthes and Nematelminthes were found, and a few parasitic species are known to occur. There may be some endemic species, both free-living and parasitic, in these two phyla. The Annulata are represented in the collections only by terrestrial Oligochaeta, which are probably all immigrants transported by man. Non-marine Polychaeta and Hirudinea may be entirely absent. Among the Arthropoda a few endemic species of terrestrial Crustacea are known, and a large number of endemic Insecta, Araneida, and free-living Acarina. Other arthropods are poorly represented or entirely absent. In the Mollusca there are numerous endemic species in a few ancient terrestrial families, and a very few species of fresh-water gastropods, all of which may be widely distributed.

The extreme paucity of the fresh-water faunas of Pacific oceanic islands is well known and the small number of aquatic species in the Marquesan collection is not surprising. But it should be stated that relatively little time was spent in collecting in streams. Even less

time was devoted to the few pools of stagnant water, almost all of which are found at low levels. This partial neglect of the fresh-water fauna was due to the fact that in the short time available general collecting was done chiefly by methods that gave the largest returns.

Some of the fresh-water species, such as the palaemonid prawns and the isopod *Ligia vitiensis*, have been derived fairly recently from marine forms and their dispersal to oceanic islands may perhaps be explained by their former marine habit. Others, such as the atyid shrimps and snails of the genus *Melania*, probably attained their present distribution in the Pacific islands after they had taken to fresh water. The occurrence of these species therefore presents about the same problem as the presence of terrestrial species. With allowance for the greater difficulty that fresh-water species must overcome in crossing the ocean, the endemic fresh-water fauna in the Marquesas is still remarkably meager in comparison with the terrestrial fauna. This applies even to the insects, though the aquatic forms are at least partially aerial in their adult phases.

A full discussion of the affinities of the fauna awaits the completion of systematic studies on the collections made by the Pacific Entomological Survey. But it is already evident that there is a general affinity between the Marquesan fauna and that of the islands to the southwest and in turn with the Indo-Malayan fauna. No direct affinity has been thus far discovered, in the invertebrates dealt with here, between the Marquesas and Hawaii, except in one genus of spiders and, according to Jacot (30),³ in some of the mites. There is little evidence, also, of any influence from America.

PROTOZOA

Nothing appears to have been written on the free-living Protozoa of the Marquesas; no attempt was made to study them, except when making a few hauls for fresh-water plankton, at Vaihakameama, Nukuhiva, when a species of *Diffugia* (?) was the only protozoan that I saw.

The presence of pathogenic Protozoa in the Marquesas may be inferred from the occurrence of the diseases caused by them, of which an account is given by Rollin (40). Syphilis has probably been rampant in the islands since the arrival of the first white voyagers, though at present it appears to occur mostly in a hereditary form.

³ Numbers in parentheses refer to Literature Cited, p. 37.

There have been disastrous epidemics of dysentery; after questioning residents in the islands, I was unable to decide whether these were of the bacillary or the amoebic form, or both. The absence of amoebic dysentery from most of the Pacific islands suggests that only the widespread bacillary form has occurred in the Marquesas. The depopulation of the Marquesas from more than 50,000 to about 2,000 has been due almost entirely to introduced diseases, especially tuberculosis, but a surprisingly small number of protozoan and other so-called tropical diseases have as yet reached the Marquesas and other islands east of Samoa. This is no doubt largely due to the absence of many insect vectors, such as anopheline mosquitoes.

It is unfortunate that time was not found for the preservation of flagellates from the Marquesan termites, of which three endemic species are known. The remaining four species, in the genus *Kaloterme* (*s. lat.*), are found in other parts of the central Pacific, and it would be interesting to know if each species has exactly the same flagellate fauna on each archipelago.

Little work has been done on the free-living Protozoa of any Pacific island, even Hawaii. Edmondson (18) observed 46 species in Tahiti, and notes that all of these are common in North America. Van Winkle (49) lists 49 species of testaceous rhizopods from Hawaii, none of which are new species.

PORIFERA

No fresh-water sponges were found in the Marquesas. It would be unwise to conclude on this evidence alone that none occur, but I have been unable to find records of any farther east than Fiji, where *Spongilla gilsoni* was described by Topsent (47). It is probable that fresh-water sponges have failed to reach the oceanic islands of the Pacific.

COELENTERATA

Hydra might be expected to occur in the Marquesas; I observed none, but looked for them only a few times. I have found no records of fresh-water coelenterates from the oceanic islands of the Pacific. Mr. O. H. Swezey and Dr. C. H. Edmondson, however, tell me that Hydra is to be found in Honolulu; so far as I know its presence in Hawaii has not been recorded in the literature.

PLATYHELMINTHES

TURBELLARIA

A few terrestrial planarians were collected at altitudes of 1,720 to 3,900 feet on Hivaoa, Nukuhiva, and Uahuka. They were observed frequently, but in small numbers, among wet vegetation, mostly in the cloud zone, and I suspect that they are limited to high altitudes. The specimens have not yet been identified; they appear to represent a single species. New Caledonia (42) has a large number of endemic land planarians. *Bipalium kewense*, now widespread, is native in Fiji, Tonga, and Samoa, and so far as I have been able to discover, this is the only land planarian which has been identified on the Pacific islands east of Fiji. I have seen at least one unidentified species in the forests of Hawaii.

I spent some time looking for fresh-water planarians in the Marquesas, without success. A search in the literature on the Pacific islands proved equally fruitless, but Dr. F. X. Williams tells me that he has observed at least two small species in streams at medium altitudes near Honolulu.

TREMATODA

We learned nothing regarding the occurrence of trematodes in the Marquesas, except in a communication from Dr. Louis Rollin, formerly Administrator of the islands. In a remarkable case of haemoptysis, he found in the patient's sputum eggs which resembled those of the lung-fluke *Paragonimus westermanni* Braun. In view of the paucity of endemic mammals and fresh-water fishes, few species of trematodes of special interest are likely to occur on the oceanic islands of the Pacific, and I know of no records beyond those of widespread species, such as *Fasciola hepatica*.

CESTODA

No tapeworms have been reported from the Marquesas. As with the trematodes, few species are likely to occur on oceanic islands, but *Drepanidotaenia hemignathi* Shipley and another, undetermined, species are known from drepanid birds of Hawaii, and interesting species may occur in the endemic birds of the Marquesas.

NEMERTINEA

No non-marine nemerteans are known in the Marquesas, nor, so far as I know, in any central Pacific island east of Samoa. There are some terrestrial species in Samoa (26). Buxton (7) writes that

Geonemertes palaensis, recorded also from Palau and Celebes, is common in the Samoan forests.

NEMATHELMINTHES

NEMATODA

The nematode worms of the Marquesas have so far received little attention, and specific, authoritative records seem to be entirely lacking. Nothing appears to have been written on free-living species. I have records of a few specimens in wet humus at about 4,000 feet altitude on Temetiu, Hivaoa, and it is likely that many species of free-living nematodes occur in the Marquesas. Numerous species have been described from the soil in Hawaii and a few other archipelagoes, but the distribution of these worms throughout the Pacific is too little known for the drawing of any conclusions regarding their origin and geographical relations.

An interesting and somewhat surprising find was that of the small worm, *Rhabditis coarctata* Leuckart, attached in large numbers to caterpillars tentatively referred to the family Gelechiidae. The worms were kindly identified by Dr. J. N. Oldham. They have been found in other parts of the world on scarabaeid and staphylinid beetles; the larval worms attach themselves to the surface of the beetles, encyst there, and are carried to fresh supplies of dung on which the worms feed (48, 50). The Marquesan specimens were found at Atuona, Hivaoa, and on Fatuhiva, on caterpillars boring in the large seeds of the Tahitian chestnut (*Inocarpus edulis*). Unfortunately, moths reared from these were lost. The caterpillars appear to belong to the family Gelechiidae, and they have been noticed within the last few years in the Marquesas, as a pest infesting almost every seed of the Tahitian chestnut in certain places. The origin of the worms in the Marquesas is a matter for speculation: they may have come with the caterpillars or other insects, or independently in dung of domestic animals. Dr. Oldham tells me that *Rhabditis coarctata* has hitherto been recorded only as a dung form, and he raises the question as to whether the caterpillars on which they were found in the Marquesas were likely to come in contact with dung. Unfortunately I do not know whether the caterpillars ever spend time outside the fruits, on the ground; but at Atuona, Hivaoa, it is possible that horses may have been tethered under the tree below which the infested fruits were found, so that contact with dung seems not unlikely.

A few parasitic nematodes are known in the Marquesas.

Marquesan children are said to be frequently infected by two species of intestinal worms. The smaller worm (*kaio* or *naio*) is probably *Enterobius vermicularis* (Linnaeus), and the larger (*potiveo*) is probably *Ascaris lumbricoides* Linnaeus. Native remedies are extracts of the bark of the banyan (*Ficus prolixa*) and of the flowers of *Gardenia tahitensis*.

Elephantiasis is common among the Marquesans, and a few white residents suffer from it. It is believed locally to have been introduced to the Marquesas about 1895 by Tahitian convicts sent to Uahuka. *Filaria bancrofti* Cobbold is probably the species concerned, as in other parts of Polynesia, and it is doubtless transmitted by one or both of the species of mosquito—*Culex fatigans* Wiedmann and *Aedes scutellaris* Walker—known to occur in the Marquesas. I have found no extensive account of filariasis in French Polynesia; a great deal of information on the disease and the rôle of mosquitoes in its transmission in Samoa and other parts of the Pacific is given by Buxton and Hopkins (8).

ACANTHOCEPHALA

No worms of the class Acanthocephala are known from the Marquesas. It is possible that there are endemic forms, though in the oceanic islands of the Pacific the only endemic species I know of is the remarkable *Apororhynchus hemignathi* Shipley from the Hawaiian drepanid bird, *Hemignathus*.

TROCHELMINTHES

A few rotifers were collected in Vaihakameama pond on Nukuhiva, at about 2,600 feet. They have not yet been identified. The most important reference to fresh-water rotifers in the oceanic islands of the Pacific is a paper by Murray (35), in which he lists 24 widely distributed species from Hawaii, 2 from Samoa, 15 from Fiji, and 2 from the Galapagos, as well as an unnamed "evidently distinct" species from Hawaii.

I know of no records of Gastrothricha from the Pacific islands.

MOLLUSCOIDEA

POLYZOA

Fresh-water polyzoans were not observed in the Marquesas, but only a short time was devoted to searching for them. The only records I have found in the Pacific islands are from Tahiti, where

two species were collected by Dr. Cyril Crossland in Lake Vaihiria, at an altitude of 1,140 feet. These were recorded by Hastings (24), one of them as a new species, *Hyalina vaihiriae*. The other, which I also found in the same locality, was assigned to the cosmopolitan *Plumatella emarginata* Allman, but Dr. Hastings informs me that revision of this species may eliminate the Tahitian forms from it. In a fresh-water fauna so small as that of Tahiti, it is perhaps surprising that at least one endemic polyzoan occurs.

ANNULATA

All of the non-marine annelids observed in the Marquesas were terrestrial oligochaetes.

So few fresh-water polychaetes are known that it is likely that none occurs in the Marquesas. A fresh-water nereid was described, as *Lycastis hawaiiensis*, by Johnson (32) from a spring near Honolulu, and from another, unrecorded, locality in Hawaii. Its occurrence is probably of no significance in connection with the true fresh-water fauna.

It is not improbable that leeches occur in the Marquesas, though none was found. Dordillon (16) gives the Marquesan name *toke omo toto* (blood-sucking worm) for leech, but this can hardly be accepted as evidence of anything except possibly a recent introduction. *Philaemon minutus* Blanchard is endemic in Samoa, in the wet mountain forests (7). In Hawaii the fresh-water leeches have not been studied; Bryan (9) states that two unidentified species are quite common in the streams of Oahu.

Oligochaeta (earthworms) occur at all altitudes in the Marquesas. In the rain forest they are to be found in small numbers in wet, decaying vegetation, under moss on tree trunks, and under stones. The soil fauna in the mountains was not investigated. The collection, which appears to include a small number of species, has not yet been identified.

The oligochaetes are of special interest in problems of zoogeography, but those of oceanic islands serve only, in the absence of endemic species, as evidence that the islands are truly oceanic. This absence may be regarded as well established, on the recent and authoritative statement of Stephenson (46, p. 674), who attributed the presence of earthworms on oceanic islands entirely to human

traffic. It is therefore to be expected that all the species in the Marquesas will be found to be immigrants of wide distribution.

The Marquesan name for earthworm is *toke*, with its variants *to'e* and *toketoke*. The mention of them in legends may indicate only that earthworms probably reached these islands along with food plants brought by the Polynesians.

ARTHROPODA

With the exception of the Onychophora, all the classes of arthropods—if the myriopods be regarded as one class—are represented in the non-marine fauna of the Marquesas. The myriopod fauna is restricted and endemic species have not yet been recorded. In the Crustacea very few endemic species are known so far; all these are terrestrial, in the orders Isopoda and Amphipoda; the few aquatic malacostracans are decapods of wide distribution. The insects are, of course, the largest class in the fauna. The endemic arachnids are limited to spiders and Acarina, both of which are well represented, and pseudoscorpions; a single introduced scorpion is present and all other orders of arachnids appear to be absent.

The absence of the Onychophora is to be expected. No named species of this class has been recorded in the Pacific east of New Britain, where *Paraperipatus novae-britanniae* (Willey) occurs, though Clark (12) states that "unidentified species, which were not preserved, have been met with in the Philippines and in Fiji."

No special attempt was made to collect Tardigrada, which are probably present. In a very short time Murray (34) was able to collect no less than 16 species in Hawaii; but none of them were regarded by him as endemic, the fauna being a heterogeneous assemblage of widespread species. An endemic species, *Macrobiotus samoanus* Richters, has been recorded from Samoa, and it is possible that many other endemic species may occur in the mountains of the Pacific islands; so far as I know, a search for them has scarcely ever been made.

No attempt was made to find members of the aberrant, parasitic order Pentastomida in the Marquesas. The vertebrate fauna is so limited that few, if any, are to be expected.

CRUSTACEA

The non-marine crustacean fauna of the Marquesas is as limited as might be expected. Aquatic species in the collections include a

few copepods, one species of the ostracod genus *Cypretta*, a semi-aquatic *Ligia*, and six widely distributed species of decapods in the families Atyidae and Palaemonidae. The terrestrial species are of considerable interest, including two endemic genera of isopods and some amphipods in the family Talitricidae.

This limited fauna presents the same general features as that of Hawaii, to which the above paragraph might be applied with few changes. The non-marine crustacean faunas of other Polynesian islands also, so far as I know, differ in few essential features.

ENTOMOSTRACA

Some branchipods may occur in the Marquesas, but possibly without endemic representatives. Only a few widespread species appear to have been recorded from the Pacific islands. It is interesting to note that *Artemia salina* (Linnaeus) has reached Hawaii (41) and that an undetermined species of *Apus*, of which specimens are preserved at the Experiment Station of the Hawaiian Sugar Planters' Association, appeared on Oahu in 1932.

Cladocera also probably occur, though very few—and none of them endemic—appear to have been reported from central Pacific islands.

OSTRACODA

The one species of ostracod known in the Marquesas was described by Furtos (21) as *Cypretta nukuhivana*. I found it in abundance in collecting plankton in a small pond, known as Vaihakameama, in western Tovii, Nukuhiva. I think that this pond is temporary, though it is the largest body of stagnant water that we found in the high interior of the Marquesas Islands. Only females were collected, and Furtos writes that males, which are rarely found in this genus, probably never occur in this species, reproduction being presumably always parthenogenetic. The genus *Cypretta* is represented in almost all the geographical regions. It is likely that other species of ostracods occur in the Marquesas; habitats suitable for them are not numerous, and even these were not exhaustively searched by us, but I am surprised that this order was found only once.

No endemic ostracods appear to have been reported from fresh water in any oceanic island in the Pacific with the exception of this

Marquesan species, which may not prove to be peculiar to the Marquesas.

COPEPODA

In a sample of plankton from Vaihakameama there were numerous small copepods, which have not yet been determined. Very few fresh-water copepods have been recorded from the Pacific islands, and most of these are species of wide distribution.

MALACOSTRACA

AMPHIPODA

Three species of amphipods were collected in the Marquesas, as reported by Stephensen (45): *Orchestia floresiana* Weber, including the new form *monospina* Stephensen, *O. marquesana* Stephensen described as new, and *Talitrus sylvaticus* Haswell. All are terrestrial species, of the family Talitridae, and they are common among wet vegetation, both on the ground and on mossy branches of trees, on the six larger islands. None were observed on the lower, uninhabited islands, where the climate is probably too dry.

Orchestia floresiana is the commonest species in the Marquesas. It was found on all the six inhabited islands, at altitudes of about 1,000 to 4,000 feet. Though it seems to be characteristic of the mountain forests, it is probably at home wherever there is a permanent habitat of wet or damp vegetation. Three specimens, two from 3,300 feet on Uapou and one from 2,900 feet on Uahuka, belong to the new form, *monospina*. *Orchestia marquesana* also was found in considerable numbers, but only at high altitudes, and only on the central islands: Nukuhiva (2,000-4,000 feet), Uapou (2,700-3,300 feet), and Uahuka (1,820-2,900 feet). It may occur on the southeastern islands, but it would probably have been collected there if it were as abundant as it is on the other islands. *Talitrus sylvaticus* is probably the least common of the three species, being collected only once on Uapou and twice on Hivaoa (about 2,000 feet), and many times on Fatuhiva (600-1,700 feet), which is the wettest island in the Marquesas.

An exhaustive search for aquatic species was not made, but I spent a fair amount of time in looking for amphipods in the mountain streams. Less time was spent at low levels, but it is surprising to read in Jardin's account of the Marquesas fauna (31): "... dans les Amphipodes, les genres *Talitrus* et *Gammarus* (nom ind. *koua*)

qu'on trouve en abondance dans tous les cours d'eau". I do not know how to account for this discrepancy between Jardin's observations and mine.

I have found no references to strictly fresh-water amphipods in the Pacific oceanic islands, and to only a few terrestrial species, all of which belong to this family, the Talitricidae.

The non-marine Marquesan amphipods present the same general features of those of other central Pacific islands, with a limited number of the Talitridae, including a small endemic element, and a few species ranging across the Pacific, some of them as far as islands of the Indian Ocean. Of the Marquesan species, *Talitrus sylvaticus* is known also in Hawaii, Australia, and Tasmania, and *Orchestia floresiana* in the Seychelles, Malay, and Melanesia. Skottsberg's "Old Pacific" element may be represented in the terrestrial amphipods of the central Pacific, since the genus *Parorchestia*, according to Chevreux (11), occurs in Hawaii, New Zealand, and the subantarctic islands.

ISOPODA

A report on the greater part of the Marquesan collection of Isopods by H. G. Jackson (28) includes 12 terrestrial species in the family Oscinidae, and one semi-aquatic species of the Ligiidae. The collection is fairly representative, since most of the habitats of these animals were explored, but as one of the endemic species was found only once and the other twice it is likely that several other endemic species are yet to be discovered. No strictly aquatic species were seen in the streams; the time spent in searching for them was limited.

LIGIDAE

Ligia vitiensis Dana—known also from Fiji and New Guinea—was taken at a single locality and, oddly enough, on the relatively dry island of Eiao, where several specimens were found running about on the face of a small cliff, at about 200 yards upstream in Vaituha Valley. It seems unlikely that this species should be restricted to a single island in the Marquesas, but in the habitat in which it was found on Eiao it is very conspicuous and unlikely to escape notice. It seems reasonable to suppose that it has been derived directly from a marine form, and its occurrence may have no bearing on the origin of the truly non-marine fauna.

OSCINIDAE

The members of the family Oscinidae form an interesting assemblage, well represented in the fauna at all altitudes and on all the islands. At low levels, the cosmopolitan wood louse *Porcellio pruinosus* Brandt and the pill bug *Cubaris murinus* Verhoeff are abundant. *Alloniscus oahuensis* Budde-Lund was found at low levels less frequently than these, as well as *Philoscia truncata* Dollfus and *Porcellio laevis* Latreille. *Philoscia fasciata* Jackson is the commonest isopod in the Marquesas. It is found wherever there is moist vegetation, on the ground and on trees and ferns, and it is therefore most abundant in the rain forest above 2,000 feet, though occurring down nearly to sea level. The other members of the cloud-zone fauna are rare species of the subfamily Armadillinae: *Spherillo montivagus* Budde-Lund, taken on Hivaoa, Uahuka, and Uapou between 2,000 and 3,000 feet; *S. testudinalis* Budde-Lund only once, on the summit of Ooumu at about 4,000 feet; *S. pygmaeus* Verhoeff, which, curiously enough, was taken once near sea level and once on Ooumu at 4,000 feet; *S. marquesarum* Jackson, found on Uapou at 2,000 and 2,700 feet; and two spinose species, in endemic genera, *Echinodillo montanum* Jackson and *Tridentodillo squamosus* Jackson, which were found respectively at 2,900 feet on Uahuka, and at nearly 4,000 feet on Nukuhiva.

The most significant features in the distribution of the Marquesan isopods are the presence of an endemic element, which will probably be found, after further collecting, to be larger than is now known; and the close affinity with the Society Islands and other groups to the southwest. The isopod faunas of all of these islands show a similarity in the preponderance of the subfamily Armadillinae among the endemic species.

There is a well-marked restriction, in greater or less degree, of the cosmopolitan and other very widely distributed species to low levels in the Marquesas, and of the endemic species, and those confined to Polynesia, to high altitudes.

There is little to be learned from the isopods, as now known, regarding the relations between the individual islands in the Marquesas. Apart from the cosmopolitan species and *Ligia vitiensis*, Nukuhiva and Uahuka have 5 species each, Hivaoa 4, Fatuhiva 3, Uapou 2, and Tahuata 1, but these differences may be due to chance

as much as other factors. The lower, uninhabited islands have only a few species of very wide distribution.

The Marquesan name for terrestrial isopods is *hotuhotu*; Dordillon (16) gives the following surprising translation for this term: "petits vers noirs qui rongent le bois; fourmilier; vers qui rongent les cadavres."

DECAPODA

The decapods have been identified by Dr. C. H. Edmondson, of Bernice P. Bishop Museum. He has kindly allowed me to make use of his determinations, as well as of information regarding their distribution. Two families are represented in the Marquesan streams, the Atyidae and Palaemonidae.

ATYIDAE

Caridina weberi de Man.

Taiohae Valley (1,200 feet), Nukuhiva, Omoa Valley (300 feet), Fatuhiva, and Hakahetau Valley (325 feet), Uapou, 18 specimens. Though less commonly found than others of this family, this species is probably present on almost all the islands in the Marquesas. Its known distribution includes Sumatra, Java, Celebes, and Flores, and its presence in other Pacific islands besides the Marquesas is to be expected.

Atya serrata Spence Bate.

Atuona Valley (800 feet), Hivaoa, Omoa Valley (300-1,600 feet), Fatuhiva, Taiohae Valley (1,200 feet), Nukuhiva, Hakahetau Valley (325 feet), Uapou, and Vaituha Valley (200 feet), Eiao, 257 specimens. This form has been recorded from Madagascar, Reunion, Mauritius, the Solomon Islands, the Marianas, Fiji, Samoa, and Tahiti.

Ortmannia alluaudi Bouvier.

Omoa Valley, Fatuhiva (300-1,600 feet), and Vaituha Valley (200 feet), Eiao, 101 specimens taken in company with *Atya serrata*. The distribution of this species is parallel to that of *Atya serrata*.

Edmondson considers it likely that *Atya serrata* and *Ortmannia alluaudi* represent a single plastic species, in a relation similar to the remarkably interesting case of *Atya bisulcata* Stimpson and *Ortmannia henshawii* Rathbun in Hawaii, as discovered by him (17). The

form *Atya* in the Marquesas seems to be a mutation of the more basic form *Ortmannia*.

Several Marquesan names were given for specimens of this family. Probably some of them were used with little precision and discrimination as to species: *pināu* (Nukuhiva, Uapou), *moke* (Fatuhiva), *koua tai* (Uapou), *oupa'a* (Fatuhiva), *koua nīpuu* (Hivaoa). Variants of *nīpuu* are *hipuu* and *ipuu*.

Each of these three species is probably present on all of the islands except Hatutu and Fatuuku, though none of them were taken on Mohotani.

PALAEMONIDAE

Three species of fresh-water prawns are abundant throughout the Marquesas.

Palaemon lar Fabricius.

On the inhabited islands and also on Eiao 450 specimens were collected as follows: Atuona and Papuaci Valleys, Hivaoa; Vaitahu Valley, Tahuata; Omoa Valley (15 and 150 feet), Fatuhiva; Taiohae Valley (1,200 feet) and Pakiu Valley (150 feet), Nukuhiva; Hakahetau Valley (1,000 feet), Uapou; Vaikivi Valley (1,400 feet), Uahuka; Vaituha Valley (200 feet), Eiao. The specimens from Vaikivi Valley, Uahuka, are much larger than those from other islands, and the Marquesans believe that these differences are constant. The distribution of this species is very wide, from Madagascar through the Indo-Pacific region as far as Mangareva.

Palaemon dispar von Martens.

Omoa Valley (6, 10, 15, and 300 feet), Fatuhiva, Vaitumata Valley, Hivaoa, and Hakahetau Valley (325 feet), Uapou, 263 specimens. The species is probably present on other islands. Its distribution is nearly as wide as that of *P. lar*, including Reunion, Mauritius, Rodriguez, Tandjong, Amboina, and Samoa.

Palaemon latimanus von Martens.

Atuona Valley, Hivaoa, Vaitupaahi Valley (1,750 feet), Tahuata, Omoa Valley (1,700 feet), Fatuhiva, Taiohae Valley (1,200 feet), Uapou, and Mohotani (1,270 feet), 294 specimens. This species more than the two others seems to prefer the cooler streams of high altitudes, though it is not restricted to them. It

has been reported from islands in the Malay Archipelago, the Philippines, Fiji, Samoa, and Tahiti.

The general Marquesan term for shrimps and prawns of all kinds is *koua*. The three species of *Palaemon* are known by many names, according to locality and to size, sex and maturity. The following were recorded by us, the prefix *koua* being omitted: for *P. lar*: *paeho* (Nukuhiva), *hetou* (female, Nukuhiva), *tipu* (young, Nukuhiva), *akae* (Fatuhiva), *hakae* (Uapou); for *P. dispar*: *ainehu* and *akae* (?) (Fatuhiva); for *P. latimanus*: *kaipimata* (Hivaoa), *aipimata* (Fatuhiva), *vaeaei* (Nukuhiva and Uapou). The terms *pinau* and *nipuu* were sometimes given to small specimens of *Palaemon*, but they probably apply strictly only to the Atyidae.

These prawns are caught by the Marquesans with nets and spears, usually with a light at night. The first food given to new-born infants is said to have been made by crushing prawns with stone pounders, a special kind of pounder being reserved for this use.

The origin of the Atyidae and Palaemonidae on oceanic islands presents an extremely interesting problem. Edmondson (17) points out that Atyidae is one of the most ancient families of fresh-water decapods, and finds no explanation for its dispersal to oceanic islands. Buxton (7) writes of the Atyidae: "These prawns, as Dr. W. T. Calman tells me, are doubtless a true and ancient fresh-water group. But the genus [*Caridina*] and some of the species are so widely spread, that he is tempted to suppose that they must at times enter the sea. In any case their distribution is anomalous, and does not appear to throw any light on our problem."

Many of the Palaemonidae ascend from the sea into brackish water, and the three species in the Marquesan streams may owe their very wide distribution to a former marine habit.

The coconut crab (*Birgus latro* Linnaeus) has been reported from the Marquesas (27). Residents in the islands assured us that it does not occur there. Edmondson suggests that it may have been exterminated by the Marquesans. A large land crab (Marquesan name, *tupa*) is common in many parts of the islands, especially on the deltaic flats at the mouths of the valleys. These species are scarcely to be considered as members of the non-marine fauna.

MYRIOPODA

Thirteen species of myriopods collected in the Marquesas have been identified by Dr. Filippo Silvestri (43; 1). The myriopods received as much attention in collecting as any group of arthropods, and the methods employed appear to cover fairly well the habitats of these animals, with the exception of subterranean species. It is therefore surprising that no endemic species were found. Of the thirteen species, seven are widely distributed throughout the tropics. Of the others, *Trigoniulus naresii* is found as far from the Marquesas as Madagascar, *Hypocambala anguina* as far as the Seychelles, *Mecistocephalus tahitiensis* and *Hanseniella orientalis* as far as Australia, *Cryptops niuensis* as far as the Solomon Islands, and *Cryptops notandus* is known only from the Marquesas and Samoa. It is possible, though unlikely, that no endemic species have been evolved in the Marquesas. The Hawaiian endemic fauna is restricted to a few genera, only one of which—*Dimerogonus*—has developed more than one described species. In Samoa only one endemic species is known. On the other hand, two endemic species of *Cryptops* and one each of *Mecistocephalus* and *Trigoniulus* have been found in Tahiti, where comparatively little collecting has been done. So far as I know, only wide-ranging species of the Symphyla and Pauropoda have been found on central Pacific islands: *Hanseniella orientalis* in the Marquesas and Samoa, and presumably introduced species of *Scutigera*, *Scolopendrella*, and *Pauropus* in Hawaii (51). The Marquesan myriopods, so far as known, were clearly derived from the southwest.

CHILOPODA

SCOLOPENDRIDAE

Scolopendra subspinipes Leach is very abundant throughout the Marquesas, having failed, apparently, to reach only two of the smallest islands, Hatutu and Fatuuku. It is a fairly recent introduction and has largely replaced *S. morsitans* Linnaeus, which is an ancient immigrant, probably arriving with the Polynesians themselves; *S. morsitans* is now restricted to fairly high altitudes on the higher islands, and to the uninhabited and inaccessible lower islands.

Cryptops niuensis Chamberlin was found under dead bark and in dead fern stalks at altitudes above 2,000 feet on all the inhabited islands except Fatuhiva, and also on Mohotani. *Cryptops notandus*,

described by Silvestri (43) from the Marquesas, and collected by him in Samoa, was found at 750 and 2,970 feet on Uahuka.

ORYIDAE

A single species, *Orphnaeus brevilabiatus* (Newport), was found in small numbers at low and intermediate altitudes. It was collected on five of the islands, but it is probably present on all.

MECISTOCEPHALIDAE

Mecistocephalus tahitiensis H. F. Wood and *M. maxillaris* Gervais are common throughout the Marquesas, at all altitudes, though most frequently collected in the mountain forests. They were never found in large numbers, but only singly or in groups of two or three.

The Marquesan name for centipede is *ve'i*: *Scolopendra morsitans* is named *ve'i enata* or *ve'i mao'i* (native centipede); *S. subspinipes* is *ve'i papa'a*, from the Tahitian for "foreign". The small species are known as *ve'i puaina* (Fatuhiva), *ve'i u'upuaina* (Fatuhiva and Tahuata), *ve'i iaufenua* (Fatuhiva), and *ve'i ka'opuaina* (Uapou), probably without distinction of the species.

SYMPHYLA

SCUTIGERELLIDAE

Hanseniella orientalis (Hansen) was collected only twice, at 2,500 feet on Hivaoa and at 450 feet on Fatuhiva.

DIPLOPODA

POLYDESMIDAE

Orthomorpha coarctata (Saussure) and *O. gracilis* Koch are very abundant throughout the six higher islands, in all regions, except where it is very dry, from sea level up to about 3,000 feet. *Cylindrodesmus hirsutus* Pocock was found only a few times, at low altitudes on Fatuhiva, Uahuka, and Eiao.

TRIGONIULIDAE

Trigoniulus naresii Pocock, like the two polydesmids, is very abundant, in all regions that are not too dry, from sea level up to about 2,000 feet.

CAMBALIDAE

Hypocambala anguina (Attems) was collected a few times, once at 1,500 feet but more often at nearly 3,000 feet or higher, on Hivaoa, Nukuhiva, and Uahuka.

Millipedes are known by the modern term *ve'i kina* (Chinese centipede).

ARACHNIDA

Of the nine orders of existing non-marine Arachnida, four—the Scorpionida, Chelonethida, Araneida, and Acarina—are represented in our collections from the Marquesas. Of these the Scorpionida are to be excluded from the native fauna. The absence of the remaining orders from our collections is not surprising, in view of their meager representation or absence on other oceanic islands in the Pacific.

The Microthelyphonida are so little known that no conclusions regarding their distribution in the Pacific islands should be made. But it is interesting to note that one species of *Koenenia* has been found in Hawaii by Van Zwaluwenburg (51) in soil at low levels.

The Pedipalpi do not seem to have been found in the Pacific farther east than Samoa (33).

The small order Ricinulei, according to Ewing (19), is known only from Africa and South and Central America.

Of the Solpugida I have found no records at all from oceanic islands in the Pacific.

The Phalangida have a few endemic species in Melanesia. *Zalmoxis savesi* (Simon) occurs in Samoa, as well as in Melanesian islands, but not even immigrants seem to have gone farther east.

The Marquesan arachnid fauna, with regard to the presence or absence of the several orders, is very similar to that of the Hawaiian and other islands in the central Pacific.

SCORPIONIDA

The widely distributed *Isometrus europaeus* (Linnæus) (*I. maculatus* de Geer) was found near villages on Hivaoa, Tahuata, Nukuhiva, and Uapou, and is probably present on all of the inhabited islands. Its Marquesan name *koropio* is derived from the French *scorpion*, and it is regarded locally as an immigrant, probably from Tahiti, of not much more than 50 years standing.

It is unlikely that other scorpions occur. The same species, *I. europaeus*, is the only one known in Hawaii, and in the Society Islands and Samoa the only other is the widespread *Hormurus australasiae* (Fabricius), which I found in abundance in the forests at low levels on Tahiti and Moorea. I have found no records of scorpions endemic to any Pacific island farther east than New Cale-

donia, where two endemic species of *Hormurus* occur. It would therefore appear that the scorpions have not reached the oceanic islands of the Pacific except as recent immigrants, which is surprising for so ancient an order.

PSEUDOSCORPIONIDA

Pseudoscorpions were found occasionally, and usually singly, in many types of country in the Marquesas, from low levels to some of the highest collecting grounds. They were taken in the course of general field work, no special search ever being made for them. Chamberlin (10) finds that three undescribed species are represented in the collection, belonging to three families and three genera: *Geogarypus*, in the family Garypidae, collected at intermediate levels on Hivaoa, Nukuhiva, and Uahuka; *Lamprochernes*, in the Chernitidae, of which adults were found at about 3,000 feet on Uapou, and immature forms, probably of the same species, at about 4,000 feet on Hivaoa; and *Oratemnus*, in the Atemnidae, from Eiao and Hatutu. All three species, being undescribed, may be endemic, though future collectors may find one or more of them elsewhere, for example in the Society Islands. It is probable that other species occur in the Marquesas.

A few endemic pseudoscorpions are known from most groups of oceanic islands in the Pacific. They appear to be a somewhat heterogeneous assemblage, probably because the order has received little attention from collectors. I am not prepared to discuss their relation to problems of distribution in the Pacific.

ARANEIDA

The spiders are an important element in the Marquesan fauna at all altitudes, and the collections made are as representative as those of most other groups of animals, particularly at high altitudes. A careful study of the collections has been made by Berland (3, 4) who records 48 species, in 32 genera and 14 families. In the following list, taken from Berland (4, p. 36), all the species described by him are known only from the Marquesas, and all those followed by the names of other authors have been found elsewhere:

- Dysderidae: *Ariadna lebronneci* Berland.
- Sicariidae: *Scytodes striatipes* L. Koch, *Scytodes marmorata* L. Koch.
- Oonopidae: *Gamasomorpha loricata* L. Koch.
- Drassidae: *Poecilochroa rollini* Berland.

Thomisidae: *Misumenops delmasi* Berland.

Clubionidae: *Corinna cetrata* Simon, *Clubiona alveolata* L. Koch.

Sparassidae: *Heteropoda regia* Fabricius, *Heteropoda nobilis* L. Koch.

Salticidae: *Bavia aericeps* Simon, *Plexippus paykulli* Audouin, *Menermus bivittatus* Dufour, *Mollica microphthalma* L. Koch, *Thorellia ensifera* Thorell, *Athamas whitmei* Cambridge, *Sandalodes calvus* Simon, *Sandalodes triangulifer* Berland, *Sandalodes nigrolineatus* Berland, *Sandalodes flavipes* Berland, *Sandalodes nigrescens* Berland, *Sandalodes magnus* Berland.

Pholcidae: *Physocyclus gibbosus* Taczanowsky, *Smeringopus elongatus* Vinson, *Pholcus ancoralis* L. Koch.

Theridiidae: *Theridion rufipes* Lucas, *Theridion fatuhivaensis* Berland, *Theridion mendozae* Berland, *Theridion 7-punctatum* Berland.

Argiopidae: *Uapou maculata* Berland, *Hivaoa argenteoguttata* Berland, *Hivaoa nigromaculata* (Berland), *Hivaoa hirsutissima* Berland, *Uahuka spinifrons* Berland, *Uahuka affinis* Berland, *Ischnyphantes pacificanus* Berland, *Leptyphantes lebronneci* Berland, *Leucauge mendanai* Berland, *Tetragnatha nitens* Audouin, *Tetragnatha macilenta* L. Koch, *Tetragnatha marquesiana* Berland, *Cyclosa tauraa* Berland, *Araneus theisi* Walckenaer, *Araneus plebejus* L. Koch.

Pisauridae: *Nukuhiva adamsoni* (Berland), *Dolomedes noukhaiva* Walckenaer.

Uloboridae: *Uloborus geniculatus* Olivier.

Dictynidae: *Syrorisa mumfordi* Berland.

The 48 species are divided by Berland into three groups: endemic, 25; "Polynesian", 14; and cosmopolitan, 9. Four genera—*Uapou*, *Hivaoa*, *Uahuka*, and *Nukuhiva*—named by Berland (4) after Marquesan islands, and unknown elsewhere, are presumably endemic.

Most of the endemic species were taken quite rarely. The most abundant species in the mountains is the endemic *Misumenops delmasi*, a light-green spider which very frequently fell into the net used in beating for insects. Salticids were commonly seen at all altitudes, but almost always belonging to *Sandalodes calvus*, a species that occurs also in Tahiti and Australia. After *Misumenops delmasi*, the commonest endemic species found was the argioid *Leucauge mendanai*. At low levels the commonest species taken was the cosmopolitan *Araneus theisi*; *Heteropoda regia* and *H. nobilis* also are abundant.

The endemic species are mostly restricted to high altitudes. Only four—*Poecilochroa rollini*, *Misumenops delmasi*, *Sandalodes magnus*, and *Syrorisa mumfordi*—were ever found below 1,500 feet and most of them were not seen below 2,000 feet. The Polynesian species also were mostly found in the mountains, and the cosmopolitan species as a whole belong to low levels.

The distribution of the endemic species throughout the Mar-

quesas is fairly uniform, with allowance for differences in size and topography of the individual islands. On each of the six larger, inhabited islands at least four endemic species were collected, but only one on Eiao—*Poecilochroa rollini*, found only on Eiao—and one on Hatutu—*Misumenops delmasi*, which is abundant in the inhabited islands. No spiders endemic to the Marquesas were found on Mohotani and Fatuuku, where the fauna in general is largely of widespread species. The distribution of the spiders in the Marquesas is thus in harmony with what is known about the distribution of other animals, and about the geological history of the islands.

In the spiders there is perhaps no island endemism within the Marquesas. This is made clear by Berland (4), who gives lists of six endemic species that have been found on three to six islands, and of seven on two islands. This leaves eleven species that have been collected on only one island, but as Berland points out the distribution of these species is as yet little known. Absence of island endemism is generally regarded as evidence of comparative youth of the islands as separate individuals, and the distribution of the spiders within the Marquesas points clearly in this direction, though the high degree of island endemism in certain other groups of animals—notably some beetles and the fulgoroid leafhoppers—points equally clearly to the opposite conclusion.

The spider fauna of the Marquesas is rather heterogeneous, there being only 3 genera with more than 2 endemic species—5 in *Sandalodes*, 3 in *Theridion*, 3 in *Hivaoa*—the remaining 14 endemic species being divided among 12 genera and 6 families. The heterogeneity in the non-endemic fauna is of course even greater.

Other general features of the Marquesan spider fauna have been fully set forth by Berland (3, 4), and need only be briefly summarized in this review.

The Mygaloidea, Agelenidae, and Lycosidae are the only large groups of spiders unrepresented in the Marquesan collections. There is a considerable development of endemic species in only three families, the Salticidae, Theridiidae, and especially the Argiopidae.

The Marquesan fauna, with 48 species as yet known, is considerably less rich than that of Samoa, with more than 80, and of Hawaii with more than 100. The degree of endemism among indigenous species in the Marquesas is 52 percent, against over 60 in Samoa and well over 70 in Hawaii. The 30 species, 7 of which are

endemic, recorded from the Society Islands by Berland (5), represent too small a portion of the total fauna to be considered in this comparison.

Berland's table (3) comparing the spiders of the Marquesas, Hawaii, and Samoa shows the similarity of the faunas with respect to the development in the several families. The exceptions are the relatively large numbers of Thomisidae and Lycosidae in Hawaii alone, and of the Clubionidae and Uloboridae in Samoa. The spiders of the Society Islands, as now known (5), show no special development in any family that is not well represented in these other islands.

Berland (3) states that the affinities of the Marquesan spiders are with those of the Society Islands, Samoa, and Tonga, and that all these islands, as well as Hawaii, have received their faunistic elements from Malaysia. Affinities with Australia and New Caledonia are very feeble. There is no affinity with America. In his second report on Marquesan spiders (4) he writes that the agriopid genera described from these islands—*Hivaoa*, *Uapou*, and *Uahuka*—belong to a group of small spiders represented abundantly in temperate lands but very meagerly in the tropics. Being perhaps confined to high mountains in the tropics, they may have escaped the notice of collectors, but these three Marquesan genera are unlike any other genera as yet known to Berland. It is tempting to suggest that they belong to Skottsberg's "Old Pacific" element, derived from Antarctica, and now represented in the mountains of Pacific islands. Berland (5a), however, finds no affinity between the spiders of the "Province Antarctique" and those of the central Pacific islands.

The development of the genus *Sandalodes* in Hawaii and the Marquesas alone among the Pacific islands is very striking, because it is the only feature shown by the spiders—with a possible exception in the genus *Ariadna*—that unites the Marquesas with Hawaii rather than with the islands to the southwest, and because similarly isolated affinities, contrasting with a more general relation in the other direction, are already known in some of the insects and mites, as well as in the flora.

In his papers on the Marquesas, Berland has not estimated the age of these islands as indicated by the spiders, but in discussing the fauna of Samoa (2), he states that the degree of endemism—which appears to be not very different from that of the Marquesan

spiders—can be explained only by long isolation, going back perhaps into the Miocene.

Recently Berland has written an excellent and comprehensive account of "Les Araignées du Pacifique" (5a). He finds it impossible to dispense with former land connections and writes:

Tout semble bien indiquer que le peuplement du Pacifique s'est fait par des migrations provenant de la région indo-malaise . . . un courant de migration bien distinct, mais de même origine, aurait peuplé la Polynésie, dont les archipels actuels ne constituent probablement que le morcellement d'un continent plus étendu, avec un rameau se détachant vers les Hawaï.

Endemism being high in almost all Pacific islands, Berland (5a) estimates the date of their isolation as not later than the middle of the Tertiary and perhaps much earlier.

The Marquesans appear to have only two names for spiders: *punaveevee* and *tufiti*. According to some informants, *punaveevee* is applied only to the large *Heteropoda regia* and *H. nobilis*; according to others, it is the general term for all kinds of spiders, the name *tufiti* being used only for the jumping spiders or Salticidae.

ACARINA

Only parts of the collections of mites and ticks from the Marquesas have been reported upon by specialists, and a very incomplete review of them is all that can be attempted here. It is based largely on the work of Jacot (30) on the mites; the determinations used here are all his, except those of some ticks kindly made by Mr. Cecil Warburton, and of ecto-parasites of rats given in a paper by Ferris (20).⁴

Small free-living mites are common in many kinds of habitats at all altitudes throughout the Marquesas and form an important element in the endemic fauna. They were collected as they were found in the course of general field work, without methods designed especially for them. The collection would probably have been very greatly increased by the use of apparatus such as the Berlese funnel, but

⁴ Recently a further report on Marquesan mites has been published by Vitzthum (52), with descriptions of the following species as new: *Nothrolaspis planus*, *Cypholaelaps semiglobulus*, *Anoplocelaeno marquesana*, *Cercomegistus simplicior*, *Dinychopsis pacifica*, *Uropoda bistellaris*, *Uropoda masculinata*, *Fuscuropoda hippocrepoïdes*, *Fuscuropoda fuscigera*, *Caeculisoma cordipes*, *Histiostoma granulatum*, and recording the following species which have been found elsewhere: *Epicrozeius seurati* Berlese, *Fuscuropoda hippocrepea* (Berlese), *Cilliba bordagei* Oudemans, *Biscirus symmetricus* (Kramer), *Alloptes phaetontis* (Fabricius), *Eriophyes preemnae* Nalepa. None of the above genera are peculiar to the Marquesas. The opinions expressed by Jacot regarding the affinities of the Marquesan mites do not require much modification as a result of Vitzthum's studies.

though it doubtless includes only a small part of the number of species occurring in the Marquesas it is probably representative enough to give some idea of the extent of diversity in the mite fauna.

Of parasitic mites, and ticks, only a few species were collected on their hosts. Some mites were taken on beetles, and on a few other insects. Three species were found on rats: the Marquesan "native" rats, which are of uncertain position among the members of the genus *Rattus* inhabiting the Pacific islands and which were probably brought to the Marquesas by the ancient Polynesian navigators, and the introduced brown rat, *Rattus norvegicus*. Three or four species of land birds were examined for ecto-parasites, but no acarines were found on them; there may be interesting species on some of the endemic birds which have not yet been searched. The cattle-tick *Boophilus australis* is now common in the Marquesas.

No fresh-water mites were found. Minute species, that cling to mosses and algae in the streams, may occur, but it is not unlikely that the meager fresh-water fauna includes none of the true water-mites or Hydracarina.

Endemism in the mites of the Marquesas is fairly high, so far as can be judged by the large proportion of species as yet unknown elsewhere. Among the 24 genera of mites mentioned here, however, all but one—the oribatid *Nesiotizetes*—have been found in other places. Island endemism within the Marquesas is shown chiefly by forms as yet collected each on a single island. These are carefully distinguished by Jacot, and in some species he separates forms inhabiting different parts of one island.

As for the origin and affinities of the Marquesan mites, Jacot (30, p. 237) writes: "The relations of the fauna are with New Zealand (*Acronothrus nukuhivae*), South America (*Paraschelobates*), but chiefly with the East Indies and Hawaii." So little is known about the mites of other Pacific islands that he advances no further conclusions. The Hawaiian affinities are interesting, being paralleled by some in other groups of animals. The American affinities are exceptional, there being scarcely any as yet found among the rest of the fauna.

PARASITIDAE

The gamasid mites are well represented in the Marquesas. One or two undescribed species are reported by Jacot (in litt.) in each of the following genera: *Cercomegistus*, *Cypholaelaps*, *Nothrolaspis*, *Uro-*

poda, *Fuscropoda* (?), and *Dinychopsis*. Most of them were found under dead leaves and bark. Some of them appear to be confined to high altitudes, which suggests that they belong to the truly endemic fauna. *Anoploclaeno ramifera* (Kramer), previously known only from southern Chile, was found at nearly 4,000 feet on Mt. Temetiu, Hivaoa. *Epicroseius seurati* Berlese and *Fuscropoda hippocrepea* Berlese, both known also in the Society Islands, were taken at low levels near Atuona, Hivaoa. *Cilliba bordagei* Oudemans, found at low levels in the Marquesas, occurs also in Tahiti and in Reunion Island in the Indian Ocean. The Marquesan "native" rats were found to be infested by *Laelaps hawaiiensis* Ewing, found also on Hawaiian and Samoan rats, and *L. echidninus* Berlese, which occurs as far off as the East Indies.

IXODIDAE

The cattle tick *Boophilus australis* Fuller, which according to Brumpt (6) occurs in Central and South America, Australia, and the Indies, was collected on Hivaoa on domestic cattle and horses. These animals are sometimes heavily infested by the ticks, for which the Marquesans use the name *utu*, the common term for louse, combined with *pifa* from the French *boeuf*.

ARGANTIDAE

On a dead nestling of the sooty tern (*Sterna fuscata*), in a great nesting colony on Teuaua Islet, off Uahuka, I found a single nymph of *Ornithodoros jalaje* Guérin-Méneville, in September 1929. According to Brumpt (6) this tick is distributed from Mexico to Paraguay and has been reported once from the Gold Coast in Africa. It is known to infest several species of mammals, and more rarely of birds. It has been recorded from Peru on nestlings of *Sula nebouxi* on guano islands, a habitat similar to that of the specimen from Uahuka. Brumpt considers it likely that more than one species are included here; Mr. Warburton writes that the Marquesan specimen resembles the variety *capensis*, but he could make no further determination of a nymph.

ERYTHRAEIDAE

An undescribed species of "running mite" in the genus *Caeculisma* was found at 2,900 feet at Hitikau on Uahuka.

BDELLIDAE

The "snout mite" *Biscirus symmetricus* (Kramer), previously known only from Tierra del Fuego, was collected at high altitudes on Hivaoa and Uapou.

ERIOPHYIDAE

Premna tahitiensis, one of the commonest shrubs at low and intermediate levels in the Marquesas, is very often heavily infested with leaf galls containing *Eriophyes premnæ* Nalepa, originally described from galls on *Premna cyclophylla* in Java.

LISTROPHORIDAE

The minute *Listrophoroides expansus* Ferris (20) was described from rats from Hivaoa. One rat that I examined was very heavily infested by them. Ferris writes that this species differs in certain respects from *L. aethiopicus* Hirst, the genotype and only other known species, but he refrains from making a new genus for it.

ORIBATIDAE

The beetle-mites, like the gamasids, are well represented in the endemic Marquesan fauna. Jacot (30) describes a new genus with one species, *Nesiotizetes adamsoni*, collected at 2,000 feet on Nukuhiva; a new subgenus with one new species, *Scheloribates* (*Paraschelobates*) *mumfordi* from the mountains of Hivaoa and Uapou; and a third new species, *Acronothrus nukuhivæ* from altitudes of 2,800 feet and above on Nukuhiva and Hivaoa. The remaining oribatids recorded by Jacot have all been found elsewhere, most of them in Hawaii only, and in the Marquesas they are represented by new subspecies, described by Jacot, as follows: *Udetaliodes hawaiiensis aculeatisetae*, *Scheloribates fimbriatus whitteni*, *Scheloribates indicus marquesalis*, *Zetes byrani marquesi*, *Galunna hawaiiensis marquesana*.

PHTHIRACARIDAE

Two species are described from the Marquesas by Jacot (30): *Phthiracarus insularis* from Nukuhiva, at about 2,000 feet, and *Indotritia lebronneci*, represented by two forms on Nukuhiva, and by a subspecies on Hivaoa and one on Tahiti in the Society Islands.

TYROGLYPHIDAE

Rhizoglyphus natiformius Jacot (30) was described from the Marquesas, where it was collected at about 4,000 feet on Hivaoa, and

Dr. Jacot reports that mites found on a nitidulid beetle at 2,500 feet on Hivaoa belong to an undescribed species of *Histiostoma*.

MOLLUSCA

The collections of land and fresh-water snails are being studied by Dr. C. Montague Cooke, Jr. What follows is based on conversations with Dr. Cooke, on his "Notes on Marquesan land shells" (14), and on my observations in the field. Both Dr. Cooke and Dr. H. A. Pilsbry have been kind enough to read and criticize the manuscript of these pages.

Andrew Garrett (23), who visited some of the Marquesas Islands about 1870, collected mostly at low and intermediate levels, and reported 52 species, a few of which were recorded by earlier writers and not found by Garrett. Between his time and the year 1929 scarcely any field work was done. Dr. H. A. Pilsbry of the Pinchot South Sea Expedition collected on five of the islands in September 1929.

A considerable amount of time was spent by the members of the Pacific Entomological Survey in collecting land snails, especially on Hivaoa and Nukuhiva, and less time on Tahuata and Fatuhiva among the six higher islands. Most attention was paid to arboreal species; relatively few collections were made under stones and none by sifting moss, dead leaves, and other debris for minute species. The other general methods of collecting covered the habitats of land snails, so far as I know them, in more or less equal degree. The fauna is sufficiently well known for the recognition of its general features, but Dr. Cooke believes that 25 to 50 percent of the total number of species have yet to be collected.

About 92 species of land and fresh-water snails have been collected in the Marquesas. Of these 72 (about 78 percent) are endemic. The occurrence of the rest is attributed by Dr. Cooke to dispersal by human agencies. The endemic species are divided between the Zonitidae (about 28), Endodontidae (about 12), Pupillidae (6), Partulidae (about 18), Tornatellinidae (about 11), Succinidae (2), and Helicinidae (about 8).

In the fresh-water fauna only 1 species of *Neritina*, 2 of *Melania*, and 1 of *Navicella* were found. No Pelecypoda are known, or to be expected.

The land snails are one of the most important elements of the

cloud-zone fauna, to which a large proportion of the species appears to be restricted. At intermediate levels, some endemic species, especially zonitids, are abundant. On the uninhabited islands, and below about 1,000 feet on the higher islands, the only endemic species seen were small snails, such as the Tornatellinidae, Pupillidae, Endodontidae, and Helicinidae. Garrett (23), however, found a number of species abundant at low and intermediate levels, which we did not collect, or found only in the cloud zone. This may be due to the fact that we did less field work at intermediate levels than higher up; it is also not unlikely that some lowland species of snails have disappeared since Garrett's time.

ZONITIDAE

In number of species the zonitids form the largest family of land snails in the Marquesas. Several species of *Microcystis* and *Trochonanina* are very abundant on all of the higher islands from 1,000 to 1,500 feet upwards. At intermediate levels, from 1,000 to 2,000 feet, they are thus perhaps the most conspicuous element in the endemic fauna, since most other genera of land snails and most of the arthropods reach their greatest development at higher levels.

Microcystis marquesana Pease, with peculiar characters possibly of subgeneric rank, is numerous and conspicuous on the vegetation in the small region of cloud zone on Uahuka.

On Uapou an undescribed species of *Microcystis*, perhaps constituting a separate subgenus, was found in large numbers on foliage from about 2,000 feet upwards.

There are three remarkable species of *Trochonanina* on Nukuhiva: *T. rectangula* Pfeiffer; a large, flattened, dark-brown, new species; and a smaller, conic, brown one. They were found by us only on the mountains to the west and northwest, at altitudes of over 3,000 feet, *T. rectangula* in abundance on the foliage, the large new species only among dead vegetation on the ground, where it was not uncommon.

It is remarkable that each of these highly evolved zonitids should have no allied forms on other islands. Yet each of them is so abundant and conspicuous that if there were related species, of similar habit, elsewhere in the Marquesas, I think they would have been discovered. Several new species and races of the *T. subvenosa*

Ancey and *T. angulifera* Ancey groups were taken on Hivaoa, Tahuata, and Uahuka.

Species of *Helicarion* (or a superficially similar, endemic genus) appear to be strictly limited to the cloud zone, where they are the most abundant land snails to be seen, crawling actively on the foliage, above altitudes of about 2,500 feet. The distribution of this genus in the Marquesas is remarkable. A single species inhabits Hivaoa, Tahuata, and Fatuhiva in the southeast group and Uapou in the central islands. On Uahuka it is replaced by a larger species, and on Nukuhiva none was found. *Helicarion* is so conspicuous on the islands where it occurs that it must certainly be absent from Nukuhiva, unless replaced by forms of quite different habit.

ENDODONTIDAE

This is one of the most interesting families in the Marquesas. Some of the 12 species of *Thaumatodon*, the only genus represented, have highly specialized characters. One species was found in large numbers under bark on Eiao and Hatutu. The others were found in very small numbers, mostly on the ground among dead leaves, in the cloud zone. Though a considerable amount of time was spent in searching this habitat, it is likely that very many species of endodonts are yet to be found in the Marquesas. It is possible that many species, with similar habits to that of Eiao and Hatutu, have been overlooked at low and intermediate levels on the higher islands.

STENOGYRIDAE

Some widely distributed species—*Subulina octona* and two or three species of *Opeas*—are abundant throughout the six inhabited islands. One or more of them were commonly found even in the cloud zone above 3,000 feet.

PUPILLIDAE

The endemic *Pronesopupa simplaria* Pease, belonging to a genus of which few species are known outside Hawaii, was found on Hivaoa, Fatuhiva, Nukuhiva, and Uahuka. The two species of *Gastrocopta* and three of *Nesopupa* appear to have been dispersed by human agencies.

PARTULIDAE

More attention was paid to collecting *Partulae* than any other land snails. They are almost always to be seen in fairly large

numbers on foliage in the cloud zone; their apparent absence at low levels was surprising, especially after one had found *Partulae* in great numbers almost down to sea level in the Tahitian valleys. In the Marquesas we never found them in abundance much below 2,000 feet, though a single specimen was taken at only 50 feet in Taipivai. No *Partulae* were found in Tovii in central Nukuhiva, in forest that seemed favorable for their development, until an altitude of about 3,000 feet was reached at Tapuaooa. Two species were numerous on the scattered trees there in November 1929; but on a second visit to Tapuaooa, during very wet weather, LeBronnec and Tauraa were unable to find any on the trees. The habits of the Marquesan *Partulae* must therefore be taken into account in considering their distribution on the basis of these collections. Though some time was spent in collecting among dead leaves, only empty shells were ever found on the ground. Strictly terrestrial species may, however, have escaped notice; moreover, as Crampton (15) has shown, many species of *Partula* spend only part of their time on the trees.

It is not impossible that *Partula* may once have inhabited Eiao, though present conditions seem to be entirely unfavorable. I made a brief search for fossil shells, without success.

The Marquesan *Partulae* belong to a subgenus, *Marquesana* Pilsbry, endemic to these islands.

TORNATELLINIDAE

The small snails of this family are represented at all altitudes and in all types of country. Dr. Cooke finds that most of the species are of wide distribution or likely to be found, on further collecting, in other island groups. Three endemic species of *Lamellidea* are described by Pilsbry and Cooke (39) in a new subgenus, *Atea*, created for them. The most interesting tornatellinid, a species of this subgenus, was conspicuous in the cloud zone on Uapou.

SUCCINIDAE

Having seen the members of this family in great abundance on trees and shrubs in Hawaii and the Society Islands, I was surprised to see none at all in the Marquesas. A fair amount of collecting among dead leaves on the ground proved fruitless until, on our first visit to the northwestern mountains of Nukuhiva, LeBronnec found

a single live snail and one empty shell on Ooumu, at 3,700 feet. Garrett, prior to 1871, found *Succinea mamillata* Pease common on the ground in mountain ravines of Nukuhiva, and *S. marquesana* Garrett common under dead leaves on Hivaoa.

VAGINULIDAE

No native slugs are known on the oceanic islands of the Pacific. A widely distributed species of *Veronicella* was found at low levels on Hivaoa. Père Siméon Delmas, of Taiohae, told me that he had never seen it on Nukuhiva, and Marquesans asserted that it was absent from Fatuhiva. The Marquesans have named it *mamafenua* (*mama*, chiton; *fenua*, land). The only other slug in our collection was a single specimen of an undetermined species, which was found, oddly enough, at the very summit of Mount Ootua, Hivaoa, at an altitude of 3,030 feet.

REALIIDAE

Records of two species of *Omphalotropis* by Pfeiffer (36) are regarded by Dr. Cooke as questionable.

ASSIMINEIDAE

The widely distributed *Assiminea nitida* Pease was found only on Eiao, and reported by Garrett, without locality, from the Marquesas.

HELICINIDAE

Interesting endemic species of this family are common in the cloud zone. They were most often found in the leaf axils of *Frey-cinetia*. A new species of *Aphanoconia* was found in abundance in company with *Thaumatodon* on Eiao; the shells were sealed, under bark, and the snails were apparently "aestivating" through the drought prevailing in October 1929.

HYDROCENIDAE

Two widely dispersed Polynesian species of *Georissa* were recorded by Garrett. Neither of these was collected by us.

NERITIDAE AND MELANIIDAE

The fresh-water molluscan fauna of the Marquesas is as limited as might be expected. Only 4 species were found, *Neritina* (*Clithon*) *souleyetiana*, *Navicella apiata* Guillou, and 2 species of *Melania*.

Neritina is abundant in the streams at low levels and *Melania* up to high altitudes. *Navicella* was found only once, at Vaituha, Eiao. By a curious coincidence this species and the isopod *Ligia vitiensis* were found, in company, at this locality only. Both are doubtless more generally distributed in the Marquesas.

The nerites have been fairly recently derived from marine forms, as have some other members of the fresh-water fauna such as the Palaemonidae, but it is believed that these snails as well as *Melania* did not attain their present wide distribution in the Pacific until after they had acquired a fresh-water habit. Their origin on the Pacific islands would appear, therefore, to present much the same problem as that of the terrestrial genera.

The general Marquesan name for snails is *pipi*. *Neritina* is *pipita'a* (*ta'a*, a spine) and *Melania* is *pipihoaka*. With the exception of the introduced *Veronicella* (*mamafenua*), we obtained no "specific" Marquesan names for any land molluscs. But Dordillon (16) gives the name *pipiputaiamu'u*, with variants, for "hélice pyramide", which may be *Trochonanina rectangula*, and *pipivao* for "coquillage des montagnes (esp. de)", and it is likely that the Marquesans once distinguished many species by name.

Most of the following general remarks are based on Cooke's "Notes on Marquesan land shells" (14, p. 15).

The affinities of the Marquesas, as regards their land-snail fauna, are with the islands to the southwest, the Marquesas having much in common with the Cook and Society Islands and in a smaller measure with the Austral Islands. There is no direct affinity with Hawaii.

The degree of endemism among the indigenous species of land snails in many central Pacific archipelagoes is nearly—if not actually—100 percent, since the non-endemic species are supposed to be recent immigrants! Of endemic genera, Hawaii has more than 20, Rapa 2 or 3, and the Society, Austral, and Cook Islands and Samoa none (13, p. 10). In the Marquesas there are a few endemic subgenera. It appears, however, that relatively few species have been evolved in the Marquesas, in comparison with the Society Islands, for example; more than 60 species were enumerated by Garrett (22) on the small island of Raiatea and more than 40 on Huahine, whereas only about 92 species are known from all of the ten Marquesas

Islands. This is surprising in view of the widely divergent characters that have been evolved in the Marquesan species of *Trochonanina*, *Microcystis*, *Thaumatodon*, and *Lamellidea*.

The amount of species formation among the genera with endemic species is apparently so uniform that these genera probably reached the Marquesas at about the same time. Since then no further migration appears to have occurred, until the arrival of species distributed by man.

There is a high degree of island endemism in the Marquesas.

With allowances for differences in the amount of collecting, and in the size and topography of the islands, it appears that the division of the species among the several islands in the Marquesas is fairly uniform, which suggests that the islands are all—except Mohotani—of similar ages. There is, however, a marked specialization in the central islands, in *Trochonanina* and *Thaumatodon* on Nukuhiva and in *Microcystis* on Uahuka and Uapou. But Hivaoa has about 25 known species peculiar to it, against about 22 on Nukuhiva, and Hivaoa and Tahuata have the most divergent species of *Partula*. Moreover, the faunas of Tahuata and Fatuhiva are little known in comparison with those of Uahuka and Uapou. The greater age indicated for the central islands may therefore be only apparent. It is interesting to note that Eiao and Hatutu have a few peculiar species, while none was found restricted to Mohotani. This is in accord with what is known regarding the insects of these three islands.

As Buxton (7) has said, the distribution of the land snails affords the most convincing evidence yet advanced in favor of past land connections in the Pacific. (See 37, 38, 13, 15.) This evidence—such as the homogeneity of the fauna throughout a wide area in the central Pacific and the natural occurrence of only a few, ancient families—is too well known to be discussed here. But it should be noted that even the malacologists have disagreed; Hedley (25) believed that islands east of Fiji, the eastern limit of *Placostylus*, are truly oceanic.

LITERATURE CITED

1. ADAMSON, A. M., Myriopoda of the Marquesas Islands: B. P. Bishop Mus., Bull. 98, pp. 225-232, 1932.
2. BERLAND, LUCIEN, Araignées (Araneida): Insects of Samoa, part 8, fasc. 2, pp. 35-78, 1929.
3. BERLAND, LUCIEN, Les Araignées des Îles Marquises: B. P. Bishop Mus., Bull. 114, pp. 39-70, 1933.
4. BERLAND, LUCIEN, Nouvelles Araignées Marquisiennes: B. P. Bishop Mus., Bull. 142, pp. 35-63, 1935.
5. BERLAND, LUCIEN, Les Araignées de Tahiti: B. P. Bishop Mus., Bull. 113, pp. 97-107, 1934.
- 5a. BERLAND, LUCIEN, Les Araignées du Pacifique: Soc. de Biogéographie, Mém., 4, pp. 155-180, 1934.
6. BRUMPT, EMILE, Précis de Parasitologie 4th ed., 1927.
7. BUXTON, P. A., Description of the environment: Insects of Samoa, part 9, fasc. 1, pp. 1-32, 1930.
8. BUXTON, P. A., and HOPKINS, G. H. E., Researches in Polynesia and Melanesia . . . : London School of Hygiene and Tropical Medicine, London, 1927-28.
9. BRYAN, W. A., Natural History of Hawaii, Honolulu, 1915.
10. CHAMBERLIN, J. C., Pseudoscorpions of the Marquesas Islands: manuscript in preparation.
11. CHEVREUX, E. D., Amphipodes de la Nouvelle Calédonie et des Îles Loyalty: Sarasin, Nova Caled., Zool., vol. 2, no. 1, pp. 1-14, 1915.
12. CLARK, A. H., The present distribution of the Onychophora, a group of terrestrial invertebrates: Smithsonian Misc. Coll., Pub. 2319, vol. 65, no. 1, pp. 1-25, 1915.
13. COOKE, C. M., JR., Evolution as a probable index of the relative ages of Pacific Islands: Haw. Acad. Sci., Proc., 1928, B. P. Bishop Mus., Special Pub. 14, 1929.
14. COOKE, C. M., JR., Notes on Marquesan land shells: Haw. Acad. Sci., Proc., 5th annual meeting, B. P. Bishop Mus., Special Pub. 16, 1930 (abstract).
15. CRAMPTON, H. C., Studies on the variation, distribution, and evolution of the genus *Partula*—the species inhabiting Tahiti: Carnegie Inst., Washington, Pub. 228, 1916.
16. DORDILLON, I. R., Grammaire et dictionnaire de la langue des Îles Marquises, Paris, 1904.
17. EDMONDSON, C. H., Hawaiian Atyidae: B. P. Bishop Mus., Bull. 66, 1929.
18. EDMONDSON, C. H., A report on the fresh-water Protozoa of Tahiti: Science, new ser., vol. 32, pp. 349-351, 1910.
19. EWING, H. E., A synopsis of the American arachnids of the primitive order Ricinulei: Ent. Soc. Am., Ann., vol. 22, pp. 583-600, 1929.
20. FERRIS, G. F., Ectoparasites of Marquesan rats: B. P. Bishop Mus., Bull. 98, pp. 117-127, 1932.
21. FURTOS, N. C., Two new species of *Cypretta* (Ostracoda) from the Marquesas Islands and Florida: B. P. Bishop Mus., Bull. 114, pp. 279-286, 1934.
22. GARRETT, ANDREW, The terrestrial Mollusca inhabiting the Society Islands: Acad. Nat. Sci., Philadelphia, Jour., 1884.

23. GARRETT, ANDREW, Mollusques Terrestres des Îles Marquises: Soc. Malac., France, Bull., vol. 4, 1887.
24. HASTINGS, A. B., Notes on some little-known phytactolaemotous Polyzoa and description of a new species from Tahiti: Ann. Mag. Nat. Hist., 10th ser., vol. 3, pp. 300-310, 1929.
25. HEDLEY, CHARLES, A zoogeographical scheme for the mid-Pacific: Linn. Soc. New South Wales, Proc., vol. 24, pp. 391-417, 1900.
26. HETT, M. L., On some land nemerteans from Upolu Island (Samoa) with notes on the genus Geonemertes: Zool. Soc. London, Proc., pp. 987-997, 1927.
27. HILL, A. W., The original home and mode of dispersal of the coconut: Nature, vol. 124, no. 3117, pp. 133-134, 151-153, 1929.
28. JACKSON, H. G., Marquesan terrestrial Isopoda: B. P. Bishop Mus., Bull. 114, pp. 145-162, 1933.
29. JACOT, A. P., Some Hawaiian Oribatoidea (Acarina): B. P. Bishop Mus., Bull. 121, 1934.
30. JACOT, A. P., Some Tyroglyphina (Sarcoptiformes) of the Marquesas Islands: B. P. Bishop Mus., Bull. 114, pp. 211-238, 1934.
31. JARDIN, EDELSTAN, Essai sur l'histoire naturelle de l'archipel de Mendaña ou des Marquises: Soc. Impériale des Sci. Nat., Cherbourg, Mém., t. 6, pp. 161-200, 1859.
32. JOHNSON, H. P., Fresh-water nereids from the Pacific coast and Hawaii, with remarks on fresh-water Polychaeta in general: Mark Anniversary vol., pp. 205-222, pls. 16, 17, New York, 1903.
33. KRAEPLIN, K., Die Skorpione und Pedipalpen von Neu-Caledonien und den benachbarten Inselgruppen: Sarasin, Nova Caled., Zool., vol. 1, no. 4, pp. 325-337, 1914.
34. MURRAY, JAMES, Tardigrada—Brit. Antarctic Exped. 1907-1909 under command of Sir E. H. Shackleton, C.V.O.: Sci. Invest. I, Rep., pt. 5, pp. 83-185, 1910.
35. MURRAY, JAMES, Rotifera of some Pacific islands collected by the Shackleton Antarctic Exped. (1909): Roy. Microsc. Soc., Jour., pp. 429-435, 1911.
36. PFEIFFER, LUDOVICO, Monograph of the genera Realia and Hydrocena: Zool. Soc. London, Proc., pp. 304-315, 1854.
37. PILSBRY, H. A., Genesis of mid-Pacific Faunas: Acad. Nat. Sci. Philadelphia, Proc., 1900.
38. PILSBRY, H. A., The dispersal and affinities of Polynesian land snail faunas: B. P. Bishop Mus., Special Pub. 7, pt. 1, pp. 147-152, 1921.
39. PILSBRY, H. A., and COOKE, C. M., JR., Notes on the land snail family Tornatellinidae: Nautilus, vol. 47, pp. 59-62, 1933.
40. ROLLIN, LOUIS, Les Îles Marquises, Paris, 1929.
41. SARS, G. O., Pacifische Plankton-Crustaceen: Zool. Jahrb., Syst., vol. 19, pp. 629-646, 1904.
42. SCHRÖDER, OLAW, Land planarien von Neu-Caledonien und den Loyalty-Inseln: Sarasin, Nova Caled., Zool., vol. 3, no. 2, pp. 257-295, 1924.
43. SILVESTRI, FILIPPO, A further report on Marquesan Myriopoda: B. P. Bishop Mus., Bull. 142, pp. 3-11, 1935.
44. SKOTTSBERG, CARL, Juan Fernandez and Hawaii, a phytogeographical discussion: B. P. Bishop Mus., Bull. 16, 1925.
45. STEPHENSEN, K., Terrestrial Talitridae from the Marquesas: B. P. Bishop Mus., Bull. 142, pp. 19-34, 1935.

46. STEPHENSON, J., *The Oligochaeta*, London, 1930.
47. TOPSENT, EMILE, Description de *Spongilla* (*Stratospongilla*) *gilsoni* n. sp., éponge d'eau douce des Îles Fidji: *Ann. Biol. Lacustre*, vol. 5, pp. 187-191, 1912.
48. TRIFFITT, M. J., and OLDHAM, J. N., Observations on the morphology and bionomics of *Rhabditis coarctata* Leuck., occurring on dung beetles: *Jour. Helminth.*, vol. 5, pt. 1, pp. 33-46, 1927.
49. VAN WINKLE, M. E., Fresh-water testaceous rhizopods of Hawaii: unpublished thesis, 1927, University of Hawaii.
50. VAN ZWALUWENBURG, R. H., The interrelationships of insects and round worms: Hawaiian Sugar Planters' Assoc., Expt. Sta., ent. ser., Bull. 20, 1928.
51. VAN ZWALUWENBURG, R. H., The soil fauna of sugar cane fields: Williams' Handbook of the insects and other invertebrates of Hawaiian sugar cane fields, pp. 339-352, Honolulu, 1931.
52. VITZTHUM, H. GRAF, Terrestrische Acarinen von den Marquesas: B. P. Bishop Mus., Bull. 142, pp. 64-99, 1935.

