

Land Snails from Mothe, Lakemba, and Karoni Islands, Lau Archipelago, Fiji¹

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ABSTRACT: Land snails sorted from bagged leaf litter on Karoni, Lakemba, and Mothe Islands in the Lau Archipelago of Fiji numbered 35 species. Literature and Field Museum of Natural History collection records add four others for a total of 39 species. There are now 13 recorded from Mothe, 20 from Karoni, and 22 from Lakemba. Nine of these taxa are introductions from outside the Pacific basin, dating from European commercial activities; three probably were introduced by Polynesian voyagers; and 27 probably are endemic to Lau. Many of the latter belong to widely distributed Pacific basin species complexes and cannot be assigned a specific name with certainty, but several are restricted to just one or two islands in Lau. The diversity of species on each island does not follow the species-area curve.

THROUGH THE COURTESY of Walter O. Cernohorsky of the Auckland Institute and Museum, it was possible to study land snails from Karoni, Lakemba, and Mothe Islands in the Lau Archipelago. These samples were made by Cernohorsky during the Royal Society of New Zealand Pacific Expedition in late June and early July 1977. The collections were obtained by filling one (Mothe) or two bags (Lakemba and Karoni) with leaf litter, then hand sorting back at camp in the evenings. It took approximately 1 hr collecting time to fill two bags. A few specimens were collected from tree trunks, and a very few empty shells of arboreal species were sorted from the litter, but undoubtedly there is underrepresentation of the tree-dwelling species.

The specimens are deposited in the Auckland Institute and Museum, with some duplicates in the Field Museum of Natural History. Catalog numbers of the latter (preceded by FMNH) are included for reference.

The collection from Karoni (179°32' E, 18°45' S) was made on 4 July 1977. Karoni

is a highly dissected island of less than half mile diameter, located just southeast of Mothe and within the same reef complex. The collection from Lakemba (179°13' E, 18°13' S) was made during an 8-day period at various times from 24 to 30 June 1977. This volcanic island is 22 sq mi. The collection from Mothe (179°30' E, 18°41' S) was taken on 7 July 1977. Mothe is also a volcanic island, but it is only 4 sq mi. The main emphasis was on marine collecting, and the land snails were obtained as a byproduct.

The 35 species included in these collections provide a number of new records for both the particular islands and Lau Archipelago, but perhaps more importantly serve to emphasize several facts. First, the collecting effort in many of the Pacific Island groups is still less than adequate. Second, for many genera it is impossible to assign meaningful specific names, as the groups have not been revised in this century. Third, a dynamic pattern of colonization by, and replacement of, introduced species of land snails exists on many Pacific Islands, and periodic collections to monitor the changes are needed. Fourth, the observed diversity of land snail species on small islands does not follow the species-area curve or McArthur-Wilson colonization-extinction model.

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SYSTEMATIC REVIEW

The sequence of family units follows standard classifications. To economize on space, references to original descriptions have been omitted. They can be located by consulting accounts cited.

CLASS GASTROPODA

SUBCLASS PROSOBRANCHIA

Family Helicinidae

The Helicinidae are diverse in the Melanesian-Polynesian area (see Solem 1959, pp. 166-170 for a synopsis of genera and distribution), but species limits are uncertain. The monograph of Wagner (1907-1911) is less than adequate. At present, "geographic names" can be assigned to populations, but the degree of relationship between morphs in different archipelagos remains unknown.

Pleuropoma mariae Wagner, 1911

Lakemba, many live (FMNH 198191); Mothe, few live (FMNH 198207).

The Samoan *P. beryllina* (Gould, 1852) and *P. beryllina flavida* (Mousson, 1869); New Hebridean *P. sublaevigata* (Pfeiffer, 1852) and *P. albescens* (Hartman, 1890); several New Caledonian taxa (see Solem, 1961, pp. 422-425); and other taxa from Tonga, Society Islands, and Melanesia apparently form a species complex.

P. vicina Wagner, 1911

Karoni, numerous live (FMNH 198178); Lakemba, numerous live (FMNH 198190); Mothe, many live (FMNH 198206).

A partial list of related taxa that range from Indonesia and the Caroline Islands to Hawaii and Samoa was given by Solem (1959, p. 177). Probably only a few species of comparatively wide distribution are involved.

Sturanyella tectiformis (Mousson, 1870)

Karoni, three dead juveniles (FMNH 198180).

An arboreal species described from Mango that may be widely distributed in Lau.

Family Poteriidae*Gonatoraphe intercostata* (Mousson, 1870)

Lakemba, one dead adult, one live juvenile (FMNH 198351).

In sculpture, these specimens are intermediate between *G. stricta* (Garrett, 1887) from Vatu Lele and *G. intercostata*, which has been recorded previously from Vanua Mbalavu, Oneata, Kimbombo, and Namuka in the Lau group. The two taxa may be synonyms.

Family Diplommatinidae*Moussonia fuscula* Mousson, 1870

Karoni, numerous live (FMNH 198174); Lakemba, four dead.

Moussonia sp.

Mothe, one live, one dead adult (FMNH 198430).

A form with heavy radial sculpture probably represents an undescribed species, differing clearly from the smooth-shelled *M. fuscula*, previously recorded from Oneata.

Family Hydrocenidae*Georissa brevissima* (Mousson, 1870)

Karoni, numerous live (FMNH 198203); Lakemba, few live and dead (FMNH 198192); Mothe, six live (FMNH 198205).

These microscopic species range from Indonesia and Western Australia to Hawaii and the Marquesas. They have never been revised as a unit. *Georissa brevissima* was described from Vanua Mbalavu.

Family Assimineidae

Features of the terminal genitalia, radula, body color pattern, and operculum are used to decide generic placement of assimineids (see Solem, 1959, pp. 198-204). Unfortunately, no data on these features are recorded

concerning the morphs described from Fiji. Most of these have been assigned to the "form genus" *Omphalotropis* Pfeiffer, 1851. The named taxa, and their original localities, are *O. costulata* (Mousson, 1870) (Vanua Mbalavu); *O. circumlineata* (Mousson, 1870) (Viti Levu and Vanua Mbalavu); *O. subsoluta* (Mousson, 1870) (Oneata); *O. moussoni* (Pease, 1869) (Viti Levu, Ticombia, Vanua Mbalavu); *O. vitiensis* (Liardet, 1876) (Taviuni); *O. ingens* (Mousson, 1870) (Oneata); *O. layardiana* (Garrett, 1887) (Vanua Mbalavu); *O. longula* (Mousson, 1871) (Ticombia); *O. parva* (Mousson, 1870) (Viti Levu, Vanua Mbalavu); and *O. bifilaris* (Mousson, 1870) (Kanathia, Viti Levu). Only the shells of the first five species have been illustrated. The remainder are known only from brief descriptions that do not include enough information to assign the names to populations.

Only two of the nine assimineid taxa represented in this collection can be assigned definite names. In all probability, those remaining are undescribed. Without a review of types and studying material from many more islands, description of these is not practical, but their listing does serve to emphasize the diversity of this group in the Lau Archipelago.

Omphalotropis (Oriella) moussoni (Pease, 1865)

Karoni, numerous (FMNH 198201).

Related taxa and possible members of a variable single species include *O. submaritima* Quodras & Moellendorff, 1894 from the Marianas; *O. granum* (Pfeiffer, 1855) from New Caledonia; and *O. setocincta* Ancey, 1890 from the New Hebrides (see Solem, 1959, p. 200).

O. costulata (Mousson, 1870)

Lakemba, numerous (FMNH 198200).

Described from Vanua Mbalavu, and probably widely distributed.

Omphalotropis sp. A

Lakemba, seven dead (FMNH 198199).

A medium-sized species with two keels and prominent spiral lirae.

Omphalotropis sp. B

Lakemba, three dead.

A large species with two prominent keels and strong radial ribs.

Omphalotropis sp. C

Lakemba, 20 dead (FMNH 198187).

Smaller, with stronger keels, but weaker sculpture than *O. costulata*.

Omphalotropis sp. D

Mothe, many dead (FMNH 198204).

Larger, sculpture weaker, and keels reduced in prominence compared with *O. costulata*.

Omphalotropis sp. E

Karoni, 12 dead.

Periphery weakly angled, no radial sculpture, smooth whorls, prominent umbilical keel, and much larger than *O. moussoni*.

Omphalotropis sp. F

Karoni, numerous dead (FMNH 198194).

Whorls strongly rounded, no radial sculpture, spire angle wide, one to two prominent keels, and same size as *O. moussoni*.

Omphalotropis sp. G

Karoni, two dead.

Juveniles of a large, radially ribbed, bikeeled species with a very wide spire angle.

SUBCLASS PULMONATA

Family Tornatellinidae

Lamellidea (L.) pusilla (Gould 1847)

Karoni, numerous live and dead, all ages (FMNH 198202); Mothe, four dead.

According to Cooke and Kondo (1960, pp. 184–193), this species ranges from the

Tuamotus to Caroline Islands, is often abundant and is usually extremely variable. Probably it has been introduced by humans over much of its range.

Family Pupillidae, *sensu lato*

The monographs by Pilsbry (1916–1935) are the most recent review of the Pacific Island pupillid taxa. They did not, of course, incorporate the extensive material collected by staff of the Bernice P. Bishop Museum in the late 1930s. Thus, the actual ranges, and in many cases, the synonymy, of taxa remain to be worked out.

Gastrocopta servilis (Gould, 1843)

Karoni, 18 dead (FMNH 198185).

A West Indian species previously reported from Hawaii and New Caledonia under different names (see Solem, 1964, pp. 133–134). Probably widely distributed.

G. pediculus (Shuttleworth, 1852)

Karoni, many dead, a few live (FMNH 198175).

This species is almost ubiquitous in the Pacific basin (see Solem, 1959, pp. 58–59).

Nesopupa vitiana (Boettger, 1880)

Karoni, many live and dead (FMNH 198176).

The differences, if any, from *N. tantilla* (Gould, 1847) and its relatives in eastern Polynesia remain to be documented.

Family Charopidae

A revision of the Polynesian and Eastern Melanesian taxa of the Charopidae is in preparation by the author. Data have been abstracted from that report.

Discocharopa aperta (Moellendorff, 1888)

Karoni, one dead (FMNH 198350).

A minute, usually overlooked species, that ranges from the Philippines and the northern half of Australia to the Society Islands.

Strong local variability in a mosaic pattern exists, with the Lau Archipelago shells showing a distinctive morphology. It has been recorded from seven other islands in the Lau Archipelago.

“Charopa” adposita (Mousson, 1870)

Karoni, numerous live (FMNH 198181); Lakemba, many dead, a few live (FMNH 198197); Mothe, one dead.

A widely distributed species in the Lau Archipelago that shows considerable variation in size and sculpture. The seven adults from Lakemba are much larger than the 32 adults from Karoni (mean diameters 3.58 mm and 2.91 mm, mean whorl counts $4\frac{5}{8}$ and $4\frac{1}{4}+$, respectively). There were 23 juveniles from Lakemba and 68 from Karoni.

“Charopa” inermis (Mousson, 1870)

Lakemba, two dead.

Another widely distributed and variable species in Lau. Both of these species belong to an undescribed genus that ranges from the Solomons to the Society Islands with a high degree of local diversity.

New genus, new species

Lakemba, four dead (FMNH 198352).

A morph not assignable to any genus I have seen, but the specimens are too worn to permit description as new. Probably arboreal in habitat.

Family Helicarionidae

The classification follows Baker (1938, 1940, 1941).

Coneuplecta (Sitalina) microconus (Mousson, 1865)

Karoni, one dead; Lakemba, one live adult; Mothe, two dead adults, one live juvenile.

Reported from the New Hebrides to Tonga and Samoa (see Solem, 1959, p. 94).

Liardetia (L.) samoensis (Mousson, 1865)

Karoni, many dead (FMNH 198173); Mothe, two dead, one live.

This species is widely distributed in Polynesia and Micronesia, and is also found on the fringes of Melanesia (see Solem, 1959, p. 96).

Lamprocystis (Naiaua) laddi H. B. Baker, 1938

Karoni, numerous (FMNH 198179); Mothe, one dead juvenile.

This species was originally described from Naiaua, Lau Archipelago.

Quantula striata Gray, 1834

Lakemba, many live and dead (FMNH 198194, FMNH 198198).

A Malayan species that became established on Viti Levu prior to 1913. This is the first published record for the Lau Archipelago.

Family Trochomorphidae*Trochomorpha (Lauhala) corallina themis* (Garrett, 1887)

Lakemba, nine live (FMNH 198188).

Previously reported from Vanua Mbalavu, Tuvutha, Yangasa Levu, Oneata, Fulanga, Kambara, Avea, and Katafanga, Lau Archipelago.

Family Subulinidae

These West Indian, African, and Oriental taxa have been widely disseminated by commerce. Usually, they have been described as endemic in their areas of introduction. All the following species were introduced into the Pacific by Caucasian commerce since the 1820s. A manuscript survey of their current Pacific distributions and patterns of species displacements has been used in identifying these specimens.

Subulina octona (Bruguiere, 1792)

Lakemba, many live and dead (FMNH

198186); Mothe, few dead and live (FMNH 198208).

Prosopeas achatinaceus (Pfeiffer, 1846)

Lakemba, many dead, few live (FMNH 198193, FMNH 198189); Mothe, one dead.

Lamellaxis gracilis (Hutton, 1834)

Karoni, one live, many dead (FMNH 198182); Lakemba, one live, eight dead (FMNH 198196).

The specimens from Lakemba are an elongate ecologic form called *oparanum* Pfeiffer, 1846. They were collected on a different date, and presumably from a different locality than the examples of *Prosopeas achatinaceus*, which usually displaces *L. gracilis*.

L. clavulinus (Potiez & Michaud, 1838)

Lakemba, two dead adults (FMNH 198195).

Opeas pumilum (Pfeiffer, 1840)

Karoni, a few dead adults and juveniles (FMNH 198177).

Family Bradybaenidae*Bradybaena similaris* (Férussac, 1821)

Lakemba, two adults.

One of the land snails that has been most widely distributed by humans. It was endemic in Eastern Asia, and probably has been carried about with sugar cane, coffee, and bananas.

PATTERNS OF DISTRIBUTION

Of the 35 species taxa listed, nine (both *Gastrocopta*, *Quantula*, the five Subulinidae, and *Bradybaena similaris*) undoubtedly owe their distribution to Caucasian commerce, while three (*Lamellidea pusilla*, *Coneuplecta microconus*, and *Liardetia samoensis*) probably have been carried about both by Polynesian and Caucasian commerce. Except for

the *Coneuplecta*, they are recorded from only one or two of the three islands.

The 23 endemic taxa mostly belong to genera with a wide distribution outside Fiji (*Pleuropoma*, *Georissa*, *Nesopupa*, *Discocharopa*, *Omphalotropis*, "Charopa," *Lamprocystis*, and *Trochomorpha*). The last four show very high degrees of local species and/or sectional diversity. *Discocharopa* apparently contains only a single species, while the extent of diversity in *Pleuropoma*, *Georissa*, and *Nesopupa* cannot be determined without extensive systematic revisions.

In contrast, the presence of an endemic new genus of Charopidae on Lakemba finds its parallel in the presence of the endodontid endemic genera *Priceconcha* Solem, 1973 on Tuvutha and *Zyzyxdonta* Solem, 1976 on Navutu-I-Loma (see Solem, 1976, pp. 465–467). An undescribed genus of Charopidae exists only on Vanua Mbalavu, so that the presence of a second new genus on Lakemba is not surprising.

There are 19 taxa in this collection from Karoni, 20 from Lakemba, and 12 from Mothe. Records in Baker (1938, 1940, 1941) and Solem (in preparation) add *Diastole* (*Laua*) *lauae* H. B. Baker, 1938 to the fauna of Karoni and an undescribed endemic charopid that is found on several islands to the fauna of Mothe. Three hours of collecting on Lakemba in 1970 by Laurie Price, Field Associate of Field Museum of Natural History, adds two more *Pleuropoma*. Thus, we know of 20 species from Karoni, 22 from Lakemba, and 13 from Mothe.

As I have pointed out elsewhere (Solem 1973), land snail diversity does not follow the species-area curve. Lakemba is 5.5 mi long, nearly as wide, reaches a maximum elevation of 720 ft, and is about 22 sq mi in area. Mothe is about 2.5 mi long, 2 mi wide, roughly elliptical, with a maximum elevation of 590 ft, and about 4 sq mi in area. In contrast, Karoni is a narrow, short limestone ridge reaching 120 ft in height, highly dissected and fragmented by bays and inlets, and only a fraction of a square mile in area. Yet there is no difference between Lakemba, the largest island, and Karoni, the smallest, in terms of species diversity.

More intensive collecting would increase the number of species known from each island, but would probably not change the basic picture of equivalent diversity. The various introduced species usually are extremely abundant when present, and their absence from one or two islands probably reflects an accurate picture of their current status. It is evident from these samples that both introduced and endemic taxa are flourishing on Lau Archipelago islands, which provides a contrast to the situation in much of Polynesia where the endemics are rapidly vanishing or restricted to minute patches of native forests. A detailed investigation of the current local distribution and abundance of both introduced and endemic taxa, comparisons with the collections made by Bishop Museum in the 1930s, and an analysis of the patterns of change would be useful in terms of understanding patterns of species replacement and the rate of change in land snail diversity.

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