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CATALOG AND BIBLIOGRAPHY OF THE NONINDIGENOUS
NONMARINE SNAILS AND SLUGS OF THE HAWAIIAN
ISLANDS

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Catalog and Bibliography of the Nonindigenous Nonmarine Snails and Slugs of the Hawaiian Islands¹

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INTRODUCTION AND EXPLANATORY INFORMATION

The impacts of alien species are one of the major threats faced by many ecosystems, especially those of islands (Cowie, 1992d). The Hawaiian Islands are no exception. In order to evaluate potential impacts and to develop control measures or management practices to deal with alien species, a basic understanding of their biology is necessary. A prerequisite to this is knowledge of the identities of the species that have invaded the region of concern.

To address this need for the non-marine snails and slugs introduced to the Hawaiian Islands, this catalog lists all the species that have been recorded as aliens in the wild in the Hawaiian Islands (22 freshwater and 63 terrestrial species). It complements the recently published catalog of the native species (Cowie *et al.*, 1995a). The two works together constitute a complete listing of the recorded land and freshwater snail fauna of the archipelago. Many of the species are included in a list of type material in the Museum of Comparative Zoology, Harvard University (Johnson, 1996).

The catalog lists all valid species-group names but also includes synonyms and nomenclaturally unavailable names if these have been used in reference to Hawaiian records; extralimital synonyms and unavailable names are excluded. Obvious incorrect subsequent spellings are not listed but may be mentioned in annotations, for clarity. Most records are derived from the literature, including unpublished reports, manuscripts, etc., but a small number are based solely on labels associated with material housed in the Bishop Museum collections. Only those species that appear to have been released or to have escaped into the wild (whether they have subsequently become established or not) are listed. Other species that have been deliberately brought to Hawaii (e.g., for biological control programs) but never released (e.g., Davis & Butler, 1964; Krauss, 1964), and species that have been brought to Hawaii either accidentally or deliberately but have been intercepted by quarantine officials, are excluded.

The catalog format closely follows the format of the catalog of native species (Cowie *et al.*, 1995a). Freshwater families are listed first, followed by terrestrial families; within each section the sequence of families is alphabetical. For simplicity, subfamilies are not recognized; neither are subgenera. Genera within families and species within genera are arranged alphabetically. Taxonomic status follows appropriate revisionary works, as indicated under each group.

If the current status of a species-group name differs from that in the original description, this is indicated, with appropriate references, in a Remarks section below the standard entry for the species.

Synonyms and unavailable names are cited in their original orthography. Valid names have been changed, if necessary, so that the ending agrees in gender with the genus with

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which the name is combined herein, but only if the species-group name can be construed definitively as adjectival in the original proposal of the name (*International Code of Zoological Nomenclature* 1985 edition, Art. 31).

Valid species-group names are listed in boldface, infraspecific names preceded by a "+". No opinion on the true status of these infraspecific taxa is implied. Synonyms are listed in italics. Nude names are listed in plain Roman type and indicated by "*Nom. nud.*". Names that have been applied incorrectly (misidentifications) are not listed, but in instances in which an incorrect name has been repeatedly used, this is made clear in the Remarks section under the correct name.

For species-group names, on the line following the name, the name is given in its original generic combination (using the original spelling, even if incorrect) and with its original status indicated (e.g., subspecies, "var.", as necessary). The name is followed by its author(s), date of publication, page number and plate/figure number(s). The author/date citation acts as a reference to the work as listed in the Bibliography. Authors' names containing the terms "de", "van", "von" are cited in the body of the catalog and alphabetized in the Bibliography by the main name.

The date given for a work is the date of publication. If the date printed in the original work is incorrect, the correct date is placed in square brackets in the Bibliography (Recommendation 22A(5) of the *Code*), but the brackets are omitted in the text.

The type locality, quoted exactly as in the original publication, is given for each available species-group name immediately following the author and citation. Any additional or explanatory information regarding the type locality is placed in square brackets following the type locality. If no type locality was given, this is simply stated.

Each valid name is followed, on the same line, by the following abbreviations in parentheses indicating the island(s) from which the taxon is known: N—Niihau, K—Kauai, O—Oahu, Mo—Molokai, M—Maui, L—Lanai, H—Hawaii itself (there are no records of alien snails and slugs on Kahoolawe); names of the Northwestern Hawaiian Islands are spelled out in full. If there is some question about the taxon's introduction to a particular island, the abbreviation for that island is preceded by a "?". If it is not possible to specify particular islands, the catalog simply says "Hawaiian Islands". Islands listed for a taxon include all islands for all synonyms as well as for the valid name. Although some species may occur on other islands, only those islands reported in the literature, or from which Bishop Museum has collections, are listed.

For each nomenclaturally available species-group name, the following information is also provided: 1) date it was first recorded in the Hawaiian Islands, 2) its status as currently established or not (omitted for junior synonyms, as this information is subsumed under the valid name), and 3) its natural range (also omitted for junior synonyms). Additional information is also provided in a Remarks section, if appropriate. Finally, a list of references, by number as listed in the Bibliography, is provided.

Little attention has been paid in the literature to introduced species of snails in the Hawaiian islands (with notable exceptions), so the date a species was first recorded may often be much more recent than when the species was in reality introduced. Similarly, there has been little recent survey work so that in many cases it is unknown whether particular species are currently established or not. Also, many of the identifications are uncertain.

The Bibliography, as well as including all the original descriptions, is a fairly com-

plete list of publications that mention non-indigenous snails in the Hawaiian Islands. It also includes more general works on particular families or genera, as deemed appropriate. Undoubtedly, I have missed more than a few publications; and I may have missed particular species entirely. I welcome corrections and updates. A searchable version of the database from which this catalog is drawn is available on the World Wide Web via the Hawaii Biological Survey home page: <http://www.bishop.hawaii.org/bishop/HBS/>

FRESHWATER SNAILS

Many of the identifications of introduced freshwater snails and slugs in the Hawaiian islands are tentative. There is much taxonomic confusion (see especially Hydrobiidae, Lymnaeidae, Physidae, Thiariidae), and the field is ripe for detailed investigation.

Family AMPULLARIIDAE

Ampullariidae (= Pilidae) are freshwater operculate snails predominantly distributed in humid tropical and sub-tropical habitats in Africa, South and Central America and SE Asia (Berthold, 1991). They include the largest of all freshwater snails and frequently constitute a major portion of the freshwater mollusc faunas of these regions. Ampullariids are commonly known as “apple snails” because many species bear large, round, often greenish shells; but other names are sometimes also used (e.g., “golden snails”, “mystery snails”, “miracle snails”), and each common name may be applied to more than one species, resulting in considerable confusion.

The taxonomy and systematics of most species have not been adequately studied since the species were originally described, and not in the light of a modern species concept. Because of the enormous intra-specific variation in shell size, shape and other conchological characters exhibited by many species, a plethora of names has arisen. The taxonomy is therefore currently very confused and identifications are frequently extremely uncertain. Nevertheless, the identity of the species recorded from the Hawaiian Islands seems relatively secure.

In the Hawaiian Islands, the two genera present, *Pila* and *Pomacea*, are readily distinguished by the character of the operculum: hard and brittle in the former but more flexible and horny in the latter.

Genus *PILA* Röding

Pila is Asian and African. Species of *Pila*, in contrast to *Pomacea* (see below), have not been widely distributed by humans, either via the aquarium trade or as food items, and they have not become such serious and widespread agricultural pests. A single record of “*Pila* sp.” from Maui (Wallace & Rosen, 1969b) probably refers to *Pila conica*, first recorded from Maui in 1966 (Cowie, 1995b).

conica. (O, Mo, M)

Ampullaria conica Wood, 1828: 22, 30, pl. 7, fig. 22. No locality given.

First Record. 1966 (Cowie, 1995b).

Status. Established.

Natural Range. Eastern Asia.

Remarks. One of the four species of “apple snails” recorded in the Hawaiian Islands (Cowie, 1995b). Apparently not the most serious pest species (which is *Pomacea canaliculata*). Especially abundant in taro on Molokai (where *Pomacea canaliculata* is absent), and where hand picking is said to provide adequate control (personal communication of taro growers, 12.xi.1991). Wood (1828) listed *conica* under genus *Helix* on p. 22 but under *Ampullaria* on p. 30. *Ampullaria conica* is here treated as the original combination.

References. 34, 47, 59, 67, 129, 131, 132, 138, 139, 177, 190, 262, 343, 392, 443.

Genus POMACEA Perry

Pomacea is centered in South and Central America, extending into the Caribbean and the south-east of the USA. One or perhaps more species have been taken from their native South America to SE Asia to be cultured for food (Mochida, 1991). The market for the snails never developed. The snails were released or escaped into the wild, becoming major pests in rice paddies. Other species have been developed as aquarium snails (Perrera & Walls, 1996) and have been moved around the world via the aquarium trade. Both their use for food and their use in aquaria have led to their introduction to the Hawaiian Islands (Cowie, 1995b). A number of publications simply refer to undetermined species of “*Pomacea*” (Cowie, 1992e, 1995c).

bridgesii. (K, O, H)

Ampullaria bridgesii Reeve, 1856 [in 1856–1858]: pl. 11, figs. 50, 51. Rio Grande, Bolivia.

First Record. 1962 (Cowie, 1995b).

Status. Established.

Natural Range. South America.

Remarks. One of the four species of “apple snails” in the Hawaiian Islands (Cowie, 1995b), but not the most serious pest (which is *Pomacea canaliculata*). Has been present in Waipio Valley (Island of Hawaii) in taro for some time, apparently without causing particularly serious concern. Originally from South America, but now common in Florida and probably brought to the Hawaiian Islands from the US mainland by the aquarium trade. Usually referred to incorrectly as “*bridgesi*”.

References. 34, 47, 59, 129, 131, 132, 135, 138, 139, 177, 190, 262, 343, 376.

canaliculata. (K, O, L, M, H)

Ampullaria canaliculata Lamarck, 1804: 32. No locality given.

First Record. 1989 (Cowie, 1995b).

Status. Established.

Natural Range. South America.

Remarks. The most serious agricultural pest of the four “apple snail” species in the Hawaiian Islands (Cowie, 1995b). First recorded on Maui, and soon thereafter on Kauai and Oahu. Also a serious pest of rice and other wetland crops throughout many parts of SE Asia (e.g., Mochida, 1991). Probably originally taken to Taiwan from its native South America, thence to other parts of SE Asia, including the Philippines, where it is the most serious rice pest causing millions of dollars worth of damage annually (Naylor, 1996; Vitousek *et al.*, 1996). Also reported from Guam (Smith, 1992). Probably brought to the Hawaiian Islands from the Philippines as a potential food resource. No adequate control measures have yet been developed although a number

have been tried with some limited success (Harry Ako, personal communication, 22.xi.1996).
References. 34, 47, 48, 59, 67, 90, 129, 131, 132, 135, 138, 139, 140, 177, 190, 250, 262, 266, 303, 324, 343, 392, 421.

paludosa. (?O, M)

Ampullaria paludosa Say, 1829: 260. Replacement name for the preoccupied *depressa* Say, 1824, which was described from eastern Florida.

First Record. 1969 (Wallace & Rosen, 1969b), but see Remarks.

Status. Unknown.

Natural Range. Florida, Georgia, Alabama (Burch, 1982), and Cuba (Perera & Walls, 1996).

Remarks. One of the four “apple snail” species recorded in the Hawaiian Islands (Cowie, 1995b). The first record (Wallace & Rosen, 1969b), which is the only record from Oahu, may be a misidentification. Only two specimens, both juveniles, have been collected subsequently (from Keanae, Maui) (Cowie, 1995b). The only native US apple snail and the predominant food of the endangered Everglades Kite. Probably brought to the Hawaiian Islands by the aquarium trade.

References. 2, 34, 47, 59, 129, 131, 132, 138, 139, 177, 190, 262, 343, 379, 380, 423, 424.

Family ANCYLIDAE

The Ancyliidae (freshwater limpets) are represented by a single species, which may be introduced. Ancyliids in the Pacific are very poorly studied and understood (Cowie, in prep.; Hubendick, 1967; Solem, 1964).

Genus FERRISSIA Walker

sharpi. (K, O, H)

Ancylus sharpi Sykes, 1900: 394, pl. 12, figs. 14, 14a. On pali, head of Nuuanu Valley [Oahu].

First Record. 1900, based on the original description.

Status. Established.

Natural Range. See Remarks.

Remarks. This species was described from Hawaiian material and has only been recorded from the Hawaiian Islands, that is, it is endemic to the Islands. However, it is possibly not distinct from other Pacific island *Ferrissia* sp(p). (e.g., *F. noumeensis*) and may in fact be introduced, although there appears to be no published statement definitively indicating either possibility (see Cowie, in prep.; Cowie *et al.*, 1995a; Hubendick, 1967; Solem, 1964). It is a very small and easily overlooked species.

References. 93, 135, 141, 142, 229, 398, 409.

Family BITHYNIIDAE

Bithyniidae are freshwater operculate snails, distributed world wide, and generally considered related to the Hydrobiidae or perhaps the Ampullarioidea (Boss, 1982).

Genus BITHYNIA Leach

+minor. (O)

Bithynia robusta var. *minor* Möllendorff, 1888: 134. Lo-fou-shan bei Canton [China].

First Record. 1940 (Alicata *et al.*, 1940).

Status. ? Established.

Natural Range. China (Walker, 1927).

Remarks. The first two records of this taxon (Alicata *et al.*, 1940; Alicata, 1946; in both cases as “*Bulimus robustus minor*”) are captions to the same photograph, reprinted. In neither case is the photograph of sufficient quality to allow definitive identification. The third record (Alicata, 1969) simply includes “*Bulimus robustus minor*” in a list of operculate freshwater species found in the Hawaiian Islands. Bishop Museum has specimens collected in 1961 from Waiahole labeled “*Bulimus robustus minor*” (BPBM Malacology 215679).

References. 9, 24, 32, 75, 304, 422.

Family HYDROBIIDAE

This family of aquatic, operculate snails is worldwide in distribution. Correct identification of the species present in the Hawaiian Islands is difficult and requires further research. Their status as native or introduced is unclear but they are included here for completeness.

It is possible that all records of both *Paludina porrecta* and the species tentatively identified as *Tryonia protea* refer to but a single species. In addition, there are unidentified specimens in the Bishop Museum from the island of Hawaii, labeled “*Hydrobia*”. Kirch & Christensen (1979) reported unidentified hydrobiids from Oahu.

Genus TRYONIA Stimpson

protea. (O, Mo)

Ammicola protea Gould, 1855: 129. Colorado Desert (Gran Jornada).

First Record. 1912, based on “fossil” material from Molokai in the Bishop Museum collections (unpublished).

Status. Unknown.

Natural Range. South west and western USA (assuming it is *T. protea*; see Remarks).

Remarks. Only tentatively identified, by R. Hershler, as *T. protea*, but certainly related to this species, if not conspecific with it. Specimens in the Bishop Museum collections labeled *Tryonia imitator* may also belong to this taxon (R. Hershler, pers. comm., 10.vi.1993). May be the same as *Paludina porrecta* Mighels (see below). The Molokai record is based on Bishop Museum collections and is not published. May or may not be introduced. Literature records in the Hawaiian Islands are based only on archaeological material. The sediments in which Athens & Ward (1993) and Athens *et al.* (1994) found their specimens predate European arrival in the Hawaiian Islands, suggesting that this species is either native or prehistorically introduced. Both these possibilities are interesting because the native snail fauna as well as the species introduced by Polynesian travelers are almost exclusively associated biogeographically with the rest of the Pacific, Australasia and eastern Asia, not the Americas. Accidentally introduced species derived from the Americas generally post-date European/American contact.

References. 54, 55, 195, 234.

Incertae sedis in HYDROBIIDAE**porrecta. (O)**

Paludina porrecta Mighels, 1845: 22. Oahu.

First record. 1845, based on the original description.

Status. Unknown.

Natural range. Unknown.

Remarks. The original description of *Paludina porrecta* by Mighels (1845) is insufficiently detailed to allow its clear identification. The only illustration of Mighels' species (Küster, 1852) is not detailed but certainly resembles material referred to *Tryonia* (see above). The species was subsequently listed by Sykes (1900) and Caum (1928), both placing it in *Paludestrina*. *Paludestrina* has been considered a synonym of *Hydrobia* (e.g., Vaught, 1989). The type material is lost (Johnson, 1949) and this taxon may never be clearly identified. See also Cowie (1995b) and Cowie *et al.* (1995a).

References. 93, 138, 142, 233, 236, 263, 296, 409.

Family LYMNAEIDAE

The Lymnaeidae are freshwater basommatophoran pulmonates distributed worldwide. The native Hawaiian species have been treated by Hubendick (1952), who appeared to have confused specimens of introduced species among his native material (Morrison, 1969). The taxonomy remains confused (Cowie *et al.*, 1995a). It is possible that other introduced and native species have been misidentified. Lutz (1892) tentatively identified his species of *Lymnaea* as possibly *peregra* Müller or *minutus* Draparnaud. Given the uncertainty of this identification, neither name is listed herein. Mitchell (1963) and Williams (1936) reported undetermined species of *Lymnaea*. These citations may refer to species of Lymnaeidae listed herein, or to other unknown species. The fauna requires further careful study. (See also Physidae).

Genus FOSSARIA Westerlund**viridis. (N, K, O, Mo, M, H)**

Lymnaea viridis Quoy & Gaimard, 1832 [*in* [1832]–1833]: 204, pl. 58, figs. 16–18. Guam.

First Record. 1890 (Morrison, 1969: “about 1890”, “late 19th century”).

Status. Established.

Natural Range. Asia (Davis, 1960c); Orient (Alicata, 1964, 1970).

Remarks. The major intermediate host of cattle liver flukes in the Hawaiian Islands. The subject of intensive efforts at biological control using insect predators and parasites (see references). The earlier records treat this species as *Fossaria ollula* Gould, which was described (Gould, 1859) from Hong Kong Island. It is possible that *ollula* Gould is a junior synonym of *viridis* Quoy & Gaimard (see Pace, 1973) but they appear not to have been formally synonymized. All records of *ollula* Gould in the Hawaiian Islands are therefore treated here as misidentifications of *viridis* Quoy & Gaimard; *ollula* Gould is not listed. Sometimes placed in genus *Galba* (e.g., Morrison, 1968; Mau *et al.*, 1990), which is sometimes treated as a senior synonym of *Fossaria* (e.g., Vaught, 1989). Following Morrison (1968), all Hubendick's (1952) records of the native Hawaiian species *Lymnaea volutata* Gould are here referred to *F. viridis*. Island distributions are thus from Hubendick (1952) as well as other literature.

References. 5, 6, 8, 9, 10, 12, 13, 15, 19, 24, 25, 26, 31, 32, 68, 97, 99, 102, 104, 135,

149, 150, 152, 158, 159, 160, 161, 164, 165, 166, 167, 168, 169, 170, 172, 177, 196, 212, 228, 234, 272, 288, 300, 302, 306, 323, 332, 372, 403.

Genus PSEUDOSUCCINEA Baker

columella. (O)

Lymnaea columella Say, 1817: 14. America ["American" in publication title].

First Record. 1950 (Morrison, 1969: "about 1950", "since at least 1952") .

Status. Established.

Natural Range. Eastern North America (Burch, 1982).

Remarks. One of the species targeted for biological control as a host of the cattle liver fluke (Alicata, 1969).

References. 14, 19, 24, 84, 150, 306, 377.

Family PHYSIDAE

The Physidae are freshwater basommatophoran pulmonate snails, closely related to the Lymnaeidae and found worldwide. In general they are distinguished from the Lymnaeidae by having sinistrally coiling shells; lymnaeid shells are dextral (with a few exceptions, notably the native Hawaiian *Lymnaea producta* (= *Lymnaea reticulata*; see Cowie *et al.*, 1995a)).

Physidae in the Hawaiian Islands are very poorly documented and their identifications are uncertain. There may well be more than one species, probably on all the main islands. It is equally unclear when these species were originally introduced. Williams (1936) mentioned an unidentified "*Physa* or *Lymnaea*"; Davis *et al.* (1961) and Schwartz & Schwartz (1949, 1951) mentioned unidentified species of *Physa*; and Evenhuis & Cowie (1994) listed collected specimens as "?Physidae". Lutz (1892) reported a species of *Physa* and referred it to "*Ph. sandwichensis* Gould", although Gould never described such a species (Johnson, 1964). (*Physa sandwichensis* Clessin is considered a synonym of *Lymnaea producta* (see Cowie *et al.*, 1995a)). The true identity of these records is unknown; they may in reality refer to the species of Physidae listed below or possibly to the sinistral native lymnaeid, *Lymnaea producta*. Equally, they may refer to other, unidentified physid species. Island distributions of the following taxa are based on the literature and Bishop Museum collections and probably do not reflect the real distributions, which may well be wider. Bishop Museum collections, labeled simply "*Physa*", are from Kauai, Oahu, Molokai, Maui, and Hawaii.

Genus PHYSA Draperaud

compacta. (K, O, M)

Limnaea compacta Pease, 1870: 6, pl. 3, fig. 4. Oahu.

First Record. 1870, based on the original description.

Status. Unknown.

Natural Range. Unknown.

Remarks. The status of this species is unclear and requires further research. It was listed as a synonym of *Lymnaea producta* Mighels (= *reticulata* Gould), a native sinistral species of

Lymnaeidae, by Cowie *et al.* (1995a). Johnson (1994) considered it a synonym of *Physa mexicana* (not native to the Hawaiian Islands). Penciled notes by Yoshio Kondo in a Bishop Museum copy of Caum (1928) suggest it is a synonym of *Physa elliptica* (see below). Bishop Museum collections include material from Maui, labeled “*Physa compacta*” (unpublished).
References. 5, 9, 12, 26, 32, 93, 97, 142, 150, 235, 334.

elliptica. (O)

Physa elliptica Lea, 1834: 115, pl. 19, fig. 83. No locality given.

First Record. 1969 (Wallace & Rosen, 1969a).

Status. Unknown.

Natural Range. Ontario south to Iowa and Missouri and east to New York (Burch, 1982).

Remarks. Treated by Burch (1982) as a “morph” of *Physella gyrina gyrina* (Say). The true identity of records of *elliptica* Lea in the Hawaiian Islands is unclear.

References. 84, 269, 423, 424.

virgata. (K)

Physa virgata Gould, 1855: 129. River Gila, and near San Diego.

First Record. 1994, based on the first literature record (Cowie, 1994a), but almost certainly present much earlier.

Status. Established.

Natural Range. North America (Burch, 1982).

Remarks. Probably present on other islands, although only reported in the literature from Kauai.

References. 84, 135, 195, 234, 412, 434.

Family PLANORBIDAE

These freshwater basommatophoran pulmonates have probably been introduced via the domestic aquarium trade from North America. Two records refer simply to “*Planorbis*” (Alicata, 1946; Alicata *et al.*, 1940). These two records, as well as Bishop Museum collections from Oahu, labeled *Helisoma duryi normale*, *Indoplanorbis exustus*, and simply “*Helisoma*”, may all be referable to the single, highly morphologically variable species listed below (*Planorbella duryi* and *P. duryi normale*). Nevertheless, there may well be more than one species of planorbid in the Hawaiian Islands. Further research is necessary. The family was reviewed by Baker (1945). Burch (1982) gave keys to the North American species.

Genus PLANORBELLA Haldeman

duryi. (K)

Planorbis (Helisoma) duryi Wetherby, 1879: 99, fig. 4. Everglades of Florida . . . the Miami country.

First Record. 1994, based on the first literature record (Cowie, 1994a), but almost certainly present much earlier (and see *normale* Pilsbry).

Status. Established.

Natural Range. North America (Florida) (Baker, 1945; Burch, 1982; Pilsbry, 1934).

Remarks. Probably introduced via the aquarium trade. The subspecies *normale* Pilsbry should

probably be considered a junior synonym, although it apparently has never been formally treated as such. This species has undoubtedly been in the Hawaiian Islands much longer than the first formal record suggests.

References. 2, 56, 84, 135, 360, 367, 435.

+normale. (O)

Helisoma duryi normale Pilsbry, 1934: 40, pl. 8, figs. 7–10. Titusville, Brevard Co. [Peninsular Florida].

First Record. 1969 (Wallace & Rosen, 1969a).

Status. Unknown.

Natural Range. Peninsular Florida (Pilsbry, 1934).

Remarks. Almost certainly a synonym of *duryi* Wetherby, but apparently never formally treated as such.

References. 56, 84, 360, 423, 424.

Family THIARIDAE

The taxonomy of the Thiaridae is confused, and, perhaps because of their predominantly clonal mode of reproduction that can lead to extensive inter-population variation in morphology, many local forms and subspecies of rather doubtful validity have been proposed. Generic limits are also poorly understood, with some authors raising certain subgenera to genera and others preferring a less inflated classification (Pace, 1973). This catalog follows the generic arrangement of Cowie *et al.* (1995a).

Thiarids are aquatic operculate snails, worldwide in distribution but with greatest diversity in the tropics (Morrison, 1954). They are predominantly found in fresh waters of streams, rivers, ponds, lakes and irrigation systems, but some species can inhabit brackish water (Pace, 1973). A number of thiarids (e.g., *Melanoides tuberculata*) have been introduced widely through human activities (Pace, 1973) but their status as native or introduced in many islands of the Pacific is unclear (Cowie, in prep.). The Hawaiian taxa are probably all introduced and all are included in this catalog. Most, if not all of the thiarid taxa described from Hawaii may well be conspecific with but a small number of widely occurring taxa.

Williams (1936) reported undetermined “*Melania*” (a junior synonym of *Thiara*). The Bishop Museum collections contain material labeled with various of the valid names and synonyms listed below, as well as material from Oahu, Lanai (no previously published records of Thiaridae) and the island of Hawaii that is simply labeled “*Melania*”. These records could refer to any of the taxa listed below.

Genus MELANOIDES Olivier

tuberculata. (K)

Nerita tuberculata Müller, 1774: 191. Coromandel [India].

First Record. 1994 (Cowie, 1994a; but see Remarks).

Status. Established.

Natural Range. Asia (Morrison, 1954); Middle East and Africa (Pointier & Marquet, 1990).

Remarks. This species, with *Tarebia granifera*, is one of the commonest thiarids in the

Hawaiian Islands, has probably been in the islands for many years, and is probably to be found on all the main islands.

References. 75, 135, 305, 310, 332, 367.

Genus TAREBIA Adams & Adams

granifera. (K, O, Mo, M, H)

Melania granifera Lamarck, 1816: 12, p. 458, figs. 4a, b. No locality given.

First Record. 1856, based on the original description of the junior synonym *mauiensis* Lea.

Status. Established.

Natural Range. Unknown (see Remarks).

Remarks. Its natural range is difficult to ascertain as it has probably been widely distributed by human activity. This species and *Melanoides tuberculata* are the commonest thiarids in the Hawaiian Islands.

References. 1, 5, 9, 16, 19, 24, 25, 26, 27, 29, 30, 32, 76, 93, 97, 135, 142, 164, 267, 270, 286, 328, 329, 332, 334, 367, 384, 434.

lateritia. (Hawaiian Islands)

Melania lateritia Lea & Lea, 1851: 196. Philippines.

First Record. 1954 (Morrison, 1954).

Status. Unknown.

Natural Range. Unknown.

Remarks. Possibly synonymous with *granifera* Lamarck, according to Pace (1973). Morrison (1954), the only Hawaiian record, simply reported the Hawaiian Islands as the probable source of introductions to the US mainland.

References. 271, 305, 332.

mauiensis.

Melania mauiensis Lea, 1856: 145. Maui.

First Record. 1856, based on the original description.

Remarks. Treated here as a junior synonym of *granifera* Lamarck (cf. Caum, 1928; Noda, 1959b), contrary to Cowie *et al.* (1995a) who treated it as a subspecies. Bishop Museum collections include material labeled *mauiensis* from the island of Hawaii (unpublished).

References. 1, 5, 9, 16, 26, 27, 29, 30, 32, 76, 93, 97, 135, 142, 164, 270, 328, 329, 334, 384, 409.

tahitensis.

Melania tahitensis Brot, 1877 (in 1874–[1879]): 323. *Nom. nud.*

First Record. 1904 (Ancey, 1904).

Remarks. Reported from Maui by Ancey (1904) who attributed the name to Pease. Listed by Brot (1874–[1879]) as a Pease manuscript name in the synonymy of *mauiensis* Lea. Also considered a synonym of *mauiensis* by Sykes (1900) and Caum (1928); *mauiensis* treated here as a synonym of *granifera* Lamarck.

References. 38, 78, 93, 142, 409.

Genus **THIARA** Röding

baldwini. (M)

Melania baldwini Ancey, 1899: 273, pl. 12, fig. 6. Lahaina, Maui.

First Record. 1899, based on the original description.

Status. Unknown.

Natural Range. Unknown.

Remarks. True identity uncertain. Possibly synonymous with one of the widespread thiarids. Probably introduced, although described from Hawaiian material.

References. 36, 93, 142, 409.

contigua.

Melania contigua Pease, 1870: 7. Kauai.

First Record. 1870, based on the original description.

Remarks. Synonym of *indefinita* Lea & Lea, according to Cowie *et al.* (1995a).

References. 93, 142, 236, 334, 409.

indefinita. (K, O, Mo, M, H)

Melania indefinita Lea & Lea, 1851: 187. Naga, Luzon, Philippines.

First Record. 1856, based on the original description of the junior synonym *newcombii* Lea.

Status. Unknown.

Natural Range. Unknown.

Remarks. True identity uncertain. Possibly synonymous with one of the widespread thiarids. Bishop Museum collections labeled as the junior synonym “*newcombi*” are the basis for the record of this species on the Island of Hawaii.

References. 5, 9, 19, 24, 25, 26, 30, 32, 77, 93, 97, 142, 271, 329, 334, 409.

kauaiensis. (K, Mo)

Melania kauaiensis Pease, 1870: 7, pl. 3, fig. 6. Kauai.

First Record. 1870, based on the original description.

Status. Unknown.

Natural Range. Unknown.

Remarks. True identity uncertain. Possibly synonymous with one of the widespread thiarids. Probably introduced, although described from Hawaiian material.

References. 93, 142, 334, 409.

newcombii.

Melania newcombii Lea, 1856: 145. Oahu, Sandwich Islands.

First Record. 1856, based on the original description.

Remarks. Synonym of *indefinita* Lea & Lea, according to Cowie *et al.* (1995a).

References. 19, 24, 25, 26, 30, 93, 97, 142, 164, 236, 270, 286, 334, 409.

oahuensis.

Melania oahuensis Brot, 1872: 43, pl. 3, fig. 2. Oahu . . . Molokai.

First Record. 1872, based on the original description.

Remarks. Synonym of *indefinita* Lea & Lea, according to Cowie *et al.* (1995a).

References. 77, 93, 142, 409.

paulla.

Melania paulla Brot, 1872: 43. *Nom. nud.*

First Record. 1872, based on the first publication of the name.

Remarks. Synonym of *indefinita* Lea & Lea, according to Caum (1928).

References. 77, 93, 142, 409.

verrauiana. (Hawaiian Islands)

Melania verrouiana Lea, 1856: 144. Sandwich Islands.

First Record. 1856, based on the original description.

Status. Unknown.

Natural Range. Unknown.

Remarks. True identity uncertain. Possibly synonymous with one of the widespread thiarids. Probably introduced although described from Hawaiian material.

References. 93, 142, 270, 334, 409.

Family VIVIPARIDAE

Viviparidae are freshwater, ovoviviparous, operculate snails distributed throughout most regions of the world, except South America (Boss, 1982). Some species, including the single species listed here, are used in domestic aquaria (Perera & Walls, 1996) and may have been dispersed via the aquarium trade. Others are certainly used as food and have been dispersed for that purpose (Chace, 1987; Cowie, 1995b).

Thaanum (1927) reported undetermined *Viviparus*. This record may refer to *Cipangopaludina chinensis* (listed below), which has frequently been placed in *Viviparus*. There may be more than one viviparid in the Hawaiian Islands but this is not documented.

Genus CIPANGOPALUDINA Hannibal

chinensis. (K, O, Mo, M, H)

Paludina chinensis Griffith & Pidgeon, 1834: 599, Mollusca pl. 1, fig. 6. No locality given.

First Record. 1900 (Sykes, 1900).

Status. Established.

Natural Range. SE and eastern Asia, China, Philippines, Japan (Pace, 1973).

Remarks. The common, large viviparid of many freshwater systems from relatively slow-flowing streams to taro patches (generally near the flow pipes and not in the still water of the body of the patches). Bears live young. The name was attributed to Gray in the original description and has been so attributed subsequently, although there appears to be no internal evidence in the original publication that Gray provided the description. Widely introduced world-wide.

References. 9, 32, 34, 47, 75, 82, 93, 94, 119, 131, 132, 135, 138, 177, 201, 332, 343, 409.

TERRESTRIAL SNAILS AND SLUGS

In addition to the species listed below, by family, a number of references simply mention slugs without sufficient detail to place them in particular families (Bryan, 1963; Fullaway, 1938; Gagné & Christensen, 1985; Illingworth, 1929; Lawrence, 1934).

Family ACHATINELLIDAE

The Achatinellidae are widespread in the Pacific basin. A number of species have also been recorded from Australia, SE Asia and the islands of the Indian Ocean but these may be artificial introductions of Pacific species (Cowie, 1992b). The Achatinellidae are thus one of four land snail families endemic to the Pacific basin, the others being Partulidae (not present in the Hawaiian Islands; Cowie, 1992b), Amastridae (endemic to the Hawaiian Islands; Cowie *et al.*, 1995a) and Endodontidae. The most recent systematic review of the Achatinellidae (Cooke & Kondo, 1961) focused on the non-Achatinelline subfamilies. The vast majority of Achatinellidae are endemic to single islands (Cooke & Kondo, 1961; Cowie *et al.*, 1995a). However, a small number of species are more widespread, and a very few appear to have been distributed by human activities.

Although not alien to the Hawaiian archipelago, at least two species of the endemic Oahu genus *Achatinella* have been deliberately introduced from Oahu to Kauai. *Achatinella bellula* was introduced to Makaweli in 1891 or 1892 by A.F. Judd and was still surviving in 1911 (BPBM Malacology 23449–23455). *Achatinella vulpina* was introduced to Haupū and Kipu in 1903 and 1909 by C.M. Cooke, Jr., and was collected alive in 1925 (BPBM Malacology 81402, 81403), 1927 (93736) and 1948 (212200); empty shells, one with a significant amount of periostracum, were collected in 1973 (252170). In addition, some time between 1890 and 1892 the “Conrad boys” released unknown species of *Achatinella* in Mahaulepū Valley (archived note, BPBM Malacology collection). The current status of these introductions is unknown. See also Christensen (1992).

Genus LAMELLIDEA Pilsbry

Species of *Lamellidea* are difficult to identify and frequently are reported simply as *Lamellidea* sp(p). (e.g., Christensen & Kirch, 1986). Evenhuis & Cowie (1994) suggested that their unidentified *Lamellidea* sp. from Oahu might be the introduced *oblonga* Pease, listed below.

dentata.

Tomatellina dentata Pease, 1871: 460. Hawaii.

First Record. 1871, based on the original description.

Remarks. Synonym of *oblonga* Pease, according to Cowie *et al.* (1995a).

References. 93, 142, 188, 236, 335, 365, 409.

oblonga. (K, O, Mo, M, H)

Tomatellina oblonga Pease, 1865: 673. Islands of the Central Pacific [in publication title].

First Record. 1871, based on the original description of the junior synonym *dentata* Pease. The original description of *oblonga* Pease, although earlier than that of *dentata* Pease, did not mention the Hawaiian Islands explicitly.

Status. Established.

Natural Range. Islands of the South and Central Pacific (Cooke & Kondo, 1961).

Remarks. Probably introduced to the Hawaiian Islands by Polynesian travelers prior to the arrival of westerners (Cooke & Kondo, 1961).

References. 37, 93, 126, 142, 215, 235, 236, 244, 246, 333, 335, 365, 409.

Family ACHATINIDAE

The Achatinidae are native to Africa and include some of the largest land snails known. Their taxonomy has been treated in detail by Bequaert (1950). The single species in the Hawaiian Islands, *Achatina fulica*, is the well-known “giant African snail”.

Genus ACHATINA Lamarck

fulica. (K, O, Mo, L, M, H)

Achatina fulica Bowdich, 1822: pl. 13, fig. 3. No locality given [probably Mauritius, according to Bequaert (1950)].

First Record. 1936 (Pemberton, 1938, 1940).

Status. Established.

Natural Range. East Africa.

Remarks. Widely introduced in the humid tropics (Mead, 1979), frequently becoming an agricultural and garden pest. Its pest status has led to the introduction of many species of predatory snails, most notably *Euglandina rosea* (Férussac), in attempts at biological control (see Oleacinidae, Rhytididae, Spiraxidae, Streptaxidae). *A. fulica* is now declining in the Hawaiian Islands, a pattern also seen elsewhere following initial population explosion (Civeyrel & Simberloff, 1996; Cowie, 1992b; Howarth, 1985; Waterhouse & Norris, 1987). However, there is no convincing evidence that this decline is due to predation by the introduced biocontrol species (Christensen, 1984a), some of which have become serious predators of native species (e.g., Hadfield, 1986; Hadfield *et al.*, 1993).

References. 2, 17, 19, 20, 21, 22, 23, 24, 25, 28, 33, 64, 65, 69, 74, 75, 79, 83, 85, 88, 89, 91, 96, 97, 100, 101, 105, 106, 108, 112, 118, 128, 145, 146, 147, 148, 149, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 178, 183, 188, 191, 206, 216, 222, 223, 224, 225, 226, 227, 237, 238, 239, 241, 253, 254, 255, 257, 259, 265, 273, 274, 275, 281, 288, 290, 291, 292, 293, 294, 295, 311, 316, 318, 322, 323, 326, 327, 331, 337, 338, 339, 342, 344, 381, 382, 389, 401, 418, 419, 424, 425, 426, 427, 428, 429, 433, 436, 441, 442, 446.

Family ARIONIDAE

This family of slugs is Holarctic, although typical members of the group (subfamily Arioninae, Genus *Arion*) are virtually confined to Europe (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Genus ARION Férussac

undetermined species. (H)

First Record. 1981, based on Bishop Museum collections.

Status. Unknown.

Natural Range. ?Europe.

Remarks. Lewin & Lewin (1984) listed undetermined *Arion* among the contents of the gut of the introduced Kalij Pheasant, the specimens having been deposited in the Bishop Museum Malacology collections (accession number 1981.281) and identified by Carl C. Christensen.
Reference. 276.

Family ARIOPHANTIDAE

Some authors (e.g., Boss, 1982) place this group as a subfamily of Helicarionidae (see below). Ariophantidae are found in southern Asia (Boss, 1982). Many species are semi-slugs, that is, they have a shell but cannot withdraw the body fully into it, and the mantle frequently covers much of the shell. This is a **new state record** for the family.

Genus PARMARION Fischer

martensi. (O)

Parmarion martensi Simroth, 1893: 107, pl. 8, figs. 20–22. Cambodja [= Cambodia].

First Record. 1996, based on a single Bishop Museum collection.

Status. ? Established.

Natural Range. SE Asia.

Remarks. Only provisionally identified (Bronwen Scott, pers. comm., 15.xi.96). However, assuming correct identification, both of this record and other records from other regions, it seems that this species is widespread (Chang, 1991; Ho, 1995; Miller, 1993; Simroth, 1893), possibly due largely to human activities. Its natural range may be more restricted.

References. 95, 219, 298, 391.

Material examined. OAHU: Kahaluu, 47-770 Lamaula Rd., 26.vii.1996, E. Horikawa (BPBM Malacology 251680).

Family ATHORACOPHORIDAE

These slugs are found in New Zealand, New Caledonia, Vanuatu, New Guinea, the Bismarck and Admiralty Islands, and eastern Australia (Solem, 1959).

Genus ATHORACOPHORUS Gould

Collinge (1896) recorded "*Janella* sp." from the Hawaiian Islands, without mentioning any specific island. *Janella* is here treated as a synonym of *Athoracophorus*, following Vaught (1989). The genus *Athoracophorus* is restricted to New Zealand (Solem, 1959).

undetermined species. (Hawaiian Islands)

First Record. 1896 (Collinge, 1896).

Status. ? Not established.

Natural Range. New Zealand.

Remarks. A very tentative record.

References. 120, 396, 420.

Family BRADYBAENIDAE

The Bradybaenidae are predominantly Asian, with their greatest diversity in eastern Asia. They are mainly found in tropical and warm temperate regions (Abbott, 1989). A single species reaches western Europe (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988) and there are a few African species (Boss, 1982). A number of species, including the single species recorded from the Hawaiian Islands, have been widely dispersed by human activities, sometimes achieving pest status.

Genus BRADYBAENA Beck

Two references (Krauss, 1962; Thaanum, 1927) simply refer to *Bradybaena* sp. No doubt these are records of the following species.

similaris. (K, O, Mo, M, L, H, Midway)

Helix similaris Rang, 1831: 15. Bourbon . . . Cuba . . . Rio-Janeiro et particulièrement au jardin de Saint-Christophe.

First Record. 1893 (Anon., 1893).

Status. Established.

Natural Range. East and SE Asia (Solem, 1959).

Remarks. Rang (1831) cited Férussac (1821) as author of the name, but *similaris* Férussac, 1821 is a *nom. nud.* Férussac gave Timor as locality. Considered native to southern China, SE Asia and Indonesia, this species is now widespread in tropical and subtropical regions, including many Pacific islands (e.g., Cowie, in prep.; Solem, 1959). The records from Molokai, Maui and Lanai are based on Bishop Museum collections but are unpublished. One of the most widespread of the introduced snails in the Hawaiian Islands.

References. 2, 3, 4, 7, 10, 11, 17, 18, 19, 21, 24, 28, 39, 41, 50, 51, 75, 88, 93, 97, 98, 109, 123, 141, 148, 163, 164, 167, 171, 178, 180, 186, 211, 216, 221, 223, 259, 276, 288, 293, 294, 295, 340, 373, 384, 385, 396, 398, 399, 409, 423, 424, 437, 439.

Family CAMAENIDAE

This family is a large and diverse group of ground-dwelling and arboreal snails, found in the Indo-Australian and American tropics (Boss, 1982; Solem, 1959).

Genus PAPUINA Martens

barnaclei. (H)

Helix barnaclei Smith, 1877: 242. Hawai, Sandwich Islands . . . about 8 miles away [from] Kailua [Kona].

First Record. 1877, based on the original description.

Status. Not established.

Natural Range. Possibly Admiralty Islands (see Remarks).

Remarks. Smith (1877) was convinced, following correspondence with the collector, Mr. Barnacle, that the locality from which he described this species was correct, even though no similar or related species was known from the Hawaiian Islands. Smith acknowledged that his specimens were almost indistinguishable from a species from the Admiralty Islands, but because of the distance between the two localities, he decided to describe his Hawaiian mater-

ial as a new species. Sykes (1900) included *barnaclei* in the Hawaiian fauna, placing it in genus *Papuina*, but noted this conundrum. He reported that detailed survey of the area had not turned up additional specimens. The problem remains unresolved. One explanation is that the Hawaiian material represented a chance but short-lived artificial introduction. A perhaps more likely explanation is that the record is a result of mislabeling, and the species never was introduced. Cowie *et al.* (1995a) overlooked this species.

References. 393, 409.

Family CERIONIDAE

Cerionidae are land snails of the Caribbean, including the Florida Keys. They have attracted considerable attention from evolutionary biologists (e.g., Woodruff, 1978; Woodruff & Gould, 1987). The two named species introduced to Oahu (Cowie, 1996) were also introduced from the Bahamas to the Florida Keys for similar experimental purposes (Bartsch, 1920; Woodruff & Gould, 1987).

Genus CERION Röding

casablancae. (O)

Cerion casablancae Bartsch, 1920: 33, pls. 32–34. The White House region on Andros [Bahamas].

First Record. 1922 (Cowie, 1996).

Status. Not established.

Natural Range. Bahamas (Andros) (Bartsch, 1920).

Remarks. Introduced along with *Cerion viaregis* Bartsch as part of the same experiment but did not become established and no specimens were retained or collected. See *viaregis*.

References. 61, 140, 444, 445.

viaregis. (O)

Cerion viaregis Bartsch, 1920: 13, pls. 7–9. King's Road, Bastian Point, Andros [Bahamas].

First Record. 1922 (Cowie, 1996).

Status. Not established.

Natural Range. Bahamas (Andros) (Bartsch, 1920).

Remarks. Live specimens of this species were sent by Paul Bartsch of the US National Museum in 1922 to C.M. Cooke, Jr. who attempted to establish populations on Oahu. The populations did not become established and a single empty shell was recovered in 1940 and is now in the Bishop Museum collections (Cowie, 1996).

References. 61, 140, 444, 445.

undetermined species. (O)

First Record. 1922 (Cowie, 1996).

Status. Not established.

Natural Range. Cuba (Bartsch, 1920).

Remarks. An unidentified species of *Cerion* from Cuba was introduced along with *Cerion viaregis* Bartsch as part of the same experiment but did not become established and no specimens were retained or collected. See *viaregis*.

References. 61, 140.

Family CLAUSILIIDAE

Clausiliidae occur in the western Palaearctic, South America, and SE Asia (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

undetermined species. (O)

First Record. 1965, based on Bishop Museum collections.

Status. Not established.

Natural Range. Unknown.

Remarks. Bishop Museum collections contain two lots of a single clausiliid species of undetermined genus and species. The specimens were collected in 1965, but clausiliids have not been recorded since then and the species seems not established. This is a **new state record** for the family.

References. 240, 351.

Material examined. OAHU: Nuuanu Valley about 200 yards from highway on left side of stream in the dirt under dead leaves, 5.ix.1965, W.R. Hay (BPBM Malacology 207626); Makiki Valley below Poloke Pl., c. 1200 ft. elevation, 23.iii.1965, Carl C. Christensen (BPBM Malacology 252169).

Family FERUSSACIIDAE

Members of this family are found in many parts of the world, mostly in warm and tropical climates (Abbott, 1989; Kerney *et al.*, 1979).

Genus CECILIOIDES Férussac

Thaanum (1927) mentioned *Cecilioides* sp. This record no doubt refers to one of the species listed below, which are probably synonyms.

aperta. (O, H)

Achatina aperta Swainson, 1840: 335, figs. 97e, f. No locality given.

First Record. 1927, based on the first record of the junior synonym *gundlachi* Pfeiffer.

Status. ? Established.

Natural Range. West Indies (Solem, 1964).

Remarks. Widely spread by human activities (Pilsbry & Bequaert, 1927; Solem, 1964). Probably in the Hawaiian Islands long before it was first formally recorded, although probably introduced after 1778, the date of western discovery of the Islands (Christensen, 1984b). Probably *aperta* Swainson and *baldwini* Ancy are synonyms, but they have never been formally synonymized.

References. 109, 142, 247, 364, 395, 398, 405.

baldwini. (K, O, M, H)

Caecilianella baldwini Ancy, 1892: 718. Manoa, Oahu.

First Record. 1892, based on the original description.

Status. ? Established.

Natural Range. Probably West Indies (see *aperta* Swainson).

Remarks. Described and recorded only from the Hawaiian Islands, but probably a synonym of the widely distributed synanthropic *aperta* Swainson (see Cowie *et al.*, 1995a), which

Christensen (1984b) considered a post-1778 introduction. The records from Kauai and Maui are based on Bishop Museum collections; published records are only for the islands of Oahu and Hawaii.

References. 35, 93, 142, 232, 247, 352, 409, 437.

gundlachi.

Achatina gundlachi Pfeiffer, 1850: 80. Cuba.

First Record. 1927 (Pilsbry & Bequaert, 1927).

Remarks. Junior synonym of *aperta* Swainson, according to Smith (1895).

References. 348, 364, 395.

Family HELICARIONIDAE

This large family constitutes one of the major elements of indigenous land snail diversity in the Pacific (Baker, 1941). Baker (1941), followed by Cowie *et al.* (1995a), treated the family in a broad sense, including as subfamilies, groups that other authors treated as families (e.g., Euconulidae). There is a diverse native Hawaiian helicarionid fauna (Cowie *et al.*, 1995a).

undetermined species. (O)

First Record. 1994 (Evenhuis & Cowie, 1994).

Status. Unknown.

Natural Range. Unknown.

Remarks. The single unidentified "euconulid" reported by Evenhuis & Cowie (1994) is a very small species, perhaps in the genus *Euconulus* or a related genus (e.g., *Guppya*). Evenhuis & Cowie (1994) tentatively considered it to be introduced.

References. 58, 142, 178.

Family HELICIDAE

This family has its center of distribution around the Mediterranean, but extends into northern and eastern Europe (Kerney *et al.*, 1979). A number of species have become pests, especially when introduced outside their normal range (e.g., Gammon, 1943; Godan, 1983).

Genus HELIX Linnaeus

aspersa. (K, O, M, H)

Helix aspersa Müller, 1774: 59. Italia.

First Record. 1952 (Anon., 1953; Kondo, 1956a).

Status. Established.

Natural Range. Mediterranean and Western Europe (Kerney *et al.*, 1979).

Remarks. Sometimes known as the "brown snail" or "garden snail". Following the first record in 1952, from Oahu, it was again recorded in 1956 (Kondo 1956b), also from Oahu. It was first reported on the Island of Hawaii in 1976 (Nakahara, 1979) and is apparently still present there, around Waimea at least (L. Miyano, pers. comm., 1995). It was confirmed as still present on Oahu in 1980 and recorded from Maui (Kula) for the first time in 1981 (Tamura *et al.*, 1981). Cowie (1996) confirmed its continuing presence on Maui. It may not now be established on

Oahu or Kauai. This species is often common in its native range, and frequently found in cultivated gardens, where it can become a pest. It has been introduced to many parts of the world, where it has also frequently achieved serious pest status, e.g., California (Gammon, 1943). It has not achieved a wide distribution in the Hawaiian Islands nor become a serious agricultural pest, although from time to time it has been intercepted by State Plant Quarantine officials (Look, 1974). Being of temperate origin, it may be restricted in the Hawaiian Islands to higher elevation localities and be unable to colonize low areas where temperatures may be too high.

References. 2, 42, 44, 45, 46, 62, 140, 189, 240, 251, 252, 253, 288, 310, 314, 315, 317, 322, 351, 398, 411, 416, 430, 432.

Family HELMINTHOGLYPTIDAE

The family is a New World group, distributed throughout North and Central America, in the Caribbean, and in western South America (Boss, 1982). It encompasses great diversity.

Genus MONADENIA Pilsbry

fidelis. (M)

Helix fidelis Gray, 1834: 67. No locality given.

First Record. 1923 (Swezey, 1924).

Status. Not established.

Natural Range. Northern California, Oregon, Washington, British Columbia (Abbott, 1989; Pilsbry, 1939).

Remarks. The sole published record of this species' presence in the Hawaiian Islands (Swezey, 1924) gave the name as "*Epigramorpha fidelis*". This record is tentatively referred to *Monadenia fidelis*, which is traditionally placed in the Helminthoglyptidae, but is now regarded by some workers as belonging to the Bradybaenidae. It used to be placed in the genus *Epiphragmophora*, which is now restricted to about 100 species in South America (Barry Roth, pers. comm., 31.i.1996). There is no genus name "*Epigramorpha*". Perhaps never escaped into the wild in the Hawaiian Islands, but included here because this is not certain.

References. 2, 200, 361, 406.

Family LIMACIDAE

These slugs are found in Europe, North Africa and North America (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Genus DEROCERAS Rafinesque

Identifications are insecure. The name *laeve* Müller may have been used to refer to *reticulatum* Müller, and vice-versa. Frequently, especially in the older literature, *Deroceras* spp. were placed in combination with the genus-group name *Agriolimax*. A number of references simply refer to undetermined species of "*Agriolimax*" (Pilsbry, 1906–1907; Schwartz & Schwartz, 1949, 1951; Thaanum, 1927; Williams, 1931).

bevenoti.

Agriolimax bevenoti Collinge, 1897: 295, fig. 9. Kauai (4,000 feet).

First Record. 1897, based on the original description.

Remarks. Described from Hawaiian material, but a junior synonym of *laeve* Müller, according to Quick (1960), followed by Cowie *et al.* (1995a). Incorrectly recorded from Oahu and Maui by Sykes (1900) and Caum (1928).

References. 93, 121, 142, 243, 371, 409.

globosum. (H)

Agriolimax globosus Collinge, 1896: 47, fig. 1. Mauna Loa, Hawaii.

First Record. 1896, based on the original description.

Status. Established.

Natural Range. Holarctic (if it is *laeve* Müller; see Remarks).

Remarks. Probably a junior synonym of *laeve* Müller but never formally synonymized. Its status is “established” under the provisional assumption it is *laeve* Müller.

References. 93, 120, 142, 371, 409.

laeve. (K, O, M, H)

Limax laevis Müller, 1774: 1. No locality given.

First Record. 1897, on the basis of the original description of the junior synonym *bevenoti* Collinge.

Status. Established.

Natural Range. Holarctic (Kerney *et al.*, 1979).

Remarks. Probably on all main islands, including Lanai (see *perkinsi* Collinge). Recorded at 2000 ft [610 m] on Kauai, 5000 ft [1524 m] on Maui, and (rather ambiguously) from 2000 ft [610 m] on Oahu by Collinge (1897). Frequently treated as “*Agriolimax laevis*” (e.g., Mau *et al.*, 1990). Preyed upon by *Euglandina rosea* (Davis & Butler, 1964). The name *laeve* Müller may have been used to refer to *reticulatum* Müller, and vice-versa.

References. 11, 18, 19, 21, 24, 25, 28, 49, 93, 97, 120, 121, 142, 163, 217, 240, 243, 287, 288, 289, 310, 351, 371, 409, 423, 424.

perkinsi. (L)

Agriolimax perkinsi Collinge, 1896: 47, fig. 2. Lanai, 2000 feet.

First Record. 1896, based on the original description.

Status. Established.

Natural Range. Holarctic (if it is *laeve*; see Remarks).

Remarks. Probably a junior synonym of *laeve* Müller, but never formally synonymized. Recorded at 2000 ft [610 m] elevation in the original description (Collinge, 1896). Its status is “established” under the provisional assumption it is *laeve* Müller.

References. 93, 120, 142, 243, 371.

reticulatum. (K, H)

Limax reticulatus Müller, 1774: 10. In horto Rosenburgensi & Fridrichsdalensi.

First Record. 1963 (Mead, 1963), although Higa (1980) considered 1977 to be the first record.

Status. Unknown.

Natural Range. Europe (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Remarks. The name *reticulatum* Müller may have been used to refer to *laeve* Müller, and vice-versa. This species is frequently intercepted by State Plant Quarantine officials.

References. 162, 217, 240, 288, 293, 310, 351.

Genus LIMAX Linnaeus**flavus.** (O, M)

Limax flavus Linnaeus, 1758: 652. No locality given [= Sweden].

First Record. 1948 (Tuthill, 1949).

Status. ? Not established.

Natural Range. Southern, western and central Europe (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Remarks. First reported from Oahu in 1948 and Maui in 1982 (Anon., 1994; Nakahara & Christensen, 1985; Tuthill, 1949). Did not become established on Oahu (Nakahara & Christensen, 1985). Perhaps not established on Maui either.

References. 49, 240, 279, 288, 295, 320, 351, 417.

maximus. (O, M, H)

Limax maximus Linnaeus, 1758: 652. No locality given [= Sweden].

First Record. 1931 (Williams, 1931) or 1949 (Pemberton, 1951; Chong, 1964) (see Remarks).

Status. Established.

Natural Range. Southern, western and (in part) central Europe, North Africa (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Remarks. First recorded 1931, if Williams' (1931) record of "a very large yellow and black *Limax*(?)" refers to *L. maximus*; otherwise first recorded in 1949.

References. 49, 103, 136, 240, 276, 279, 288, 341, 351, 404, 437.

poirieri.

Limax poirieri Mabille, 1883: 52. La Grande Canarie [= Grand Canary, Canary Islands].

First Record. 1982 (Nakahara & Christensen, 1985).

Remarks. Junior synonym of *valentianus* Férussac, according to Kerney *et al.* (1979).

References. 49, 240, 285, 320.

sandwichiensis. (Hawaiian Islands)

Limax sandwichiensis Souleyet, 1852: 497, pl. 28, figs. 8–11. Îles Sandwich.

First Record. 1852, based on the original description.

Status. Unknown.

Natural Range. Unknown.

Remarks. "A very doubtful species" (Collinge, 1896). Its true identity remains unknown. Some authors have placed it in *Agriolimax* (e.g., Caum, 1928; and see Collinge, 1896). No additional information is available.

References. 93, 107, 120, 142, 243, 402, 409.

tenellus. (Hawaiian Islands)

Limax tenellus Müller, 1774: 11. No locality given.

First Record. 1896 (Collinge, 1896).

Status. ? Not established.

Natural Range. Northern, western and central Europe (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Remarks. The only record is that of Collinge (1896), who mentioned no particular island. Perhaps a misidentification.

References. 120, 240, 310, 351.

valentianus. (M)

Limax valentianus Férussac, 1822: 20. Valence, en Espagne [= Valencia, Spain].

First Record. 1982, based on the first record of the junior synonym *poirieri* Mabilie.

Status. Unknown.

Natural Range. Iberian peninsula (Kerney *et al.*, 1979).

Remarks. Senior synonym of *poirieri* Mabilie, according to Kerney *et al.* (1979). A European species now widespread by human activities.

References. 49, 181, 240, 320.

Family MILACIDAE

This family of slugs is predominantly southern European, but a number of species have been widely distributed by humans, and some have become agricultural pests, especially of potatoes (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Genus MILAX Gray

Thaanum (1927) recorded an undetermined species of *Amalia* (junior synonym of *Milax*) without specifying a particular island. This record probably refers to the single species listed below.

abori.

Amalia abori Collinge, 1897: 294, figs. 4–6. Haleakala, Maui, 5,000 feet, and Olaa to Kilauea, 2,000 to 4,000 feet.

First Record. 1897, based on the original description.

Remarks. Described from Hawaiian material but a junior synonym of *gagates* Draparnaud, according to Quick (1960).

References. 93, 121, 142, 371, 409.

gagates. (M, H)

Limax gagates Draparnaud, [1801]: 100. H.F.M. [= Habitat Français meridional, i.e., southern France].

First Record. 1897, based on the original description of the junior synonym *abori* Collinge.

Status. Established.

Natural Range. Western Europe and the Mediterranean region (Kerney *et al.*, 1979).

Remarks. Recorded damaging rare native plants in Haleakala National Park (Gagné, 1983; Loope, 1995).

References. 49, 93, 120, 121, 142, 175, 187, 227, 240, 283, 371, 404, 409.

Family OLEACINIDAE

Oleacinids occur naturally in the Neotropics, predominantly Central America and the Caribbean (Boss, 1982). They are carnivorous. The species listed here were deliberately introduced in the 1950s as potential biocontrol agents against *Achatina fulica*.

Genus OLEACINA Röding

oleacea. (O)

Achatina oleacea Deshayes, 1830: 11. On presume que cette espèce vient des Antilles.

First Record. 1956, based on the first record of the junior synonym *straminea* (see Davis & Butler, 1964; Kondo, 1956).

Status. Not established.

Natural Range. West Indies (Cuba, ? Haiti; Abbott, 1989; Pilsbry, 1907–1908).

Remarks. One of the many species released as biological control agents against *Achatina fulica*. Generally reported as subspecies *straminea* Deshayes, which is here treated as a junior synonym, following Abbott (1989).

References. 2, 148, 163, 165, 173, 252, 259, 291, 295, 353, 426, 433.

straminea.

Achatina straminea Deshayes, 1851: 172, pl. 123, figs. 11, 12. No locality given.

First Record. 1956 (Davis & Butler, 1964; Kondo, 1956b).

Remarks. Junior synonym of *oleacea* Deshayes, according to Abbott (1989).

References. 2, 148, 163, 165, 174, 252, 259, 291, 353, 426, 433.

undetermined species. (O)

First Record. 1956 (Davis & Butler, 1964).

Status. Not established.

Natural Range. Cuba.

Remarks. Released into the wild but apparently never established (Davis & Butler, 1964). Considered by Davis & Butler (1964) as distinct from *O. oleacina straminea* (treated here as *O. oleacea*), also introduced (see references).

References. 163, 165, 295, 426, 433.

Genus SALASIELLA Strebel

The genus *Salasiella* is placed in family Oleacinidae (F.G. Thompson, pers. comm., 3.i.1996).

undetermined species. (O)

First Record. 1956 (Krauss, 1964).

Status. Not established.

Natural Range. Cuba (Krauss, 1964).

Remarks. Released as part of the biological control program against *Achatina fulica*.

Reference. 259.

Family PHILOMYCIDAE

This family of slugs is found in eastern North America, Central America, and in eastern and southern Asia (Boss, 1982; Solem, 1959). Generic distinctions seem unclear, but the present records are placed in *Meghimatium* (of southern and eastern Asia; Solem, 1959), of which *striatum* Hasselt (listed below) is the type species. *Meghimatium* has also been considered a subgenus of *Philomycus* (e.g., Vaught, 1989). Thaanum (1927) and

Boss (1982) mentioned unidentified Philomycidae, and Pilsbry (1906, p. 183) mentioned unidentified *Philomycus*; probably both records refer to the species listed below, but neither author mentioned specific islands.

Genus MEGHIMATIUM Hasselt

Following Caum (1928), all three species listed below are considered synonyms, with *striatum* Hasselt as the senior synonym. Other authors (Collinge, 1899; Sykes, 1900), synonymized *australis* Bergh with *bilineata* Benson, but retained them distinct from *striatum* Hasselt. Their true status requires further research. The genus-group names *Philomycus* and *Tebennophorus* have sometimes been used in combination with these species-group names.

australis.

Philomycus australis Bergh, 1870: 863, pl. 13, figs. 11–14. Oahu.

First Record. 1846, based on the original description, which indicated that the specimens had been collected in October 1846.

Remarks. Junior synonym of *striatum* Hasselt, according to Caum (1928).

References. 66, 120, 121, 122, 409.

bilineata.

Inclilaria bilineata Benson in Cantor, 1842: 486. Chusan [in publication title].

First Record. 1846, based on the original description of the synonym *australis* Bergh, to which Collinge (1896, 1897) referred his material collected in 1895, but which he subsequently (Collinge, 1899) synonymized with *bilineata* Benson.

Remarks. Junior synonym of *striatum* Hasselt, according to Caum (1928).

References. 75, 92, 93, 120, 121, 122, 218, 409.

striatum. (K, O)

Meghimatium striatum Hasselt, 1824: 82. Java [in publication title].

First Record. 1846, based on the original description of the junior synonym *australis* Bergh.

Status. Established.

Natural Range. Asia (Solem, 1959).

Remarks. Senior synonym of *bilineata* Benson and *australis* Bergh. Type species of *Meghimatium* Hasselt (by monotypy).

References. 120, 121, 122, 214, 396, 409.

Family POLYGYRIDAE

Polygyrids occur widely in North America, extending into Central America and the West Indies (Boss, 1982).

Genus POLYGYRA Say

cereolus. (O)

Helix cereolus Megerle von Mühlfeld, 1816: 11, pl. 2, figs. 18a, b. Vermuthlich Westindien?

First Record. 1995 (Cowie, 1996).

Status. ? Established.

Natural Range. Florida (Abbott, 1989; Pilsbry, 1940).

Remarks. Cowie (1996) is the only record of the family in the Hawaiian Islands. It is not known when or how this species was introduced. In Florida it is common.

References. 2, 140, 309, 362.

Family PUPILLIDAE

The pupillids have a world-wide distribution and are one of the major indigenous groups of land snails in the Pacific (Pilsbry, 1927–1935). Family-level classifications of various authors differ, as do assignments of genera to families and subfamilies. The conservative approach adopted by Cowie *et al.* (1995a), is also adopted here, using Pupillidae in a broad sense. Most of the pupillid species in the Hawaiian Islands (Cowie *et al.*, 1995a) are endemic (and now rarely encountered), but a very small number of widely distributed species have been dispersed through human activities and are considered artificially introduced.

Genus GASTROCOPTA Wollaston

Kirch (1983) referred to “*Gastrocopta*” from Barbers Point, Oahu, without indicating a particular species. This record no doubt refers to one of the taxa listed below.

+*kailuana*. (O)

Gastrocopta servilis f. *kailuana*. Pilsbry, 1917 [*in* 1916–1918]: 143, pl. 24, figs. 5, 6. On the north (Koolau or windward) side of Oahu, at Kaelepulu, Kailua.

First Record. 1917, based on the original description.

Status. Unknown.

Natural Range. Caribbean, Neotropics (assuming it is *servilis* Gould).

Remarks. Included as introduced, despite having been described from Hawaiian material, because it is probably a synonym of *servilis* Gould, although it has never been formally treated as such.

References. 142, 354.

lyonsiana.

Pupa lyonsiana Ancey, 1892: 713. Punahou, Oahu.

First Record. 1892, based on the original description.

Remarks. Synonym of *servilis* Gould. Bishop Museum collections include material labeled *lyonsiana* from Kauai, Oahu, Molokai, Maui and Hawaii, although only Oahu and Maui are mentioned in the literature.

References. 35, 38, 93, 111, 142, 246, 359, 397, 409.

+*nacca*. (O, H)

Vertigo nacca Gould, 1862: 280. Hawaii.

First Record. 1862, based on the original description.

Status. Unknown.

Natural Range. Possibly between the Philippines and New Caledonia (Pilsbry, 1917 [*in* 1916–1918]) (if it is *pediculus* Shuttleworth).

Remarks. Treated as a “race” of *pediculus* Shuttleworth by Pilsbry (1916–1918). Included as introduced, despite having been described from Hawaiian material, because it is probably a synonym of *pediculus* Shuttleworth, although it has never been formally treated as such.

References. 38, 93, 109, 110, 142, 197, 234, 236, 354, 409.

pediculus. (H)

Pupa pediculus Shuttleworth, 1852: 296. Cum praecedente [*pleurophora* Shuttleworth, which was described from “Marquesas et Taite” [= Tahiti]].

First Record. 1982 (Kirch, 1982; but see *nacca* Gould).

Status. Unknown.

Natural Range. Possibly between the Philippines and New Caledonia (Pilsbry, 1917 [in 1916–1918]).

Remarks. Probably ssp. *nacca* Gould is a synonym, in which case *pediculus* Shuttleworth would have been in the Hawaiian Islands since at least 1862 (see *nacca* Gould). In fact, *pediculus* may well be a Polynesian introduction (Solem, 1964; Carl C. Christensen, pers. comm., 27.xii.1996).

References. 2, 109, 110, 244, 354, 388, 398.

servilis. (K, O, Mo, M, H, Midway, Pearl & Hermes, Laysan)

Pupa servilis Gould, 1843a: 356, pl. 16, fig. 14 [1843b: 138]. Santa Cruz . . . and near Matanzas [Cuba].

First Record. 1892, based on the original description of the junior synonym *lyonsiana* Ancy.

Status. Established.

Natural Range. Caribbean, Neotropics (Pilsbry, 1916–1918).

Remarks. Now a dominant member of land snail communities in many lowland areas (Christensen, 1983).

References. 35, 38, 93, 107, 111, 123, 134, 142, 178, 192, 193, 234, 246, 247, 359, 397, 398, 399, 409.

Genus PUPISOMA Stoliczka

orcula. (K, O, Mo, M, H)

Helix orcula Benson, 1850: 251. In agro Bengalensi et Baharico, necnon versus occidentem usque ad ripas fluvii Goomty . . . a day’s march from Jounpore, and on the road thence to Benares . . . at Dinpore, near Patna . . . the whole route from Barrackpore, in Bengal, to the borders of Sikkim, and thence to Chuprah in Bahar [India].

First Record. 1912, based on Bishop Museum collections.

Status. Unknown.

Natural Range. Asia (Pilsbry, 1920–1921).

Remarks. Records from Kauai, Molokai and Maui are based on Bishop Museum collections (unpublished).

References. 63, 109, 356, 357, 359.

Family RHYTIDIDAE

Rhytididae (= Paryphantidae) are carnivorous snails found in South Africa, the

Seychelles, Indonesia, Melanesia, parts of Micronesia and Polynesia, New Zealand and Australia (Boss, 1982; Solem, 1959).

Genus NATALINA Pilsbry

cafra. (O)

Helix cafra Férussac, 1821: 25. La Cafrerie.

First Record. 1959, based on two shells labeled as *Natalina cafra* in the Bishop Museum collections.

Status. Not established.

Natural Range. South Africa (Abbott, 1989; Zilch, 1959–1960).

Remarks. The only literature referring to this species in the Hawaiian Islands is Mead (1979), who indicates that it was brought to Hawaii as part of the biocontrol efforts against *Achatina fulica* in the 1950s, but not released. The specimens were collected from Hauula, Oahu, but their identity requires confirmation and this record remains tentative.

References. 2, 180, 295, 448.

Family SPIRAXIDAE

Spiraxidae are carnivorous snails native to the southeastern United States through Central America and the Caribbean to Brazil and Peru (Boss, 1982).

Genus EUGLANDINA Crosse & Fischer

rosea. (K, O, Mo, M, H)

Achatina rosea Férussac, 1821: 50. Les Florides [= Florida].

First Record. 1955, based on many citations (e.g., Kondo, 1956; Weber, 1956; Davis & Butler, 1964).

Status. Established.

Natural Range. Florida and neighboring parts of the southeast USA from North Carolina to Louisiana (Mead, 1979).

Remarks. The most significant of the predatory snail species introduced deliberately during the 1950s as potential biological control agents against *Achatina fulica*. While some have argued that *E. rosea* has been successful in controlling *A. fulica* (e.g., Nishida & Napompeth, 1975), there remains no convincing evidence that this is the case, *A. fulica* having declined for unknown but probably unrelated reasons (Christensen, 1984; Civeyrel & Simberloff, 1996; Cowie, 1992b). There is, however, ample evidence of its devastating effects on native Hawaiian land snail faunas (e.g., Hadfield, 1986; Hadfield *et al.*, 1993). It will even go under water to attack freshwater snails (Kinzie, 1992). *E. rosea* has been widely introduced throughout the tropics and subtropics for control of *A. fulica*, always resulting in serious threat to the native snail faunas (Civeyrel & Simberloff, 1996; Cowie, 1992b; Griffiths *et al.*, 1993).

References. 2, 52, 85, 105, 108, 109, 112, 114, 115, 116, 118, 127, 128, 130, 132, 137, 147, 148, 149, 152, 153, 154, 158, 159, 160, 162, 163, 165, 169, 171, 172, 176, 178, 180, 183, 186, 188, 191, 198, 202, 205, 206, 208, 209, 210, 213, 216, 222, 224, 225, 226, 227, 238, 242, 247, 249, 252, 255, 259, 262, 264, 273, 275, 277, 278, 288, 291, 292, 293, 294, 295, 299, 301, 311, 322, 327, 330, 381, 382, 383, 386, 387, 389, 401, 404, 418, 419, 424, 425, 426, 429, 431, 436.

Family STREPTAXIDAE

Streptaxids are carnivorous snails, distributed predominantly in South America, SE Asia, India and especially Africa (Boss, 1982). They are now widely distributed throughout the tropics and subtropics, in part due to human activities. Frequently, they have been introduced deliberately for use in attempts at biological control of *Achatina fulica* (e.g., Krauss, 1964). Notwithstanding reports to the contrary (e.g., Godan, 1983), there is no satisfactory evidence that they have had a significant impact on populations of *A. fulica* (e.g., Christensen, 1984a). In general, streptaxids introduced for biological control have not become as abundant as *Euglandina rosea* (see above, Spiraxidae), but they nevertheless may well have had a significant impact on native land snail faunas.

Genus EDENTULINA Pfeiffer

affinis. (O)

Edentulina affinis Boettger, 1913: 349, pl. 15, fig. 8. Kipatimu, German East Africa [= Tanzania].

First Record. 1957 (Davis, 1958b; Davis & Butler, 1964; Krauss, 1964).

Status. Not established.

Natural Range. Kenya (Waterhouse & Norris, 1987), Tanzania (Boettger, 1913).

Remarks. One of the many predatory snails released into the wild in attempts to control *Achatina fulica*, but apparently never established (Davis & Butler, 1964; Mead, 1979).

References. 64, 72, 118, 148, 163, 165, 259, 291, 295, 344, 426, 428.

+bulimiformis. (O)

Ennea obesa bulimiformis Grandidier, 1887: 188. Collines montueuses qui séparent l'Ousaghara de l'Ousegeua [= hilly hills that separate Ousaghara from Ousegeua; Tanzania].

First Record. 1957 (Krauss, 1964).

Status. Not established.

Natural Range. Kenya (Waterhouse & Norris, 1987), Tanzania (Grandidier, 1887).

Remarks. One of the many predatory snails released into the wild in attempts to control *Achatina fulica*, but apparently never established (Krauss, 1964; Mead, 1979).

References. 199, 259, 295, 426.

Genus GONAXIS Taylor

A number of references (Davis & Krauss, 1968; Fisher & Orth, 1985; Hadfield & Kay, 1981; Krauss, 1962; Lee, 1982; Lilloco, 1983; Schalie, 1970) mention *Gonaxis* sp(p)., without indicating the species. No doubt they all refer to one or other of the species listed below.

kibweziensis. (O, M)

Streptaxis kibweziensis Smith, 1894: 165, fig. 1. Kibwezi [Kenya].

First Record. 1952, based on many sources (e.g., Weber, 1953).

Status. Established.

Natural Range. East Africa (Kenya) (Abbott, 1989; Waterhouse & Norris, 1987).

Remarks. One of the many predatory snails released into the wild in attempts to control *Achatina fulica*. Has become established but apparently not especially widespread or abundant.

References. 2, 64, 108, 118, 130, 148, 149, 151, 152, 153, 158, 162, 163, 164, 165, 186, 191, 225, 226, 252, 259, 265, 288, 291, 293, 295, 322, 327, 344, 381, 394, 426, 427, 428, 429.

quadrilateralis. (K, O, M, H)

Ennea quadrilateralis Preston, 1910: 527, pl. 7, fig. 2. Shimbi [= Simba] Hills, British East Africa [= Kenya].

First Record. 1957, based on many sources (e.g., Davis, 1958b).

Status. Established.

Natural Range. East Africa (Kenya) (Waterhouse & Norris, 1987).

Remarks. One of the many predatory snails released into the wild in attempts to control *Achatina fulica*. Has become established but apparently not especially widespread or abundant.

References. 2, 108, 118, 130, 148, 149, 151, 152, 153, 154, 158, 159, 162, 163, 164, 165, 167, 168, 169, 170, 171, 186, 222, 225, 226, 241, 259, 265, 288, 291, 293, 294, 295, 319, 322, 323, 327, 369, 381, 383, 426.

vulcani. (O)

Gonaxis vulcani Thiele, 1911: 184, pl. 4, figs. 22, 23. Vulkan Niragongo in einer Höhe von 2500–3000 m [Central Africa].

First Record. 1956, based on a number of sources (e.g., Weber, 1957d).

Status. Not established.

Natural Range. Africa (Zaire) (Pilsbry, 1919).

Remarks. One of the many predatory snails released into the wild in attempts to control *Achatina fulica*, but apparently never established (Davis & Butler, 1964; Mead, 1979).

References. 130, 163, 165, 259, 291, 295, 355, 414, 426, 433.

Genus GULELLA Pfeiffer

Davis & Butler (1964), Krauss (1964) and Mead (1961a, 1979) mentioned introduction of *Gulella* sp., without indicating the species. Probably they all refer to one or both of the species listed below.

bicolor. (O, H)

Pupa bicolor Hutton, 1834: 86 [description], 93 [name]. Mirzapur . . . and at the base of the walls of my Bungalow . . . between Agra and Neemuch [India].

First Record. 1940, based on Krauss (1964), who stated that Yoshio Kondo found one dead specimen on Oahu in 1940 or 1941.

Status. Not established.

Natural Range. Possibly Asia (Naggs, 1989); possibly Africa or the Mascarene Islands (Solem, 1989).

Remarks. The first record may be due to an accidental introduction. Subsequently deliberately introduced for control of *Achatina fulica* and *Subulina octona* but apparently not established (Mead, 1961a; Davis & Butler, 1964; Krauss, 1964). This species has been introduced widely and is now circum-tropical in distribution (Naggs, 1989; Solem, 1989). Its nomenclature and distribution, and their taxonomic implications, have been discussed in detail by Naggs (1989). There is no consensus in assigning this species to genus nor in the status of the subgenus *Huttonella*, of which it is the type species (Naggs, 1989).

References. 148, 149, 163, 165, 230, 259, 291, 295, 312, 400, 426, 433.

wahlbergi. (O, M)

Pupa wahlbergi Krauss, 1848: 80, pl. 5, fig. 5. Terra natalensi [= Natal, South Africa].

First Record. 1956 (Davis & Butler, 1964).

Status. ? Established.

Natural Range. South Africa (Krauss, 1848) and possibly central/western Africa (Waterhouse & Norris, 1987).

Remarks. Introduced to Oahu and Maui for control of *Achatina fulica* in 1956. Recovered from the wild on Oahu in 1960 and 1964 (Davis & Butler, 1964; Krauss, 1964) and considered established by 1972 (Mead, 1979). It may have since disappeared.

References. 43, 118, 148, 153, 163, 165, 256, 259, 291, 295, 381, 426.

Genus PTYCHOTREMA Mörch**walikalense.** (O)

Ptychotrema walikalense Pilsbry, 1919: 203, fig. 72. Walikale [Zaire].

First Record. 1956 (Weber, 1957d; Krauss, 1964).

Status. ? Not established.

Natural Range. West Africa (Zaire) (Pilsbry, 1919; Weber, 1957d).

Remarks. One of the many predatory snails released into the wild in attempts to control *Achatina fulica*, but probably not established.

References. 165, 259, 295, 355, 433.

undetermined species. (O)

First Record. 1956 (Weber, 1957d).

Status. ? Not established.

Natural Range. Belgian Congo (Weber, 1957d).

Remarks. One of the many predatory snails released into the wild in attempts to control *Achatina fulica*, but apparently never established. Possibly a different species from *P. walikalense*, as Weber (1957d) listed both *P. walikalense* and *Ptychotrema* sp. as separate taxa.

References. 295, 433.

Genus STREPTAXIS Gray**contundata.** (K)

Helix contundata Férussac, 1821: 30. Le Brésil [= Brazil].

First Record. 1961 (Davis & Butler, 1964; Krauss, 1964).

Status. Not established.

Natural Range. South America (Brazil) (Abbott, 1989).

Remarks. Generally referred to as “*contusus*” [sometimes misspelled “*contusis*”] but this is strictly an unjustified emendation (published by Férussac on p. 67, which appeared on 13 July 1821) of the original name, *contundata* (published by Férussac on p. 30, which appeared on 26 May 1821). One of the many predatory snails released into the wild in attempts to control *Achatina fulica*, but seems not to have become established.

References. 2, 163, 165, 167, 180, 258, 259, 295.

Family STROBILOPSIDAE

The family contains about 30 species in the single genus *Strobilops*, distributed in North America, the Caribbean, parts of South America, the Galapagos and eastern Asia (Boss, 1982).

Genus STROBILOPS Pilsbry

aenea. (O)

Strobilops aenea Pilsbry, 1926: 69. Cazenovia, N.Y. [New York State, USA].

First Record. 1944 (F. Haas *in litt.* to C.M.Cooke, Jr., 6.xii.1944; Haas, 1945).

Status. Unknown.

Natural Range. Massachusetts to Michigan, Illinois and Arkansas, south to southern Florida and Louisiana (Pilsbry, 1927–1935)

Remarks. Only reported once in the Hawaiian Islands when it was considered established (Haas, 1945).

References. 204, 358, 359

Family SUBULINIDAE

A number of subulinids are now widespread in the tropics and subtropics as a result of human activities (e.g., Christensen & Kirch, 1981, 1986; Solem, 1959, 1978), as well as being established greenhouse aliens in temperate regions (Kerney *et al.*, 1979). In the Pacific, one species at least (*Allopeas gracile*) appears to have been dispersed by Pacific islanders prior to European exploration, while others are more recent introductions. They are often extremely abundant.

Characterization of subulinid genera is not well understood. However, following Cowie *et al.* (1995a), *Allopeas* and *Paropeas* are treated here as genera, not as subgenera, respectively, of *Lamellaxis* and *Prosopeas*.

Species level taxonomy is also difficult, there being much intra-specific conchological variation that, combined with many species' wide distributions, has resulted in numerous synonyms. A number of species have been described from the Hawaiian Islands, but are now considered junior synonyms of extralimital taxa (Cowie, *et al.*, 1995a). Many misidentifications of these introductions have probably been made, such that the following island distributions and identifications are in many cases highly insecure and should be treated with caution.

The name *tuckeri* Pfeiffer, placed in *Pseudopeas* by Pilsbry (1906–1907), has been used for Hawaiian subulinids, but incorrectly (see Christensen & Kirch, 1986; Pilsbry, 1906–1907); this species should not be considered present in the Hawaiian Islands and is excluded from this catalog list. Kirch (1983) referred to undetermined "*Pseudopeas*" and "Subulinidae", and three references (Mead, 1963; Thaanum, 1927; Williams, 1931) referred to "*Opeas*" without indicating particular species; all these records could conceivably refer to any one or more of the subulinids listed below.

Genus ALLOPEAS Baker

clavulinum. (H)

Bulimus clavulinus Potiez & Michaud, 1838: 136, pl. 14, figs. 9, 10. L'île Bourbon [= Réunion].

First Record. 1906 (Pilsbry (1906 [*in* 1906–1907])).

Status. Established.

Natural Range. Probably tropical East Africa (Kerney *et al.*, 1979).

Remarks. Pilsbry (1906–1907) considered the subspecies *hawaiiense* Sykes “scarcely separable” from *clavulinum* s.s. Modern revision would probably synonymize them, and therefore the distribution of *clavulinum* in the Hawaiian Islands would be wider than indicated here.

References. 19, 24, 109, 240, 313, 352, 368.

+hawaiiense. (K, O, Mo, M, H)

Opeas prestoni var. *hawaiiense* Sykes, 1904: 113, fig. 3. Hawaii, Kawaioloa, Mauna Loa at 1,500 feet . . . Hawaii, Hilo.

First Record. 1900 (Sykes, 1900, 1904).

Status. Established.

Natural Range. Unknown.

Remarks. Pilsbry (1906–1907) considered *hawaiiense* Sykes “scarcely separable” from *clavulinum* s.s. but retained it as a distinct variety of *clavulinum*. Modern revision would probably synonymize them. The record from Molokai is derived from Bishop Museum collections (unpublished). Pilsbry (1906–1907) thought it probably to have been introduced from Japan.

References. 93, 142, 352, 409, 410.

gracile. (N, K, O, Mo, M, H)

Bulimus gracilis Hutton, 1834: 84 [description], 93 [name]. Mirzapoor . . . Futtehpoor Sikra . . . between Agra and Neemuch [India].

First Record. 1846, based on the original description of the junior synonym *junceus* Gould.

Status. Established.

Natural Range. Probably Neotropics (Solem, 1964).

Remarks. Distributed on “all the islands” (see Cowie *et al.* 1995a), but only explicitly in the literature from Oahu, Molokai, and Hawaii, with the junior synonym *oparanus* Pfeiffer also recorded from Maui. Bishop Museum collections labeled *oparanus* and *pyrgiscus* (both junior synonyms) are the basis for the records from Niihau and Kauai. Probably introduced by Polynesian travelers prior to the arrival of westerners in the Hawaiian Islands (Christensen & Kirch, 1986).

References. 19, 60, 75, 93, 107, 109, 110, 111, 134, 142, 178, 188, 230, 234, 244, 245, 248, 313, 352, 398, 399, 409, 410.

junceus.

Bulimus junceus Gould, 1846: 191. Society and Sandwich Islands.

First Record. 1846, based on the original description.

Remarks. Junior synonym of *gracile* Hutton, according to Cowie *et al.* (1995a).

References. 60, 93, 142, 194, 234, 352, 409, 410.

oparanus.

Bulimus oparanus Pfeiffer, 1846a: 34. Island of Opara [= Rapa].

First Record. 1906 (Pilsbry, 1906 [*in* 1906–1907])).

Remarks. Junior synonym of *gracile* Hutton, according to Cowie *et al.* (1995a).

References. 19, 24, 93, 142, 178, 346, 352, 399.

pyrgiscus.

Bulimus pyrgiscus Pfeiffer, 1861: 24. Sandwich Islands.

First Record. 1861, based on the original description.

Remarks. Junior synonym of *gracile* Hutton, according to Cowie *et al.* (1995a).

References. 93, 142, 350, 352, 409, 410.

upolensis.

Stenogyra upolensis Mousson, 1865: 175. Upolu, Samoa.

First Record. 1906 (Pilsbry & Vanatta, 1906).

Remarks. Junior synonym of *junceus* Gould (e.g., Pease, 1871) or *oparanus* Pfeiffer (e.g., Pilsbry, 1906–1907); *junceus* Gould and *oparanus* Pfeiffer both subsequently treated as synonyms of *gracile* Hutton by Cowie *et al.* (1995a). Here, *upolensis* Mousson is therefore treated as a synonym of *gracile* Hutton. **New synonymy.**

References. 93, 308, 335, 352, 366.

Genus OPEAS Albers

beckianum. (K)

Bulimus beckianus Pfeiffer, 1846b: 82. ? Opara [= Rapa; incorrect, according to Pilsbry (1906–1907)].

First Record. 1914, based on Bishop Museum collection labels.

Status. Unknown.

Natural Range. Central and South America (Pilsbry, 1906–1907).

Remarks. Possibly misidentified, although unpublished notes of Carl C. Christensen indicate that BPBM Malacology 37668 was identified as *beckianum* by H.A. Pilsbry and that a few other specimens collected between 1914 and 1936 belong to this species. The name *micra* d'Orbigny has been suggested as a possible identity (unpublished notes of G.A. Solem).

References. 19, 24, 347, 352.

goodallii.

Helix goodallii Miller, 1822: 381. The environs of Bristol [England] [in publication title; no doubt imported].

First Record. 1906 (Pilsbry, 1906 [in 1906–1907]).

Remarks. Synonym of *hannensis* Rang, according to Proschwitz (1994), because the name *goodallii* is preoccupied. Frequently misspelled “*goodalli*”.

References. 19, 24, 178, 240, 297, 352, 370.

hannense. (N, K, O, H)

Helix hannensis Rang, 1831: 41, pl. 3, fig. 8. Village de Hann sur la presqu'île du Cap-Verd [West Africa].

First Record. 1906, based on the first record of the synonym *goodallii* Miller.

Status. ? Established.

Natural Range. Tropical Central America (Kerney *et al.*, 1979; as the junior synonym *pumilus* Pfeiffer).

Remarks. Senior synonym of *goodallii* Miller and *pumilus* Pfeiffer, according to Proschwitz

(1994). The records from Niihau, Kauai and Hawaii are based on material in the Bishop Museum collections labeled “*goodalli*”. Widely distributed by humans (Kerney *et al.*, 1979).

References. 19, 24, 110, 178, 240, 352, 370, 373.

mauritianum. (O, M, H)

Bulimus mauritianus Pfeiffer, 1854: 150. Mauritius [in publication title].

First Record. 1906 (Pilsbry, 1906 [in 1906–1907]).

Status. Unknown.

Natural Range. Unknown.

Remarks. The records from Oahu and Hawaii are based on material in the Bishop Museum collections tentatively identified as either *mauritianum* or *opella*.

References. 19, 24, 93, 349, 352.

+prestoni. (H)

Opeas prestoni Sykes, 1898: 73, pl. 5, fig. 4. Uda Pussellawa [Sri Lanka].

First Record. 1906 (Pilsbry, 1906 [in 1906–1907]).

Status. Unknown.

Natural Range. Unknown.

Remarks. This subspecies is probably synonymous with *mauritianum* s.s. but has not been formally synonymized and so is retained here as a distinct subspecies of *mauritianum*, following Pilsbry (1906–1907) and pending further research.

References. 93, 352, 408, 409.

opella. (K, O, Mo, M, H)

Opeas opella Pilsbry & Vanatta, 1906: 785, fig. 1. Honolulu [material also reported from Hilo, Island of Hawaii].

First Record. 1906, based on the original description.

Status. Established.

Natural Range. Possibly “the East Indies or China” (Pilsbry, 1906–1907).

Remarks. The records from Kauai, Molokai and Maui are based on material in the Bishop Museum collections (often only labeled “*opella* type”).

References. 19, 24, 93, 142, 178, 352, 366.

pumilus.

Bulimus pumilus Pfeiffer, 1840: 252. Cuba [in publication title].

First Record. 1906 (Pilsbry, 1906 [in 1906–1907]).

Remarks. Junior synonym of *hannense* Rang, according to Proschwitz (1994).

References. 110, 240, 345, 352, 370.

striolata.

Stenogyra striolata Nevill, 1878: 166. *Nom. nud.*

First Record. 1878 (Nevill, 1878).

Remarks. Placed in subgenus *Opeas* of genus *Stenogyra* by Nevill (1878) and in genus *Opeas* by Sykes (1900), both of whom attributed the name to Pease. The true identity of this record is unknown.

References. 325, 409.

Genus PAROPEAS Pilsbry**achatinaceum.** (K, O, Mo, M, H)

Bulimus achatinaceus Pfeiffer, 1846b: 82. Java.

First Record. 1904, based on the original description of the junior synonym *henshawi* Sykes.

Status. ? Established.

Natural Range. Java, Sumatra, Bornea (Pilsbry, 1906–1907); Australasia (Kirch, 1979).

Remarks. The records from Molokai and Maui are based on material in the Bishop Museum collections labeled as the junior synonym *javanica*.

References. 19, 21, 24, 28, 93, 109, 142, 163, 178, 246, 247, 313, 347, 352, 410, 423, 424, 437.

henshawi.

Opeas henshawi Sykes, 1904: 112, fig. 2. Hawaii, Hilo.

First Record. 1904, based on the original description.

Remarks. Junior synonym of *achatinaceum* Pfeiffer, according to Naggs (1994) and Cowie *et al.* (1995a).

References. 93, 142, 313, 352, 410.

javanica.

Achatina javanica Reeve, 1849 [*in* 1848–1850]: *Achatina* pl. 17, fig. 79. Java.

First Record. 1906 (Pilsbry, 1906 [*in* 1906–1907]).

Remarks. Junior synonym of *achatinaceum* Pfeiffer, according to Naggs (1994).

References. 19, 21, 24, 28, 93, 163, 178, 246, 313, 352, 374, 423, 424, 437.

Genus SUBULINA Beck**octona.** (K, O, Mo, H, Midway)

Bulimus octonus Bruguière, [1789]–1792: 325. Les Îles Antilles [Caribbean].

First Record. 1903, or earlier (Cooke, 1928), although not earlier than about 1870 (Anon., 1925).

Status. Established.

Natural Range. Tropical America (Kerney *et al.*, 1979; Solem, 1964).

Remarks. One of the most common snails of disturbed (especially urban and suburban) areas in the Hawaiian Islands. Reported as prey of *Gonaxis* spp. (Davis & Butler, 1964). Records from Kauai and Molokai based on Bishop Museum collections (unpublished). Probably on all main islands. Although identification of subulinids is extremely difficult, *Subulina octona* is perhaps the most clearly recognizable of the species in the Hawaiian Islands.

References. 4, 7, 10, 11, 17, 19, 21, 24, 28, 40, 50, 51, 53, 80, 86, 96, 97, 109, 110, 117, 118, 123, 124, 148, 149, 163, 178, 186, 216, 240, 247, 293, 295, 352, 398, 423, 424, 437.

Family VERONICELLIDAE

The Veronicellidae [= Vaginulidae] include a large number of species of terrestrial slugs distributed widely in the humid tropics and subtropics (Boss, 1982; Hoffman, 1925). The name Veronicellidae has priority over Vaginulidae, although both have been widely used (Cowie, in prep.). Nomenclature at all levels in the family has been confused. Identifications are also difficult. A number of species, including two of those recorded in the Hawaiian Islands, are widely distributed throughout much of the humid tropics, probably in large part due to human activities.

Genus LAEVICAULIS Simroth

alte. (O, Mo, H, Midway)

Vaginulus alte Férussac, 1822: 14. Environs de Pondichéry [= Pondicherry, India].

First Record. 1900, based on records of the junior synonym *leydigi* Simroth.

Status. Established.

Natural Range. Central Africa (Solem, 1964).

Remarks. The well-known black slug. C.M. Cooke, Jr. (*in litt.* to H.B. Baker, 30.iv.1927) said “*Veronicella* [sic] now is abundant here and was not known in 1901”. Abundant at Moanalua (Oahu) in 1964 (Davis & Butler, 1964). The record of undetermined *Veronicella* by Thaanum (1927) probably refers to this species. Appears now to be declining, perhaps as a result of displacement by *Vaginula plebeia* (see below). This species is widely distributed from East Africa through southern Asia and the islands of the Indian and Pacific Oceans (Hoffman, 1925), probably largely through human activities. The records from the Island of Hawaii and from Midway are based on Bishop Museum collections (BPBM Malacology 207459, collected by S. Conant on Midway in 1983) and on specimens in the U.S. National Museum of Natural History (J.W. Thomé, pers. comm., 1996).

References. 11, 17, 19, 21, 24, 25, 28, 40, 49, 51, 75, 88, 96, 97, 123, 141, 163, 181, 184, 216, 220, 221, 223, 268, 288, 321, 398, 407, 417, 423, 424, 437, 440.

leydigi.

Vaginula leydigi Simroth, 1889: 552. Queensland [Australia].

First Record. 1900: “about 1900” (Williams, 1931); since 1900 (Nakahara *et al.*, 1981); “early 1900’s” (Anon, 1994).

Remarks. Junior synonym of *alte* Férussac, according to Hoffman (1925) and Forcart (1969).

References. 11, 17, 40, 49, 51, 88, 184, 220, 221, 223, 268, 288, 321, 390, 407, 437, 440.

Genus VAGINULA Férussac

The genus-group name *Vaginula* is a justified emendation of the original spelling “*Vaginulus*” (Cowie, in prep.).

plebeia. (O, H)

Vaginulus plebeius Fischer, 1868: 145. Nova Caledonia [= New Caledonia].

First Record. 1978 (Anon., 1994; Nakahara *et al.*, 1981).

Status. Established.

Natural Range. Brazil and the West Indies (Solem, 1964).

Remarks. The common brown slug; quite variable in color.

References. 21, 28, 49, 57, 87, 88, 141, 182, 220, 288, 321, 398, 447.

Genus VERONICELLA Blainville

cubensis. (O)

Onchidium cubense Pfeiffer, 1840: 250. Cuba [in publication title].

First Record. 1985 (Kumashiro, 1987; as *Veronicella floridana*; misidentification).

Status. Unknown.

Natural Range. Cuba.

Remarks. Considered the correct name for the species previously identified as *Veronicella floridana* (Binney) (see Kumashiro, 1987; Kumashiro & Hue, 1991), which was originally described from “Meta-lee-chee Key, Charlotte Harbor, on the western coast of Florida” (Binney, 1851) and is distributed in Florida, Central America and the Caribbean (Hoffman, 1925), perhaps in part through human activities. The two taxa may be synonymous, but were retained as distinct by Thomé (1975) who placed *floridana* Binney in genus *Leidyula* and *cubense* Pfeiffer among a list of unassigned species. Here, *cubense* Pfeiffer is provisionally retained in *Veronicella*, the genus to which it has been referred in the Hawaiian literature. As a misidentification, *floridana* Binney is not listed here.

References. 49, 71, 220, 260, 261, 288, 345, 415.

Family ZONITIDAE

This catalog follows Kerney *et al.* (1979) and Baker (1941) for assignment of genera to this family. The family includes significant numbers of endemic Pacific species, including Hawaiian species (Baker, 1941; Cowie *et al.*, 1995a), but a number of species have also been introduced.

Genus HAWAIIA Gude

kawaiensis.

Helix kawaiensis Reeve, 1854 [in 1851–1854]: pl. 182, fig. 1256. Kawai [= Kauai].

First Record. 1854, based on the original description.

Remarks. Junior synonym of *minuscula* Binney, according to Baker (1941) and Cowie *et al.* (1995a). The name *kawaiensis* Pfeiffer is a junior homonym (see Cowie *et al.*, 1995a).

References. 58, 142, 197, 336, 375.

minuscula. (K, O, Mo, L, M, H, Midway)

Helix minuscula Binney, 1841: 435, pl. 22, fig. 4. Ohio . . . Vermont.

First Record. 1850 (“before 1850”; Solem, 1964). The junior synonym *kawaiensis* Reeve described from Hawaiian material in 1854.

Status. Established.

Natural Range. North America.

Remarks. Despite the genus name, which was established for the junior synonym *kawaiensis* Reeve, this species is not an indigenous species in the Hawaiian Islands but has been introduced since western contact. The species is now widely distributed from the Caribbean to the Pacific, Japan and north-east Asia (Peile, 1936) and also now found widely in greenhouses in Europe

(Kerney *et al.*, 1979). The record from Lanai is based on Bishop Museum collections (unpublished).

References. 2, 58, 70, 107, 109, 114, 123, 142, 178, 203, 240, 247, 336, 352, 375, 398, 437.

Genus OXYCHILUS Fitzinger

Identification of the various *Oxychilus* species is difficult (Kerney *et al.*, 1979; Lloyd, 1970). Although *O. alliarius* is certainly present, the presence of *O. cellarius* needs confirmation. It is also difficult to distinguish these *Oxychilus* species from the native *Nesovitrea hawaiiensis* (Ancey). Two references (Asquith & Messing, 1992; Hadfield & Miller, 1989) simply mention undetermined species of *Oxychilus*.

alliarius. (K, Mo, M, H)

Helix alliardia Miller, 1822: 379. The environs of Bristol [England] [in publication title].

First Record. 1937, based on Bishop Museum collections, reported by Christensen (1983).

Status. Established.

Natural Range. North-western Europe as far north as southern Scandinavia (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Remarks. The "garlic" snail, so called because it smells strongly of garlic when irritated; a good identification feature. Recorded at 6000 ft [1829 m] elevation on Maui, and between 2600 ft [792 m] and 7200 ft [2195 m] on Hawaii. The records from Kauai and Molokai are based on Bishop Museum collections (unpublished).

References. 107, 125, 188, 212, 225, 240, 276, 280, 297, 307, 351, 386, 387, 419.

cellarius. (M)

Helix cellaria Müller, 1774: 28. Havniae [= Copenhagen, Denmark].

First Record. 1963 (Bryan, 1963).

Status. Unknown.

Natural Range. Europe, except the far east and northern Scandinavia (Kerney *et al.*, 1979; Pflieger & Chatfield, 1988).

Remarks. Both Bryan's (1963) record and the labeled specimens in the Bishop Museum collections may be misidentifications of *alliarius* Miller.

References. 2, 81, 240, 280, 295, 310.

Genus STRIATURA Morse

undetermined species. (H)

First record. 1937, based on Bishop Museum collections

Status. Established.

Natural Range. Unknown.

Remarks. Specimens collected in 1992, 1993 and 1996 have been tentatively referred to this genus (Cowie & Nishida, 1993; Cowie *et al.*, 1995b; Evenhuis *et al.*, 1996). Similar specimens in the Bishop Museum collections have been labeled *Striatura meniscus*, but incorrectly. The specimens do not correspond to anything in the type collections of *Striatura* in the Bishop Museum nor to the written treatment of Baker (1941). They cannot be identified further and

may belong to an undescribed species. The species is abundant in dry areas on the western side of the saddle between Mauna Kea and Mauna Loa and towards Hualalai and Puuwaawaa. Nothing is known of its biogeographic status, but it is included here as it is possibly non-indigenous.

References. 58, 143, 144, 179.

Genus ZONITOIDES Lehmann

arboreus. (O, M, H)

Helix arboreus [Say], 1819: [7], pl. 4, fig. 4. United States [in introduction].

First Record. 1928 (Baker, 1941).

Status. Established.

Natural Range. Canada to Mexico, and the Caribbean (Abbott, 1989; Kerney *et al.*, 1979).

Remarks. The article in which the original description appeared is anonymous and unpaginated; the author mentions having previously published in the *Journal of the Academy of Natural Sciences of Philadelphia*, hence the inference of Say's authorship (Gary Rosenberg, pers. comm., 11.xii.1996). Fairly common and probably present on all main islands, although only recorded from Oahu, Maui and Hawaii.

References. 2, 58, 75, 109, 178, 240, 363, 378, 387.

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