*Records of the Hawaii Biological Survey for 1999. Bishop Museum Occasional Papers* 63: 35–49. (2000)



# The Centipede Order Lithobiomorpha in the Hawaiian Islands (Chilopoda). I. The Epigean Fauna

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## Introduction

The chilopod order Lithobiomorpha comprises short-bodied anamorphic forms with strong tergite heteronomy, 15 segments and leg pairs in adults (6–8 of each in 1st stadia), and more than 14 antennal articles. Twelve epigean species occur in Hawai'i, most unquestionably introduced; Williams (1931) provides a dorsal view of a specimen of *Lithobius* sp., which shows the general form of representatives of this order. The Hawaiian lithobiomorphs have not been examined in detail, but our knowledge of them is relatively advanced because of Eason's study (1977) of *Lithobius hawaiiensis* Silvestri. He redescribed and illustrated this species, summarized Hawaiian representatives of the Lithobiidae, and briefly recounted their literature, thus forming the basis for the present contribution. Eason (1992) classified the Lithobiomorpha and recognized 2 families, Lithobiidae and Henicopidae, the former with 4 subfamilies and the latter with 2; both families occur in Hawai'i and are readily distinguished by the presence (Lithobiidae) or absence (Henicopidae) of spurs on the legs. Although others placed the Hawaiian species of *Bothropolys* Wood in the family Ethopolidae, but we agree with Eason (1992) that this taxon warrants only subfamilial status under the Lithobiidae.

This work summarizes literature records of epigean Hawaiian lithobiomorphs, with synonymies for the 7 species whose literature is complex, and provides new ones from the collection of the first author (MZ); the British Museum of Natural History, London, United Kingdom (BMNH); the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM); the Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah (BYU); and the Bishop Museum, Honolulu (all samples not otherwise labeled). A study of forms inhabiting laval tubes is in preparation by the first author. More Hawaiian samples undoubtedly exist in American repositories, but the second author has not attempted to record them during visits to these institutions. We invite future students to issue supplements to our work as additional material is discovered.

## Family Henicopidae
## Subfamily Henicopinae

***Lamyctes africana*** (Porat) **New island records**

*Lamyctes hawaiensis* (sic): Attems, 1938: 366, 370.

*Lamyctes africana*: Attems, 1940: 279, figs. 9–15, 17, 19–22.

*Diagnosis.* Up to 10.0 mm long; antennae with 24–29 articles, usually 28; only single large ocellus on each side; prosternal teeth 2+2, lateral prosternal prominence present; all tergites without posterior projections; coxal pores small, circular, mostly 2,2,2,2, sometimes 2,3,2,2 or 2,3,3,2, separated from each other by more than their own diameter; anterior tarsal articulations absent in 1st–12th legs; 15th tarsus slender, about 6–10 × longer than broad; all legs with 2 accessory apical claws, both about 1/2 as long as principal claw; tibia of 1st–12th legs with sharp distal projection on anterior edge; 15th legs long and slender; female gonopods with 2+2 conical spurs, claw narrow, without lateral denticles.

*Occurrence in Hawai'i.* Kure, O'ahu, Maui (all new island records), and Hawai'i.

*Published records.* Island of Hawai'i, Nauhi Gulch, Mauna Ke'a (Attems, 1938, 1940).

*Material examined.* **HAWAI'I:** 3♀, Saddle Rd, Pu'u Huluhulu, under stones, 28 Jul 1979, F.G. Howarth; 1♀, Slopes of Mauna Ke'a, 8000–9000 ft, 24 Aug 1966, T. Symon; 2♀, Hawaii Volcanoes Natl. Park, Mauna Loa Trail, isolated *Metrosideros* with *Coprosma montana, Styphelia, Vaccinium*, 8100 ft, 21 Jul 1970, F.J. Radovsky, duff; 1♀, Hawaii Volcanoes Natl. Park, Mauna Loa Summit Trail, bomb zone, 2150 m, 14 Jun 1979, M.L. Goff & F.J. Radovsky; 1♀ juv, same locality, leaf litter, 2220 m, 20 Oct 1970, M.L. Goff; 36♀,5♀ juvs, 3 juvs, 2 larvae, Hawaii Volcanoes Natl. Park, Mauna Loa Summit Trail, *Metrosideros* cone, *Styphelia, Vaccinium, Coprosma, Dubautia*, 2286–2316 m, Sep 1971–Jul 1972, J. Jacobi. **KURE:** 1♀, 21 Apr 1978, Dallas Grady. **O'AHU:** 1♀, Koko Head, 3 Jan 1985, V. & B. Roth; 4♀, Mt Ka'ala, in culvert on road, 1200 m, 3 Oct 1975, F.G. Howarth. **MAUI:** 1♀,1♀ juv, Haleakalā, Halemanu Trail, 8000 ft, 30 Apr 1945, E.C. Zimmerman.

*Remarks. Lamyctes africana* occurs in southern Africa and Madagascar, it is also known in southwestern Australia, the Juan Fernandez Is, and St. Paul Is (Atlantic Ocean), where it is considered introduced (Attems, 1940). A female from Mauna Loa Summit Trail has 1+1 short spurs on the gonopods.

***Lamyctes emarginatus*** (Newport) **New synonymy; Lectotype designation**

*Lamyctes fulvicornis* var. *hawaiiensis* Silvestri, 1904: 325, figs. 1–2. Attems, 1909: 8; 1914: 48, 56, 93; 1928: 61. **syn. nov.**

*Lamyctes fulvicornis hawaiiensis*: Chamberlin, 1920: 71. Nishida, 1994: 26.

*Diagnosis.* Up to 11.5 mm long; antennae usually with 25–28 articles; only single ocellus on each side; prosternum with anterior margin narrow, armed with 2+2 teeth; all tergites without triangular projections at posterior angles; 1–3 coxal pores separated by more than their own diameter, usually 2,2,2,1 (2,3,3,1; 3,3,3,2) in males, 2,2,3,2 (2,2,2,2; 2,3,3,2; 2,3,3,3; 3,3,3,3) in females; anterior tarsal articulations absent in 1st–12th legs; all legs with 2 accessory apical claws; tibia of 1st–11th legs with sharp distal projection on anterior edge; 15th legs long, slender, 1st tarsal joint of 15th legs about 7–10 × longer than wide; female gonopods with 2+2 conical spurs, claw narrow, without lateral denticles.

*Occurrence in Hawai'i.* Kure, Maui, Midway, and the island of Hawai'i.

*Published records.* Hawaiian Islands in general (Attems, 1914, 1928). Island of Hawai'i (Nishida, 1994), Kona (Silvestri, 1904; Attems, 1909; Chamberlin, 1920).

*Material examined.* **HAWAI'I:** 2♀, Above Pu'ula'au, under rock, 8900 ft, 24 Feb 1975, "H.J."; 4♂, Kaluakakauka (Douglas Monument), 6040 ft, 26 Mar 1962, G.E. Haas; 1♀ **(here designated as Lectotypus of** *Lamyctes fulvicornis hawaiiensis* Silvestri), 2♀ (here selected as Paralectotypi of *Lamyctes fulvicornis hawaiiensis* Silvestri) labelled "*Lamyctes fulvicornis* (Mein.) var. *subproximus* Silv., cotypi!, Kona, Hawaii, 4000 ft, Perkins, VIII.1892", "Kona, Hawaii, 4000 ft., Perkins, VIII.1892" "04–10.28.3–5", "1904.X.28.3–5", together with the anonymous comment "This is apparently the specimen described in *Fauna Hawaiiensis* as var. *hawaiiensis*" (BMNH); 1♀, 1 juv. "*Lamyctes fulvicornis* (Mein) var. *subproximus* Silv., Kona, Hawaii, 4000 ft., Perkins, VIII.1892" (handwritten in china ink by F. Silvestri). **KURE:** 1♀, 19 Mar 1979, R. Grady (MZ). **MAUI:** 1♀, Haleakalā, 8000 ft, 4 Mar 1965, leaf litter, J.W. Beardsley; 1♂, Haleakalā, Kahalaku overlook, 2740 m, 28 Nov 1992, *Andropogon* litter and dirt, S.F. Swift; 1♂, nr. Pu'uhuau, Haleakalā, 5500 ft, 27 Apr 1945, E.C. Zimmermann (MZ); 1♂, Waipoli road jct, paved 6 sections, 10 Aug 1993, R.W. Baumann (BYU). **MIDWAY:** 13♀, Sand I, under leaves, 29 Jan 1955, C.F. Clagg.

*Remarks.* Attems (1928) thought *Lamyctes fulvicornis hawaiiensis* should be reexamined; later he (Attems, 1938) thought it was probably identical with *L. castanea* Attems from South Africa, or *L. neozelandica* Archey from New Zealand. Finally, Attems (1940) synonymized *L. f. hawaiiensis* under *L. africana*. The characters showed by the type specimens of *L. f. hawaiiensis*, here reexamined, falls however in the variation of *Lamyctes emarginatus* as redescribed by Archey (1937), especially for the distal sharp projection on anterior edge of the tibia which is present only on 1st–11th legs and not, as the original

description of *L. f. hawaiiensis* stated, also on 12th legs. Therefore, the synonymy proposed by Attems (1940) is here rejected and the new synonymy of *L. emarginatus* is proposed. *Lamyctes emarginatus* has been recorded from New Zealand, Kermadec I, and Chatham I (Archey, 1937); it is also known from Tasmania were it has been introduced (Mesibov, 1986). Two females from Midway have 3+2 spurs on gonopods.

***Lamyctes coeculus*** (Brolemann)

*Lamyctinus coeculus*: Silvestri, 1909: 39. Chamberlin, 1920: 72. Attems, 1928: 62; 1938: 366. Nishida, 1994: 26.

*Diagnosis.* Up to 5.0 mm long; antennae usually with 24 articles; ocelli absent; prosternal teeth 3+3–4+4, lateral prosternal spine absent; all tergites without posterior projections; anterior tarsal articulations absent in 1st –12th legs; all legs with 2 accessory apical claws; tibia of 1st–11th legs with a distal sharp projection on its anterior edge; 15th legs long and slender; female gonopods with 2+2 conical spurs, claw narrow, without lateral denticles.

*Occurrence in Hawai'i.* O'ahu and Hawai'i.

*Published records.* Islands in general (Attems, 1938). O'ahu in general (Chamberlin, 1920; Nishida, 1994); Mt Tantalus, Honolulu (Silvestri, 1909; Attems, 1928).

*Material examined.* **HAWAI'I:** 2 juv, Mauna Ke'a, upper Waiłuku Riv, under silversword, date and collector unknown. **O'AHU:** 1 ♀, Stream along Nu'uanu-Pali Drive, Norfolk Pine Grove, 17 Feb 1985, V. & B. Roth; 1 ♀, Lualualei, Halona Val., soil under shade, 465 m, 8 May 1996, S.F. Swift.

*Remarks.* Recorded from Afrotropical and Neotropical areas, this species is also present in Europe, were it is exclusively synanthropic (Eason, 1982). *Lamyctes coeculus* was originally described in *Lamyctinus*, which was synonymized under *Lamyctes* by Brolemann (1932). Several specimens were also taken at an unspecified Hawaiian location in soil with plants from Tahiti (Chamberlin, 1930).

***Pleotarsobius heterotarsus*** (Silvestri)

*Lamyctes heterotarsus* Silvestri, 1904: 42, figs. 3–4.

*Pleotarsobius heterotarsus*: Attems, 1909: 12; 1914: 48, 56, 94; 1928: 63; 1938: 366. Chamberlin, 1920: 73. Nishida, 1994: 26.

*Diagnosis* (from Silvestri, 1904). Approximately 7.0 mm long; number of ocelli unknown; antennae with 19 articles; prosternal teeth 2+2, lateral prosternal spine absent; all tergites without posterior projections; anterior tarsal articulations absent in 1st –12th legs; coxal pores 1–2; all legs with 2 accessory apical claws; tibia of 1st–11th legs with a distal sharp projection on its anterior edge; 15th metatarsus plurisegmented (about 15 segments).

*Occurrence in Hawai'i.* Hawai'i.

*Published records.* Island of Hawai'i in general (Attems, 1928, 1938; Nishida, 1994), Kona (Silvestri, 1904; Attems, 1909, 1914; Chamberlin, 1920).

*Material examined.* None.

*Remarks. Pleotarsobius heterotarsus* is known only from the type specimen and has not been collected since 1892. It may be an endemic Hawaiian species, as it is not known to occur elsewhere.

## Family Lithobiidae
## Subfamily Ethopolinae

***Bothropolys maluhianus*** Attems

*Lithobius asperatus*: Attems, 1903: 92. Silvestri, 1904: 323.

*Bothropolys asperatus*: Attems, 1914: 48. Nishida, 1994: 26.

*Bothropolys maluhianus* Attems, 1914: 48, 57, 99; 1938: 366. Nishida, 1994: 26.

*Bothropolys oahuanus* Chamberlin, 1920: 78.

*Diagnosis* (from Attems, 1903, 1914). About 20.0 mm long; antennae with 20 articles; about 20 ocelli on each side; prosternal teeth 7+7, prosternal spine lateral to lateral tooth; tergites 7, 9, 11 and 13 with posterior projections; 10–20 coxal pores irregularly arranged in about 3 rows; without VaC spine on 14th and 15th legs, latter without accessory apical claw; female unknown.

*Occurrence in Hawai'i.* O'ahu.

*Published records.* Islands of Hawai'i in general (Attems, 1914, 1938; Chamberlin, 1920). O'ahu in general (Silvestri, 1904; Nishida, 1994), Maluhia (Attems, 1903, 1914).

*Material examined.* None.

*Remarks.* This species is based on a single male that Attems (1903) first recorded as *L. asperatus* L. Koch. Attems (1914), recognizing that his specimen belonged to a different species, proposed *maluhianus* for it, and Chamberlin (1920), unaware of Attems' (1914) action, proposed *oahuanus* for the same specimen (see also Eason, 1972). Eason (1977) synonymized *oahuanus* under *maluhianus*. While possibly being an endemic Hawaiian species, he thought it might prove to be *B. rugosus* (Meinert), which has been recorded in the Hawaiian Islands and is native to China, Korea, Japan, and Philippines. Eason (1992) again suggested that *Bothropolys* may have been introduced to the Hawaiian Islands. No other records exist aside from the single male described by Attems (1903).

***Bothropolys rugosus*** (Meinert)

*Lithobius rugosus* Meinert, 1872: 306. Silvestri, 1904: 323. Eason, 1974: 20, figs. 6–7.
*Lithobius xanti*: Stuxberg, 1875: 10. Silvestri, 1904: 323. Attems, 1938: 366.
*Bothropolys rugosus*: Attems, 1914: 48, 57, 99.
*Ethopolys rugosus*: Chamberlin, 1920: 78. Attems, 1938: 366.

*Diagnosis.* Up to 21.0 mm long; antennae with 20 articles; 18–23 ocelli on each side; prosternal teeth 7+7, lateral prosternal spines small and posteriolateral to lateral tooth; posterior projections feeble on T.6, broad but not prominent on T.7, and prominent and narrow on TT.9, 11, and 13; 13–23 coxal pores irregularly arranged in about 3 rows; VaC spine present on 15th legs; anterior tarsal articulations present in all legs; 15th legs without accessory apical claws; prefemur of 15th legs of male with a very feeble narrow dorsal sulcus, femur with a more distinct dorsal sulcus in his distal half, female gonopods with 2+2 conical spurs, claw narrow, without lateral denticles.

*Occurrence in Hawai'i.* O'ahu, Maui, Hawai'i.

*Published records.* Hawaiian Islands in general (Stuxberg, 1875; Silvestri, 1904; Attems, 1938). O'ahu in general (Meinert, 1872; Silvestri, 1904; Attems, 1914; Chamberlin, 1920; Eason, 1974).

*Material examined.* **HAWAI'I**: 1♀, Mauna Loa, primarily Stainback Hwy, *Metrosideros* to lower elevation, 6–8 Sep 1974, J. Jacobi. **MAUI**: 1♀, 'Iao Valley, Dec 1927, collector unknown; 1♀, Waihe'e, 16 Mar 1967, N.L.H. Krauss. **O'AHU**: 1♂, 1♀, Mt Tantalus, rotten log, 8 Nov 1923, S.C. Ball (MZ); 1♀, juv., Mt Tantalus, dead *koa*, 13 May 1928, E.H. Bryan, Jr.; 2♂, Mt Tantalus, 8 Jul 1928, N.L.H. Krauss; 1♂, Honolulu, slopes of Mt Tantalus, 10 Dec 1939, R.P. Currie (USNM); 1♀, Honolulu, Waikīkī, in yard, Jul 1964, M. Roth; 2♀, Pearl City, 28 Mar 1968, B. Chambers; 1♂, Nu'uanu, 18 Mar 1984, S.F. Swift. 4♀, Wai'anae Mts, 700 ft, 13 Apr 1933, E.H. Bryan; 2♂, Kamananui Val, 1 Oct 1933, N.L.H. Krauss.

*Remarks.* This species, also known from China, Korea, Japan, and the Philippines, properly belongs in *Bothropolys*, as *Ethopolys* is confined to an area west of the Rocky Mountains in the continental United States (Eason, 1992). Eason (1974, 1977) suggested that *B. rugosus* had been introduced in the Hawaiian Islands from either Japan or the mainland of eastern Asia.

**Subfamily Lithobiinae**

***Lithobius (Lithobius) hawaiiensis*** Silvestri

*Lithobius hawaiiensis* Silvestri, 1904: 324. Eason, 1977: 485, figs. 1–6. Nishida, 1994: 26.
*Archilithobius hawaiiensis*: Attems, 1914: 48, 57.
*Kauabius hawaiiensis*: Chamberlin, 1920: 78.
*Lithobius hawaiensis*: Attems, 1938: 366.

*Diagnosis.* Up to 20.0 mm long; lateral marginal interruptions of head distinct; antennae with 27–29 articles; ocelli 17–19 on each side; prosternal teeth 2+2, lateral prosternal spine setiform; 1st tergite narrower than head; all tergites without posterior projections; anterior tarsal articulations distincts, 15th accessory apical claw well developed; VaC spine present on 14th and 15th legs; 15th legs of males longer and more slender than those of female, with a feeble dorsal distal setose protuberance on the femur; female gonopods with 2+3 or 3+3 spurs and tridentate claws.

*Occurrence in Hawai'i.* Kaua'i, Maui, O'ahu, and Hawai'i.

*Published records.* Islands of Hawai'i in general (Attems, 1914, 1938). Kaua'i in general (Nishida, 1994), Makaweli and Kahōluamano (Silvestri, 1904; Chamberlin, 1920; Eason, 1977).

*Material examined.* **HAWAI'I:** 1♀, "Kona, Hawaii, 3000 ft, Perkins, 9.1892" (printed), "*Lithobius hawaiiensis* Silv., Juvenos, Kona, Hawaii, 3000 ft, Perkins, IX.1892" (handwritten, china ink, ?Silvestri's hand). **KAUA'I:** 1♂, Jul–Aug 1917, C.N. Forbes; 1♂, Halemanu, 8 Nov 1919, Cooke (MZ). **MAUI:** 1♀, "coll. Perkins, ? Maui" (printed), "? *Lithobius hawaiiensis* Silv., Defectous example !, Maui, Perkins" (Silvestri's hand); 1♂,1♀, Haleakealā Natl. Park, ridge E of Kīpahulu Valley, moss, 6100 ft, 24 Jun 1981, W.C. Gagné. **O'AHU:** 3♂, 1♀, Ko'olau Mts, Poamoho Trail, 2 Jun 1977, litter nr. summit, F.G. Howarth (MZ); 1 , Kawailoa Forest Res., 75 m, 25 Aug 1973, mossy leaf litter, W.C. Gagné; 1♂, Konahuanui, 3000 ft, 9 May 1943, E.C. Zimmerman; 2♂, Mt Ka'ala, 3500–4000 ft, beating vegetation, 11 Apr 1948, C.H.S. Dybas; 1♀ imm, Mt Ka'ala, 4000 ft, moss on tree, 19 Apr 1966, C.M. Yoshimoto; 1♂,2♀ imm, Mt Ka'ala, on moss, 21 Jun 1967, C.M. Yoshimoto; 1♀ imm, Mt Ka'ala, moss on tree, 1700 m, summit, 18 Jan 1983, F.G. Howarth.

*Remarks. Lithobius hawaiiensis* was proposed by Silvestri (1904) for 2 specimens collected on Kaua'i by R.C.L. Perkins and is known only from the Hawaiian Islands. The species was redescribed by Eason (1977) based on the types, the only specimens previously known. In the present material are 2 females, 1 from Maui and 1 from the island of Hawai'i, that belong to the Perkins's original series. They were identified as *L. hawaiiensis* by Silvestri, tentatively so for the female from Maui but were not included in his 1904 paper. Both specimens are in poor condition but correspond well with Eason's (1977) redescription; that from Maui bears 3+3 gonopodal spurs.

Regarding the other specimens we examined, those from O'ahu are 11.0–12.0 mm long; they have 22–26, frequently 23, articles on the antennae; and the ocelli are 1+4,4,4, 1+4,4,5, 1+4,5,4,3 or 1+4,5,5. The male from Kawailoa Forest Reserve has 3+2 prosternal teeth because of a small internal supranumeral tooth on 1 side; the coxal pores 3,4,4,3; 3,5,4,4; 4,6,6,4; or 5,5,4,4; the VaC spine is present on the 14th and 15th legs or only on the latter; the female gonopods have 3+3 spurs; and the male gonopods are large, with only 1 article bearing 2 long apical setae. The specimen from Konahuanui has no VaC spine; females from Mt Ka'ala has 2+2 or 2+3 spurs on gonopods.

Eason (1977) concluded that this species is probably neither endemic nor indigenous to the Hawaiian Islands. He suggested that it is an immigrant from an unknown area in eastern Asia, where the chilopod fauna is still poorly known.

***Lithobius (Lithobius) forficatus*** (Linnaeus)

*Lithobius forficatus*: Attems, 1938: 366.

*Diagnosis.* Up to 30.0 mm long; lateral marginal interruptions of head distinct; antennae with

35–43 articles; ocelli 20–30 on each side; prosternal teeth 5+5, 6+6, 6+7, lateral prosternal spine setiform; T.1 narrower than head; TT.9, 11, 13 with prominent posterior projections; anterior tarsal articulations distinct; 15th accessory apical claw absent; VaC spine absent; 15th legs long, slender in both sexes; female gonopods with 2+2 conical spurs, claws tridentate.

*Occurrence in Hawai'i.* Hawaiian islands in general, no specific island has been recorded.

*Published records.* Hawaiian islands in general (Attems, 1938).

*Material examined.* None.

*Remarks.* This west Palaearctic chilopod has also been introduced to Newfoundland, North and South America, and St. Helena (Eason, 1964). Also recorded from Singapore and New Zeland (Attems, 1914). The only Hawaiian record is the general citation by Attems (1938), and *L. forficatus* does not appear to be established in the archipelago.

***Lithobius (Lithobius) obscurus*** Meinert **New state record**

*Diagnosis.* Up to 19.0 mm long; lateral marginal interruptions of head distinct; antennae with 26–28 articles; ocelli 14–18 on each side; prosternal teeth 2+2, lateral prosternal spine setiform, irregular shoulders present lateral to spine; TT.9, 11, 13 with triangular posterior projections; anterior tarsal articulations distinct; 15th accessory apical claw present but very small; VaC spine absent; 15th legs with 1 or 2 supplementary posterior prefemoral spines; male with 15th femur bearing prominent wart-like outgrowth arising from shallow circumscribed depression; female gonopods with 2+2 conical spurs, claws tridentate.

*Occurrence in Hawai'i.* The island of Hawai'i.

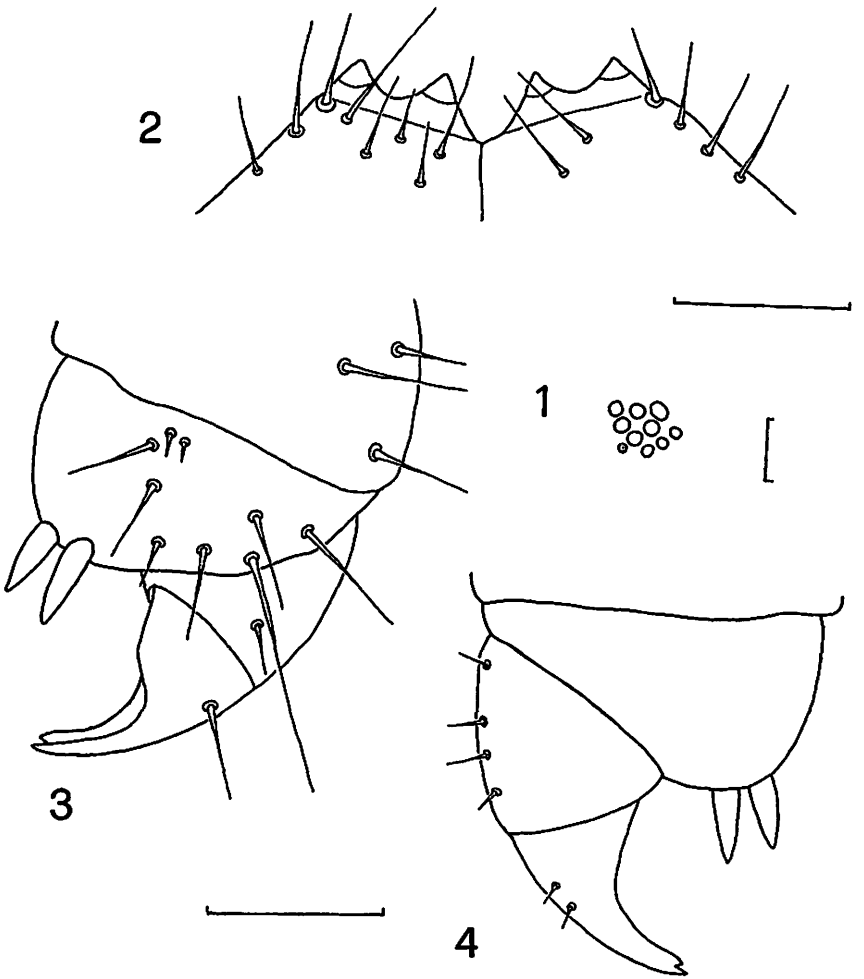
*Published records.* None.

*New records.* **HAWAI'I:** 1 ♂, Hāmākua Forest Reserve, 0.25 mi E of Waikoekoe, 28 Aug 1963, *'ōhi'a*-fern debris, 2200 ft, G.E. Haas.

*Remarks.* This species is naturally widespread in Canary Islands, Azores, Morocco, and southern Spain; it has been introduced to Bermuda, South America, New Zealand, Australia, and South Africa (Eason, 1973, 1974, 1991; Eason & Ashmole, 1992). Attems (1914) erroneously recorded it from Philippines. The single immature male reported here is the first record for the Hawaiian Islands.

***Lithobius (Lithobius)*** sp. **New state record**

*Description.* (Figs. 1–4). Size 13.0 mm long and 1.6 mm broad at T.10. Color pale brown with narrow longitudinal, feebly pigmented area in middle of tergites. Head smooth, almost as long as broad, broader than T.1, posterior border feebly sinuate, with median thickening, projection of lateral marginal interruptions distinct. Antennae 5.1–5.2 mm long, with 25–29 articles, all slightly elongated, last article 2.5 × longer than broad. Ocelli (Fig. 1) 1+3,3,2 (left side), 1+2,3,2 (right side) not well pigmented, arranged in irregular rows, principal ocellus large, suboval, posterosuperior ocellus smaller than principal ocellus but larger than secondary ones. Organ of Tömösváry (Fig. 1) smaller than secondary ocellus, close to ocelli. Prosternum (Fig. 2) with 2+2 teeth, porodont setiform, free borders slope obliquely without shoulders lateral to porodont. Tergites smooth, T.1 narrower than T.3, trapeziform, posterior border straight; lateral borders of TT.3, 5, 8, 10 slightly convergent posteriorly, those of TT.12, 14 convergent posteriorly, those of T.7 parallel; posterior borders of TT.3, 7 straight, those of TT.5, 8, 10, 12 slightly sinuate or sinuate, those of T.14 concave; posterior angles of TT.3, 5, 8, 10 rounded, those of T.7 blunt, those of TT.12, 14 angulate; posterior borders of TT.2, 4, 6, 9, 11, 13 straight; lateral borders of TT.2, 4 rounded, those of TT.6, 9, 11, 13 parallel; posterior angles of TT.2, 4, 6 blunt, no triangular projections at posterior angles of TT.9, 11, 13 whose posterior angles are blunt in TT.9 13 and angulate in T.13. Coxal pores 3,5,5,5, circular, small, separated from each other by own diameter or less; diameter of 1–2 proximal pores smaller than that of distal ones. Tarsal articulations of 1st–13th legs not fused; 14th legs 3.5 mm long, not swollen; 15th legs




**Figs. 1-4.** *Lithobius (Lithobius)* sp. 1, left ocelli and organ of Tömösváry. 2, dental margin of prosternum, ventral view. 3, left female gonopod, ventral view. 4, left female gonopod, dorsal view. Scale bar = 0.2 mm.

5.0 mm long, not swollen, apical claw long, accessory apical claw present, 1/2 as long as apical claw; glandular pores on internal side of 13th–15th legs. Spinulation in Table 1. Gonopods (Figs. 3–4) with 2+2 cylindro-conical unspaced spur, claw long, with distinct lateral denticle on internal side; dorsolateral setae smaller than general setae, 4 in a line on 2nd article, 2 smaller ones on 3rd.

*Occurrence in Hawai'i.* O'ahu.

*Published records.* None.

**Table 1.** Spinulation of *Lithobius* sp.

| | Ventral | | | | | Dorsal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | t | P | F | T | C | t | P | F | T |
| 1 | - | - | p | am | m | - | - | mp | p | a |
| 2 | - | - | p | amp | m | - | - | mp | ap | a |
| 3-6 | - | - | p | amp | m | - | - | mp | ap | ap |
| 7-11 | - | - | mp | amp | am | - | - | amp | ap | ap |
| 12 | - | - | mp | amp | am | - | - | amp | p | p |
| 13 | - | m | amp | amp | am | a | - | amp | p | p |
| 14 | a | m | amp | amp | am | a | - | amp | p | p |
| 15 | a | m | amp | amp | m | a | - | amp | p | - |

*Material examined.* **O'AHU:** 1♀, Ko'olau Mts, Wiliwilinui Range, 2500 ft, 13 Jan 1970, sweeping *Ilex anomala* at night, W.C. Gagné.

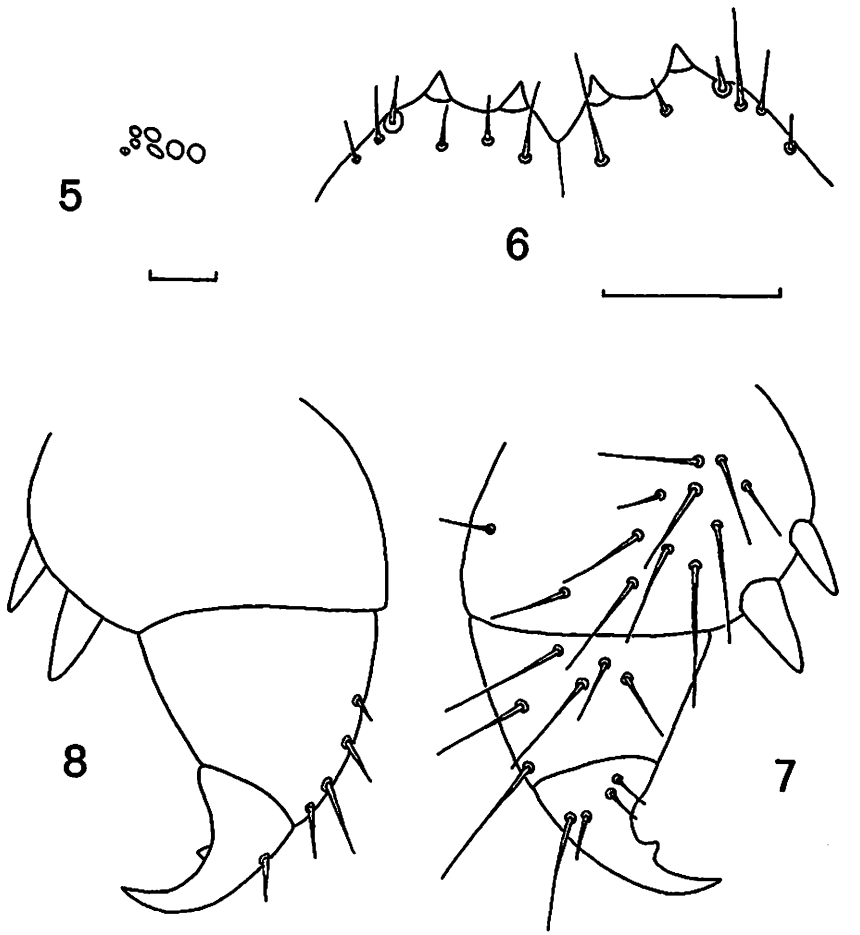
*Remarks.* This specimen is quite different from any of the species listed in this paper and does not seem to belong to any of those included in Attems's (1914) or Chamberlin's (1920) catalogues of the Indo-Australian fauna. It is not referrable to any of the species recorded by Chamberlin (1930, 1931, 1938, 1940, 1941, 1944) as occasionally intercepted in quarantine in the Hawaiian islands. As no more specimens of either sex are available, we cannot establish its identity.

***Lithobius (Sigibius)*** sp. cfr. ***bullatus*** Eason **New state record**

*Description* (Figs. 5–8). Size 8.5 mm long, 1.5 mm broad at T.10. Color light brown. Head smooth, 1.1 mm broad, as broad as long, as broad as T.1 and T.5, posterior border straight, posterior marginal ridge with median thickening, projection of lateral marginal interruption distinct. Antennae 2.0–2.5 mm long, left antenna damaged at 20th article, right antenna with 27 articles; 1st 3 articles of each antenna large, longer than broad, intermediate articles smaller, as long as broad, last 3 articles of left antenna elongate, distal articles of right antenna as long as broad; terminal article of right antenna 2 × as long as broad. Ocelli (Fig. 5) 1+6 on each side, pigmented, arranged irregularly, close to each other; principal ocellus followed posteriorly by another ocellus equal in size; other 5 ocelli smaller, forming main mass. Organ of Tömösváry (Fig. 5) small, smaller than 1 small ocellus, close to main ocellar mass. Prosternum (Fig. 6) broad, with 2+2 teeth, porodont setform, stout; borders sloping obliquely lateral to porodont, without shoulders but with trace of convexity. T.1 smooth, narrower than T.3, trapeziform with posterior border straight; other large tergites smooth, posterior borders of TT.3, 7 straight, those of TT.5, 8, 10 slightly sinuate, those of TT.12, 14 emarginate, posterior angles of TT.3, 5, 8 rounded, those of TT.10, 12, 14 are slightly rounded, those of T.7 angulate, lateral borders of TT.3, 5, 7 parallel, those of TT.8, 10, 12, 14 progressively convergent posteriorly; TT.9, 11, 13 with posterior angles rounded, without posterior triangular projections. Intermediate tergites with lateral borders parallel, posterior angles blunt, posterior borders straight. Coxal pores 5,5,5,4, circular, separated from each other by own diameter. Legs 1st–12th with tarsal articulation fused; 13th legs missing; 14th legs 2.5 mm long, slightly swollen; 15th legs 3.0 mm long, slightly swollen, accessory apical claw present. Glandular pores on internal side of 14th and 15th legs. Spinulation in Table 2. Female gonopods (Figs. 7–8) with 2+2 conical spaced spurs, slightly elongate, claw broad, with proximal lateral denticle on external side; dorsolateral setae as stout as general setae on 2nd article, 4 in a line, slightly shorter distal 5th more medially placed, 3 smaller on 3rd.

*Occurrence in Hawai'i.* O'ahu.

*Published records.* None.




Figures 5–8. *Lithobius (Sigibius)* sp. cf. *bullatus* Eason, 1993. 5, left ocelli and organ of Tömösváry. 6, dental margin of prosternum, ventral view. 7, right female gonopod, ventral view. 8, right female gonopod, dorsal view. Scale = 0.2 mm.

*Material examined.* O'AHU: 1 ♀, Stream along Nu'uanu-Pali Dr, Norfolk Pine Grove, 17 Feb 1985, V. & B. Roth.

*Remarks. Lithobius bullatus* was proposed by Eason (1993) on the basis of a male and 2 females collected in Hong Kong. The species also occurs in southern China (Eason, 1992). As *Sigibius* Chamberlin is essentially a west Palaearctic subgenus, the species is considered to be introduced to east Asia (Eason, 1993). There is little doubt that *L. bullatus* has been introduced by commerce at the Hawaiian Islands.

The female from O'ahu agrees well with the original description, but the prosternum is more prominent and the teeth are sharper, and the spur of the gonopods seems to be

**Table 2.** Spinulation of *Lithobius* sp. cf. *bullatus* Eason, 1993; 13th legs damaged: spines in parentheses are hypothesized.

| | Ventral | | | | | Dorsal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | t | P | F | T | C | t | P | F | T |
| 1 | - | - | p | am | m | - | - | p | a | a |
| 2 | - | - | p | am | m | - | - | p | ap | a |
| 3 | - | - | p | am | m | - | - | p | ap | ap |
| 4-7 | - | - | p | am | am | - | - | ap | ap | ap |
| 8 | - | - | p | amp | am | - | - | ap | ap | ap |
| 9-10 | - | - | mp | amp | am | - | - | ap | ap | ap |
| 11 | - | - | mp | amp | am | - | - | amp | ap | ap |
| 12 | - | - | mp | amp | am | - | - | amp | p | ap |
| 13 | - | ? | ? | ? | ? | a | (-) | (amp) | (p) | ? |
| 14 | - | m | amp | am | - | a | - | amp | p | - |
| 15 | - | m | amp | am | - | a | - | amp | p | - |

more elongate (cf. Eason, 1993: figs. 16, 18). Other differences include: 1+6 ocelli instead of 1+5, coxal pores 4–5 instead of 5–6 (in females), single dorsolateral seta on 3rd article of the gonopod instead of 5 smaller than those of 2nd article. Since the main diagnostic features of *L. bullatus* are on the male 15th femur (with a dorsal depression) and tibia (with a dorsal sulcus and a distal node), the identity of this specimen cannot be determined with certainty until more material of both sexes is available.

***Lithobius (Monotarsobius) moananus*** (Chamberlin) **New combination; New island records**

*Onebius moananus* Chamberlin, 1926: 92. Attems, 1938: 366. Butler & Usinger, 1963:239. Nishida, 1994: 26.

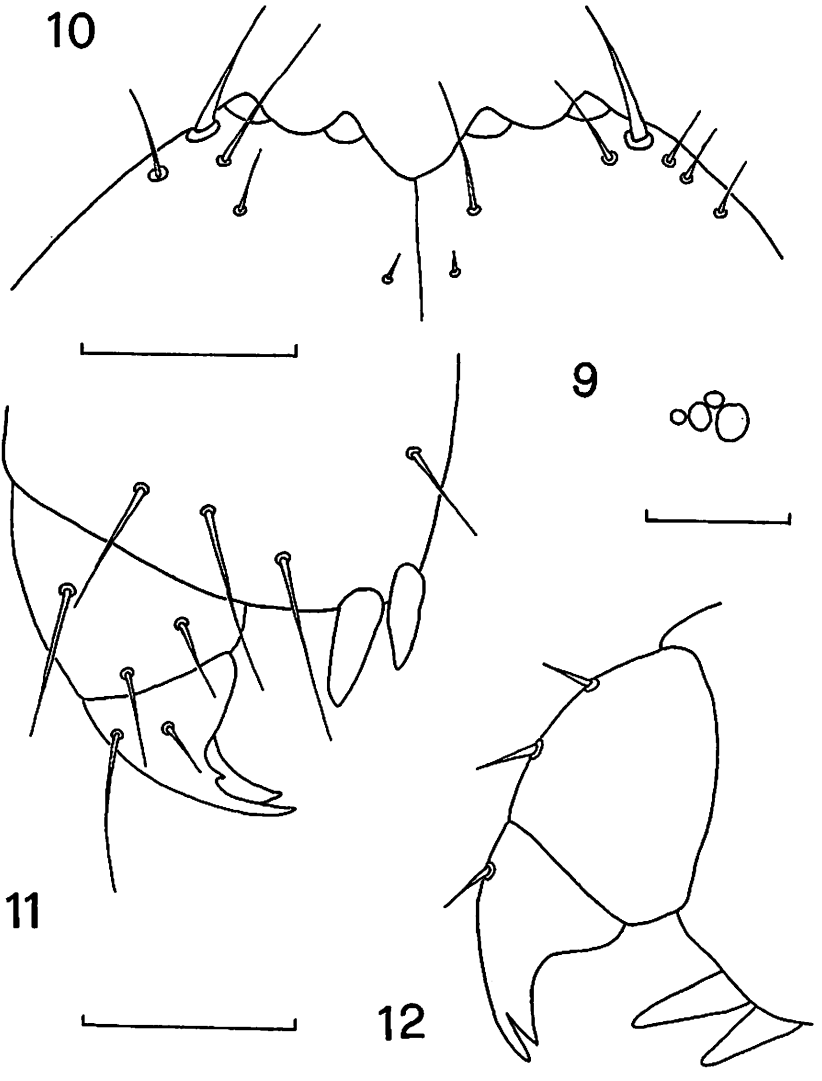
*Diagnosis* (Figs. 9–12): 5.5 mm long; lateral marginal interruptions of head distinct; antennae with 20 articles; ocelli 5–6; prosternal teeth 2+2, lateral prosternal spine setiform; all tergites without posterior projections; anterior tarsal articulations not distincts; 15th accessory apical claw absent; VaC spine absent; female gonopods with 2+2 spurs and tridentate claws.

*Occurrence in Hawai'i.* Kure, Maui, Midway, Moloka'i, and O'ahu.

*Published records.* Islands of Hawai'i in general (Attems, 1938). Kure (formerly Ocean) Island (Chamberlin, 1926; Butler & Usinger, 1963; Nishida, 1994).

*New records.* **KURE**: 3♀, "Ocean I, 9.23, 4.18.23", "D.T. Fullaw. coll." (printed), "*Onebius moananus* Chamb. 22" (china ink, handwritten by R.V. Chamberlin). **MAUI**: 1♂, West Mountains, 7 Jan 1932, N.L.H. Krauss. **MIDWAY**: 2♀, Eastern I, 15 May 1997, under rocks, G.M. Nishida (MZ). **MOLOKA'I**: 1♀, Pu'ulilolilo, 3000 ft, Mar 1965, T. Suman. **O'AHU**: 1♀, Ko'olau Mts, Poamoho Trail, litter nr. summit, 2 Jun 1977, F.G. Howarth.

*Remarks.* Chamberlin (1926) erected the genus *Onebius* to accommodate this species. Eason (1977) thought that *O. moananus* was identical with *Monotarsobius sasanus* Murakami from Japan but, since *M. sasanus* is characterized by the structure of the male 15th leg, he did not proposed a formal synonymy. The single male from Maui, here identified as *moananus*, cannot be used to clarify the identity of the species because the 15th legs are missing. Eason (1992) further suggested that *Onebius* is a synonym of *Monotarsobius* Verhoeff; however, he did not formally associate this names. Although Nishida (1994) cited *O. moananus* as an endemic Hawaiian species, we follow Eason (1977) in considering *O. moananus* as probably an immigrant from Japan, since Kure is




**Figs. 9-12.** *Lithobius (Monotarsobius) moananus* (Chamberlin, 1926). **9**, left ocelli. **10**, dental margin of prosternum, ventral view. **11**, right female gonopods, ventral view. **12**, right female gonopod, dorsal view. Scale bar = 0.2 mm for fig. 9; 0.4 mm for figs. 10-12.

**Table 3.** Spinulation of *Lithobius moananus* (Chamberlin, 1926), from Kure, female 6.0 mm long.

| | Ventral | | | | | Dorsal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | t | P | F | T | C | t | P | F | T |
| 1 | - | - | - | - | m | - | - | - | - | a |
| 2-3 | - | - | - | - | m | - | - | - | a | a |
| 4-8 | - | - | - | - | m | - | - | - | ap | a |
| 9-11 | - | - | - | am | m | - | - | - | ap | ap |
| 12 | - | - | p | am | m | - | - | - | ap | ap |
| 13 | - | - | mp | am | m | - | - | mp | p | a |
| 14 | - | m | mp | m | - | - | - | mp | - | - |
| 15 | - | m | mp | m | - | a | - | mp | - | - |

the most outlying Hawaiian islet and is only 4000 km east of Yokohama.

This species seems also close to *Nipponobius cepeus* Chamberlin especially in the general size, the number of ocelli, the number of coxal pores, the spinulation of 14th and 15th legs, and the general arrangement of the female gonopods, although 15th accessory apical claw is present in *N. cepeus*. It was proposed for a single female taken in quarantine (see Deletions) at Honolulu in plant material from Japan (Chamberlin, 1940).

In the material from Bishop Museum examined here are 3 female from Kure identified as *Onebius moananus* by R.V. Chamberlin. As Chamberlin's original description is brief and without illustrations, and since these specimens seems to belong to the original series, although not designed as type, we redescribe them below.

*Desription*: Size 4.0–6.0 mm long and 0.7 mm broad at T.10. Color light brown. Head smooth, as long as broad (0.6 mm), larger than T.1, posterior border straight, with median thickening, projection of lateral marginal interruptions present even if not well evident. Antennae 1.0–1.2 mm long, with 18–19 articles, last article elongate. Ocelli (Fig. 9) 1+2,2, 1+2,1 or 1+3, pigmented, in 1 or 2 rows, principal ocellus of same size or slightly larger than other, posterosuperior ocellus of same size as secondary ocelli. Organ of Tömösváry not visible. Prosternum (Fig. 10) with 2+2 small teeth, porodont setiform, lateral borders sloping obliquely, without shoulders. T.1 smooth, slightly narrower than T.3, trapeziform, posterior border straight; other large tergites smooth, with posterior borders slightly sinuate in TT.3, 5, 8, 10, straight in T.7, 12, 14, lateral borders parallel in TT.3, 7, 5, progressively posteriorly convergent in TT.8, 10, 12, 14; posterior angles rounded in TT.3, 5, 8, 10, blunt in T.7, angulate in TT.12, 14; lateral borders parallel in TT.2,4, 6, posterior angles angulate in TT.2, 4, rounded in T.6, posterior borders straight in TT.2, 4, 6; TT.9, 11, 13 with parallel lateral borders, posterior angles rounded, without posterior projections, posterior borders straight. Coxal pores 1,2,2,2, circular, those of 13th–15th legs separated by more than their diameter. Tarsal articulations fused in 1st–13th legs;14th legs 1.2 mm long, slightly swollen; 15th legs 2.0 mm long, slightly swollen (presence/absence of accessory apical claw not remarkable because all specimens have 15th legs missing or damaged); glandular pores on internal side of 13th–15th legs. Spinulation in Table 3. Gonopod (Figs. 11–12) with 2+2 conical spur, internal one smaller, claw wide, tridentate, with lateral denticles equal in size; dorsolateral setae almost as stout as general setae, 2 in line on 2nd article, single seta on 3rd.

**Deletions**

A number of Hawaiian lithobiomorph records represent samples taken in quarantines of plants from distant parts of the world, and 7 new species were inadvisedly proposed for intercepted specimens. These records show the ease with which exotic arthropods are unknowingly and accidentally brought into the Hawaiian islands, where they escape and

establish reproducing populations. There is no evidence that any of these species have become established (Eason, 1977), so we officially delete them from the Hawaiian fauna. In addition to these species, unidentifiable forms of *Lithobius* and *Lamyctes* have been discovered in soil with plants from China and Japan, respectively (Chamberlin, 1930).

**Family Henicopidae**
**Subfamily Henicopinae**
1. *Lamyctes fulvicornis* Meinert. *Lamyctes fulvicornis*, probably an Australian species, has been introduced throughout temperate parts of North America, plus Greenland, New Foundland, the Canary and Azores Islands, Iceland, Faroe Islands, Europe, north and east Africa, and the Near East; its wide dispersal is attributed to its ability to reproduce parthenogenetically (Eason, 1992). Chamberlin (1930) recorded *L. fulvicornis* from an unspecified Hawaiian location in soil with plants from Los Angeles, California. It has not been encountered in a Hawaiian environment, and we therefore delete it from the islands' fauna.
**Family Lithobiidae**
**Subfamily Ethopolyinae**
1. *Bothropolys migrans* Chamberlin. Chamberlin (1930: 69) proposed this species for 4 specimens taken at an unspecified site on *Dioscorea* sp. from China.

**Subfamily Lithobiinae**
2. *Nipponobius sinensis* Chamberlin. Chamberlin (1930: 68) proposed this species for 2 adult males taken at an unspecified site on *Lillium* sp. from China.
3. *Nipponobius cepeus* Chamberlin. Chamberlin (1940: 50) proposed this species for a specimen taken at Honolulu in packing with *Vandateres grandiflora* from Japan.
4. *Nipponobius australis* Chamberlin. Chamberlin (1944: 64) proposed this species for a female taken at Honolulu in packing with *Epidendrum* sp. from Australia.
5. *Lithobius borealis* Meinert. This species was encountred at an unspecified site in packing with orchids from England (Chamberlin, 1930: 68).
6. *Oabius pylorus* Chamberlin. This species was encountred at an unspecified site in soil with chives from San Francisco (Chamberlin, 1930: 68).
7. *Tidabius vector* Chamberlin. Chamberlin (1931: 190) proposed this species for a male taken at Honolulu in packing with orchids from Mexico.
8. *Tidabius emporus* Chamberlin. Chamberlin (1941: 3) proposed this species for a female taken at Honolulu in packing with *Rhynchostylis retusa* from Japan.
8. *Australobius* (*Malayobius*) *vians* Chamberlin. Chamberlin (1938: 628) proposed this species, erecting the subgenus *Malayobius* to accommodate it, for a female possibly a molt short of maturity, which was taken at an unspecified site from the "Malay States". A male of a second species of this "group" was taken at Honolulu a year later, but he chose not to describe it.

**Acknowledgments**
We thank Sabina Swift (BPBM), Janet Margerison (BMNH), Jonathan Coddington (USNM), and Richard W. Baumann (BYU) for loaning samples in their charge. The second author also thanks Dr. Swift for arranging travel to Hawai'i, to examine the Bishop Museum's chilopod holdings and for numerous courtesies and kindnesses extended during this time.

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