

- P-0244 HAWAI'I: East slope of Mauna Loa, Kīpuka Ki Weather Station, 1220 m, pitfall trap, 10–12.iv.1972, J. Jacobi
- P-0257 HAWAI'I: East slope of Mauna Loa, 1280–1341 m, pitfall trap, 8–10.v.1972, J. Jacobi
- P-0268 HAWAI'I: East slope of Mauna Loa, 1890 m, pitfall trap, 5–7.vi.1972, J. Jacobi
- P-0269 HAWAI'I: East slope of Mauna Loa, 1585 m, pitfall trap, 5–7.vi.1972, J. Jacobi
- P-0271 HAWAI'I: East slope of Mauna Loa, 1280–1341 m, pitfall trap, 5–7.vi.1972, J. Jacobi
- P-0281 HAWAI'I: East slope of Mauna Loa, 1981 m, pitfall trap, 10–12.vii.1972, J. Jacobi
- P-0284 HAWAI'I: East slope of Mauna Loa, 1585 m, pitfall trap, 10–12.vii.1972, J. Jacobi
- P-0286 HAWAI'I: East slope of Mauna Loa, Kīpuka Ki Weather Station, 1220 m, pitfall trap, 10–12.vii.1971, J. Jacobi
- P-0291 HAWAI'I: East slope of Mauna Loa, Kīlauea Forest Reserve, 1646 m, pitfall trap, 10–12.vii.1972 J. Jacobi
- P-0294 HAWAI'I: East slope of Mauna Loa, 1981 m, pitfall trap, 14–16.viii.1972, J. Jacobi
- P-0300 HAWAI'I: East slope of Mauna Loa, Kīlauea Forest Reserve, 1646 m, pitfall trap, J. Jacobi
- P-0307 HAWAI'I: East slope of Mauna Loa, 1981 m, pitfall trap, 17–19.ix.1972, J. Jacobi
- P-0313 HAWAI'I: East slope of Mauna Loa, Kīlauea Forest Reserve, 1646 m, pitfall trap, 17–19.x.1972, J. Jacobi
- P-0322 HAWAI'I: East slope of Mauna Loa, Mauna Loa Strip Road Weather Station, 1585 m, pitfall trap, 15–17.i.1973, J. Jacobi
- P-0323 HAWAI'I: East slope of Mauna Loa, 1280–1341m, pitfall trap, J. Jacobi
- P-0332 HAWAI'I: East slope of Mauna Loa, Power Line Area, 1490 m, pitfall trap, 15–17.i.1973, J. Jacobi

The Milliped Family Paradoxosomatidae in the Hawaiian Islands (Diplopoda: Polydesmida)

ROWLAND M. SHELLEY, SELENA B. BAUER (North Carolina State Museum of Natural Sciences, P.O. Box 29555, Raleigh, North Carolina 27626-0555, USA) & SABINA F. SWIFT (Hawai'i Biological Survey, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai'i 96817-0916, USA)

Introduction

Because of their status as the commercial center of the Pacific, the Hawaiian islands have been flooded with exogenous species. Some have been deliberately imported, but most enter the state accidentally with plants and cargo from other parts of the world, particularly the Pacific Rim. These organisms thrive in warm, moist environments and quickly become established on the islands. The arthropod class Diplopoda exemplifies this phenomenon, and excepting the endemic forms of *Nannolene* Bollman (order Spirostreptida: family Cambalidae)¹, the Hawaiian fauna is comprised entirely of introduced species, primarily in the orders Spirobolida, Julida, and Polydesmida. The Hawaiian julidans are detailed by Shelley & Swift (1998); in the Spirobolida, *Trigoniulus corallinus* (Gervais) (Pachybolidae: Trigoniulinae) has been reported from the island of Hawai'i (Chamberlin,

1. The endemic Hawaiian cambaloids, traditionally assigned to *Nannolene*, probably are not congeneric with the type species, *Julus burkei* Bollman, in northern California. They were originally assigned to *Dimerogonus* Attems but probably are not congeneric with its type species either. *D. orophilus* Attems, in Australia. Verhoeff (1944) erected *Hawaicambala*, spelled as "*Hawaicambala*" by Hoffman (1980), for these cambaloids, but this genus was invalidly proposed because no type species was designated nor were any species specifically included. Verhoeff's proposal was accompanied by the general statement, "Ein Dutzend Arten beschrieb Silvestri von Hawaii, eine Art Attems von Japan," but genus-group names proposed after 1931 must include at least one component species to be valid. Consequently, *Hawaicambala* Verhoeff, 1944, has no standing in nomenclature (Jeekel, 1971, Hoffman, 1980). To rectify this situation, Mauriès (1983) designated *Dimerogonus aveburyi* Silvestri (1904) as the type species of *Hawaicambala* and thereby also became the author of the genus. Consequently, if a separate genus is required for the Hawaiian cambaloids, the taxon will be *Hawaicambala* Mauriès, 1983, not *Hawaicambala* Verhoeff, 1944; otherwise, *Hawaicambala* Mauriès is a synonym of *Nannolene*.

1922; Nishida, 1994) and is established on O'ahu and Kaua'i (Shelley, 1998), and 2 or 3 species in the family Spirobolellidae have been encountered on several islands. The principal Hawaiian representative of the Polydesmida is the family Paradoxosomatidae with 3 species—*Oxidus gracilis* (C.L. Koch), *Asiomorpha coarctata* (Saussure), and *Akamptogonus novarae* (Humbert and Saussure) — which have been introduced throughout the world and hold no systematic importance. We present identifying features of these three millipeds and records from Hawai'i, with the islands listed in alphabetical order and localities arranged in general north to south sequences. Localities corresponding to numbered pitfall and/or berlese samples of *O. gracilis* and *A. novarae* at the Bishop Museum, all from the island of Hawai'i, are provided in the appendix. Repository acronyms are as follows: BPBM - Bishop Museum, Honolulu, Hawai'i; BYU - Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah; CAS - California Academy of Sciences, San Francisco; NMNH - National Museum of Natural History, Smithsonian Institution, Washington, D. C.; PMNH - Peabody Museum of Natural History, Yale University, New Haven, Connecticut.

For the purposes of this contribution, the Paradoxosomatidae is distinguished by the relatively narrow, parallel-sided body; the smooth, glabrous dorsum; the smooth, entire paranotal margination; and the strong, transverse metatergal grooves. *Oxidus gracilis* is virtually pan-global, occurring on all the inhabited continents and many islands, and occupying urban areas throughout North America; it is extremely adaptable and may be the world's most common non-parasitic, metazoan animal. *Asiomorpha coarctata* is pan-tropical and, in North America, is established in Florida, south Georgia, and along the Gulf Coast; *Akamptogonus novarae*, however, is a newcomer to the continental United States and is known only from California: Mendocino, Sonoma, and Napa counties, San Francisco (Golden Gate Park), Santa Barbara, and Torrey Pines State Park near San Diego (Hoffman, 1979; unreported specimens examined by the first author). In addition to the distinctive configuration of the male gonopods, *Akamptogonus novarae* is reliably identified by the different body form and color pattern that persists in alcohol for several years, so females are readily recognized in the absence of males. The most reliable determinant between *O. gracilis* and *Asiomorpha coarctata* is the gonopodal configuration. Their somatic features are similar, but the caudolateral paranotal corners of all segments of the latter are prolonged and acuminate, whereas those of anterior and midbody segments of the former are not extended and blunt; female and juvenile samples are distinguished by this feature. Blower (1985, fig. 72a) provides a whole body drawing in lateral perspective of a male of *O. gracilis*.

Several other paradoxosomatid species have been introduced into distant parts of the world, particularly on islands. While none have been encountered in Hawaiian environments, all may eventually become established on one or more of the islands. Three such species have been intercepted in quarantine at Honolulu, in soil with plants from Ceylon, Java, China, and the Philippines (Chamberlin, 1923, 1941); they confirm that human commercial activities like the importation of plants and associated soil from foreign countries is the principal mechanism through which exotic milliped introductions occur. As there is no evidence that these species now occur in the Hawaiian islands, we delete them at the conclusion of the paper. Another commonly introduced paradoxosomatid, never encountered in Hawai'i, is *Chondromorpha xanthotricha* (Attems), which is native to India/Sri Lanka, is now widespread in the northern Neotropics, and is established on the Philippine

Islands (Luzon), New Caledonia, the Fiji Islands, Bali, and Samoa (Chamberlin 1920; Jeekel, 1963, 1972, 1982). Because the paranotal corners are angular and extended, *C. xanthotricha* has the general body form of *A. coarctata*, but the metatergites are densely pubescent with low tubercles, in contrast to the smooth, glossy dorsum of the latter, which has scattered segmental setae. Reasonably accurate illustrations showing the tergites and gonopods *in situ* of *C. xanthotricha* are found in Loomis (1948, figs. 4–6) under the synonym, *Xaymacia granulata* Loomis.

***Oxidus gracilis* (C. L. Koch, 1847)**

New island records

*Diagnosis.*² Dorsum relatively flat, deep chestnut brown to black in adults, juveniles pallid; paranota extending directly laterad, corners blunt and not extended on anterior and midbody segments, prolonged and acuminate caudad; gonopods relatively short and broad, extending anteriorly between caudal legs of preceding (6th) segment, divided at midlength into 4 clearly separated terminal branches. Reasonably accurate illustrations that show the general form of the gonopod so as to enable reliable determinations are available in Attems (1909, figs. 26–27; 1937, fig. 101), Schubart (1934, fig. 283; 1945, fig. 38), Causey (1943, fig. 1), Shelley (1978, fig. 45), and Golovatch & Enghoff (1993, figs. 115–16). Blower (1985, fig. 72) showed a medial view of a gonopod plus one of the structures *in situ*; Golovatch & Enghoff (1993, figs. 12–14) provide SEM photos of the gonopod in 3 perspectives.

Occurrence in Hawai'i. Known from all the major islands except Kaho'olawe and Ni'ihau.

Published records: "Hawaii," referring to the islands in general [Schubart (1934) and Silvestri (1935) [as *Orthomorpha gracilis*]; Attems, 1937, 1938a, 1940]. HAWAI'I: Hilo (Pocock, 1893³ [as *Strongylosoma gracile*], Silvestri, 1904; Chamberlin, 1920 [as *Orthomorpha gracilis*]). Kilauea (Attems, 1903 [as *Orthomorpha gracilis*], Silvestri, 1904). MAUI: Olinda (Karsch, 1880 [as *Polydesmus (Paradesmus) gracilis*]). MOLOKA'I: Kalae (Attems, 1903 [as *Orthomorpha gracilis*], Silvestri, 1904). O'AHU: Honolulu (Pocock, 1903 [as *Strongylosoma gracile*]; Silvestri, 1904; Chamberlin, 1920 [as *Orthomorpha gracilis*], 1922).

Material examined: HAWAI'I: Niuli'i Beach Pk. (BPBM). Kohala Mts. (BPBM). Pu'u Waa Waa Ranch, Waihou-Henahena Gate, 31 December 1937 (BPBM). Kaumana Cv., 290 m, on rock 100 m inside dark zone, 21 July 1971, F.G. Howarth (BPBM). Pu'u Wa'awa'a Lava Tube, 30 September 1971, F.G. Howarth (BPBM). Honoka'a, 610 m, Hamakua For. Res. Cv., upper section, 2000 ft., 24 April 1971, F.G. Howarth (BPBM). Kalopa St. Pk., 19 September 1972, O. S. & C. M. Flint (NMNH) and 730 m, 7 June 1983, V.F. Lee (CAS). Kazumura Cv., dark zone, 700 ft. in, 22 July 1971, F.G. Howarth (BPBM), and Station 8, 8 December 1972, F.G. Howarth, W.C. Gagné (BPBM). S. Kona (BPBM). 15 mi SW Hilo (BPBM). Kīpuka Puauulu, 16 January 1964, Clayton (FSCA) and Bird Park Cv. #1, dark zone, 3 July 1971, F.G. Howarth (BPBM). Hawai'i Volcanoes Nat. Pk., between Volcano House and Crater Hotel (BPBM); Fern-'Ohi'a For., 1160 m, 6 June 1983, V.F. Lee (CAS); and Thurston Lava Tube, dark zone, 23 July 1971, F.G. Howarth, W.C. Gagné (BPBM). Volcano, Hongo Store Cv., 28 September 1971, F.G. Howarth, J. Jacobi (BPBM). Ola'a Forest (BPBM). Also the following numbered samples at the BM (see appendix): BM-Berlese 00249, 00250, 00251, 00488, 00491, 00502, 00582, 00727, 00938, 01166, 01178. Pitfall P-0001, P-0002, P-0003, P-0004, P-0008, P-0009, P-0016, P-0020, P-0022, P-0023, P-0024, P-0025, P-0028, P-0031, P-0032, P-0036, P-0039, P-0040, P-0041, P-0042, P-0043, P-0050, P-0051, P-0052, P-0055, P-0056, P-0058, P-0066, P-0077, P-0078, P-0080, P-0081, P-0084, P-0089, P-0180, P-0181, P-0192, P-0194, P-0202, P-0219, P-0220, P-0242, P-0244, P-0245, P-0246, P-0258, P-0259, P-0270, P-0274, P-0296, P-0297, P-0302, P-0309,

2. The diagnostic features cited in this contribution only contrast these 3 species and only apply to islands with exclusively introduced paradoxosomatids. They will not contrast congeneric species and will not work in areas of Asia and the Pacific Rim with complex, indigenous paradoxosomatid faunas.

3. According to Silvestri (1904), the diplopod records of Pocock (1893) are the first from Hawai'i, then called the Sandwich Islands. However, this distinction really belongs to Karsch (1880), who described *Iulus anguinus*, from Olinda, Maui, and reported *O. gracilis* from this locality.

P-0315, P-0318, P-0321, P-0322, P-0329, P-0331. **KAUAI**: Na Pali-Kona For. Res., Mohihi-Waiālae Tr., 1040–1070 m, 12 May 1991, D.H. Kavanaugh (CAS). Koke'e St. Pk. (BPBM). Koke'e, 4–6 August 1961, T. Maa, Miyatake, C. Yoshimoto (BPBM) and 9 March 1963, N.L.H. Krauss (BPBM). Alakai Swamp, 15 August 1971, F.G. Howarth (BPBM), and 27 May 1992, R.W. Baumann, H. Spafford (BYU). (BPBM). Haena Caves, 7 August 1961, T. Maa (BPBM). 4 mi W Lihue, along hwy. 50, Hoinakaunalehua Stream, 20 May 1992, R.W. Baumann, M.L. Nelson (BYU). 2 mi SE Lawa'i, along Hwy. 530, 22 May 1992, R.W. Baumann, M.L. Nelson (BYU). Koloa, Limestone Quarry Cv., debris in deep twilight zone, 5 m, 21 June 1972, F.G. Howarth (BPBM); Koloa Cv. #2, rotting wood, 46 m, inside dark zone, 11 August 1971, F.G. Howarth (BPBM); and Knudsen Cv. #1, 45 m, twilight and dark zones, 23 June 1972, F.G. Howarth (BPBM). Hanapepe, 20 May 1992, R.W. Baumann, M.L. Nelson (BYU). Poipu Beach, 24 May 1992, R.W. Baumann (BYU). Pacific Botanical Garden, 26 May 1992, R.W. Baumann, H. Spafford (BYU). Koke'e St. Pk., Pu'u Kila Lookout, 25 May 1992, R.W. Baumann, H. Spafford (BYU). Polihale St. Pk., NE Barking Sands Military Res., 21 May 1992, R.W. Baumann, H. Spafford (BYU). Along Kanaie River, 1067 m, 3 September 1961, S.D. Ripley (PMNH). Waimea Dist., Mt. Kahili, 919 m (BPBM). Waimea Dist., Mohihi Valley (BPBM). **LĀNA'I**: Garden of the Gods, 27 April 1994, R.W. Baumann, C.E. Campora (BYU). Kaumalapau, 27 April 1994, R.W. Baumann, C.E. Campora (BYU). Top of Lāna'ihale Mt., 12 July 1968, D. M. Allred (BPBM). **MAUI**: Pu'u Kukui Trail (BPBM). Puu Mahoe Cv. #1, 2,300 ft., twilight zone, 11 December 1971, S. Montgomery, F.G. Howarth (BPBM). Lahaina, Lahainaluna High School, 4 August 1993, R.W. Baumann, R. Ochoa (BYU). Iao Valley St. Pk., along Iao Stream, 4 August 1993, R.W. Baumann (BYU). Waihoi Valley, 847 m, Berlese of litter and soil, 29–30 June 1972, P. Ching (BPBM). Ko'olau For. Res., 1584 m, on rotting log, 8 August 1973, W.C. Gagné (BPBM). Wailuku Hts., 11 August 1993, R.W. Baumann, R. Ochoa (BYU). Waipoli Rd., 3 mi above jct. Hwy. 377, 10 August 1993, R.W. Baumann, R. Ochoa (BYU). Olinda (BPBM). Hana, 5 mi (8 km) W jct. hwy., 360 W Airport Rd., sifting leaf litter & rotting logs, 24 January 1973, F.G. Howarth, E. L. Bousfield (BPBM). Mt. Haleakalā, NW slope E Olinda, Waikamoi Flume, 1310 m, 9 May 1991, D. H. Kavanaugh (CAS). Hana, Waikoi Valley, Trench Cv., 19 August 1972, F.G. Howarth, W.C. Gagné (BPBM). **MOLOKA'I**: Moloka'i Forest Res., Pu'u Kolekole (BPBM), and Pu'u Kolekole Tr. (BPBM). E. Kaunakakai (BPBM). Kamiloloa Gulch (BPBM). Pukuo'o (BPBM). Hanalilolilo, 914–1,067 m, 3 August 1965, T. Suman (BPBM). Kaulolo, under mist leaves at roadside, 8 July 1968, D. M. Allred (BPBM). **O'AHU**: Kaena Point St. Pk., 22 April 1994, R.W. Baumann, C. E. Campora (BYU). N. slope of Pu'u Pueo (BPBM). Pupukea (BPBM). N. end of Ko'olau Mts. (BPBM). Laie, Koloa Gulch, 21 April 1994, R.W. Baumann, C. E. Campora (BYU). Sacred Falls St. Pk., 21 April 1994, R.W. Baumann, C. E. Campora (BYU). Kualoa Pk., along Hwy. 83, 21 April 1994, R.W. Baumann, C. E. Campora (BYU). Kaha'u Beach Pk. (BPBM). Ko'olau Mts., Opaelua Valley, E. Wahiawa, 6 July 1964, T. Suman (BPBM); windward side, 11 June 1964, R. F., T. S. (BPBM); and Poamoho Trail, sifting leaf litter nr. summit, 2 June 1977, F.G. Howarth (BPBM). Wai'anae Mts., Mt. Ka'ala, 1220 m, in swamp, 2 August 1964, T. Suman (BPBM), 1,190–1,220 m, 18 May 1991, D.H. Kavanaugh (CAS), and summit, 1,220 m, crawling on dead branch at night, 4 November 1996, S.F. Swift (BPBM); S. end Wai'anae Mts. (BPBM). Mānoa (BPBM). Waterfall at head of Mānoa Valley, 1925, T.D.A. Cockerell (NMNH). Kuliouou Val. (BPBM). Aiea Heights, 11 December 1962, C. Yoshimoto (BPBM). Pearl City, 28 March 1968, B. Chambers (BPBM). Honolulu, Salt Lake, 26 July 1977, G.M. Nishida (BPBM); Makiki Heights Rd., 27 September 1964, T. Suman (BPBM); Judd St. Cv., 30 m, on wood in twilight zone, 21 May 1972, F.G. Howarth (BPBM); Diamond Head, 30 May 1991, W.E. Steiner (NMNH); Mt. Tantalus (BPBM). Konahuuui Val. (BPBM). Mt. Ka'ala Tr. and summit, Mt. Ka'ala (BPBM). Waimano Tr. (BPBM). Ulumawao Pk. (BPBM). Halawa (BPBM). Waikane Tr. (BPBM). Kailua, Pu'u O Ehu (BPBM).

Remarks. Entomologists and arthropodologists from numerous universities and museums in the continental United States have visited Hawai'i and collected *O. gracilis* on various islands. The first author has seen many more Hawaiian samples but has not recorded them, and *O. gracilis* is expected on all major islands in the archipelago. As the holdings at all North American institutions have been sorted and organized, persons inter-

ested in Hawaiian records can retrieve the samples from jars containing this species. *Oxidus gracilis* is a major urban pest in the continental United States and regularly invades houses and buildings; it undergoes sporadic population explosions that can overwhelm homeowners (see O'Neill & Reichle, 1970). Commonly known as the "hothouse" or "greenhouse" millipede because of its prevalence in these structures, *O. gracilis* is one of the few millipeds whose life history is understood. Readers interested in its ecology and general biology are referred to Causey (1943) and Bennett & Kerr (1973).

Asiomorpha coarctata (Saussure, 1860)

Diagnosis. Dorsum relatively flat, deep chestnut brown to black in adults, juveniles pallid; paranota extending directly laterad, corners angular, acuminate, and strongly extended on all segments; gonopods relatively long and slender, extending anteriorly to between caudal legs of 5th segment, appearing undivided but actually divided around midlength into 3 closely appressed, indistinct branches. Reasonably accurate illustrations that show the general form of the gonopod are available in Attems (1898, fig. 85; 1937, fig. 75) and Schubart (1945, fig. 40).

Occurrence in Hawai'i. Known only from Kaua'i and O'ahu.

Published records (all as "*Orthomorpha coarctata*"). "Hawaii," referring to the islands in general (Silvestri, 1935; Attems, 1938a). KAUA'I: Lihue (Attems, 1903; Silvestri, 1904). O'AHU: Honolulu (Chamberlin, 1920).

Material examined: KAUA'I: Koke'e St. Pk., Kalalau Lookout, 4000 ft. [1220 m], 9 March 1963, N.L.H. Krauss (BPBM). O'AHU: In cane field, exact location and collector unknown, 28 March 1930 (NMNH). Honolulu, Kalihi Valley, 30 m, 25 February 1982, F.G. Howarth (BPBM). Pearl City, 28 March 1968, B. Chambers (BPBM). Kailua, Pu'u O Ehu (BPBM).

Remarks. In Hawai'i, *Asiomorpha coarctata* is rare in comparison to *O. gracilis*, whereas it is more abundant than the latter on Caribbean Islands. Additional Hawaiian samples are available in American and Canadian repositories, which can be retrieved from jars labeled as this species. Where it occurs, *A. coarctata* can become locally abundant, but unlike *O. gracilis*, it is not infamous for invading houses. Bennett & Kemp (1973) studied the biology and behavior of populations in Florida.

Akamptogonus novarae (Humbert & Saussure, 1869) **New island records**

Diagnosis. Dorsum gently arched or vaulted, brownish orange in color, protergites and anterior halves of metatergites (anterior to transverse grooves) distinctly lighter, forming subcontinuous middorsal stripe; paranota interrupting slope of dorsum and extending directly laterad; gonopods relatively short and broad, extending anteriorly to between caudal legs of preceding (6th) segment, divided at midlength into three clearly separated terminal branches. Illustrations that show the general form of the gonopod are available in Attems (1937, fig. 315) and Hoffman (1979, fig. 1).

Occurrence in Hawai'i. Known from the islands of Hawai'i and O'ahu.

Published records. "Hawaii," probably meaning the islands in general (Jeekel, 1981; Shear, 1992).

Material examined: HAWAII'I: Kohala Mts. (BPBM). Waipio Valley (BPBM). Kalopa St. Pk., 19 September 1972, O.S. & C.M. Flint (NMNH). Kipuka Pua'ulu, Bird Park Cv. #1, dark zone, 3 July 1971, F.G. Howarth (BPBM). Honoka'a, Hamakua For. Res. Cvs., 600 m, lower section, twilight zone, 24 April 1972, F.G. Howarth (BPBM) and 610 m in upper section, 24 April 1972, F.G. Howarth (BPBM). Hawai'i Volcanoes Nat. Pk., 1 August 1976, C.F.E. Roper (NMNH); Mauna Loa, entrance to Bird Park Cv. #2, twilight zone, 1250 m, 9 December 1976, D. & M. Davis (NMNH); and Kilauea Iki floor (BPBM). Also the following numbered samples at the BM (see appendix): 00249, 00250, 00938, 01030, 01094, 01142, 01178, P-0004, P-0008, P-0009, P-0013, P-0015, P-0018, P-

0023, P-0025, P-0027, P-0031, P-0040, P-0041, P-0043, P-0051, P-0055, P-0061, P-0068, P-0080, P-0081, P-0082, P-0090, P-0091, P-0180, P-0181, P-0193, P-0195, P-0196, P-0205, P-0218, P-0220, P-0222, P-0230, P-0244, P-0245, P-0246, P-0258, P-0259, P-0271, P-0272, P-0273, P-0274, P-0275, P-0286, P-0289, P-0296, P-0297, P-0304, P-0309, P-0310, P-0312, P-0315, P-0316, P-0329, P-0332. O'AHU: Honolulu, Mānoa, under stone, 13 February 1944, N.L.H. Krauss (NMNH).

Remarks. The initial report of *A. novarae* from "Hawaii" is an obscure reference to unpublished samples by Jeekel (1981: 21), which is itself an unofficial mimeographed report of an expedition to Australia, not a scientific publication. The actual statement is, "It appears to spread gradually through human agency, and has been recorded recently from California, U.S.A., and became known from Hawaii (unpublished)." Shear's citation (1992) is based on this unsupported statement. We have no idea which island the source material came from or where it is housed, but as Dr. Jeekel is an authority on the Paradoxosomatidae, the citation must be considered valid. Obviously, *A. novarae* had been discovered in the state prior to 1981, possibly in the 1970s.

Deletions

Chamberlin (1923, 1941) inadvicably proposed 2 new genera, 1 new subgenus, and 4 new species for 4 paradoxosomatid samples taken in quarantine at Honolulu in 1921–1922 and 1938; they actually comprise only 3 species, all previously described. One of his genera, *Desmoxytes*, is the senior name for an assemblage of Oriental paradoxosomatids with sculptured, ornamented dorsums and elaborate paranota. It now encompasses the spectacularly ornamented "Chinese Dragon Milliped," *D. draco* (Cook & Loomis), as Golovatch & Enghoff (1994) placed its original genus, *Hylomus* Cook and Loomis, in synonymy under *Desmoxytes*. However, the other 2 genus-group names, *Chinosoma* and *Ceylonismus*, the latter proposed as a subgenus of *Euphyodesmus* Attems, have been synonymized under older names, as have all 4 specific names. We officially delete all 3 species from the Hawaiian fauna.

Desmoxytes planata (Pocock, 1895) (= *D. coniger* Chamberlin, 1923; *Euphyodesmus* (*Ceylonismus*) *vector* Chamberlin, 1941). Originally discovered on the Andaman Islands, in the Bay of Bengal, this species is readily transported by commerce and is known from Thailand, the Seychelles, Java, Ceylon, and Fiji (Jeekel, 1980a,b; Golovatch & Enghoff, 1994); Jeekel (1980a) speculated that its native area was probably Myanmar or Malaya. Chamberlin (1923) proposed *Desmoxytes* and *D. coniger* for 3 males, 1 female, and numerous juveniles that were intercepted in soil with plants coming from Bogor (formerly Buitenzorg), Java. Attems (1938a) recorded the species from Hawai'i, meaning the islands collectively, with a question mark, misspelling the specific name as "*corniger*"; later that year, he (Attems, 1938b) spelled the name correctly and listed Honolulu as its locality. Chamberlin (1941) proposed *Euphyodesmus* (*Ceylonismus*) *vector* for nine specimens of unknown sex taken "in soil about plants from Ceylon." Jeekel (1980a, figs. 1–3) provided drawings of a body segment and a gonopod, which enable reliable determinations of *D. planata* if it is ever discovered in a Hawaiian environment.

Helicorthismorpha holstii (Pocock, 1895) (= *Chinosoma hodites* Chamberlin, 1923). This species is known from the Ryukyus, China, and Vietnam; Chamberlin (1923) proposed *Chinosoma* and *C. hodites* for 1 male and 3 juveniles that were intercepted in soil with a cactus plant from an unspecified locality in China. Attems (1938a) cited *C. hodites* and listed Honolulu as its locality. Jeekel (1980a) placed *Chinosoma* in synonymy under *Helicorthismorpha* Attems and *C. hodites* under *H. holstii*; he also provided drawings of

a somite and a gonopod that enable reliable determinations of *H. holstii* if it is ever discovered in the Hawaiian islands.

Helicorthomorpha orthogona (Silvestri, 1898) (= *Orthomorpha hodites* Chamberlin, 1941). This species is known from Taiwan, the Philippines, and New Guinea; Chamberlin (1941) proposed *O. hodites* for a male found on a root of *Phalaenopsis stuartiana* shipped from the Philippines. Jeekel (1967) referred *O. hodites* to *Helicorthomorpha*; thirteen years later, he (Jeekel, 1980a) placed *O. hodites* in synonymy under *H. orthogona*. No recent gonopod drawings of *H. orthogona* exist, so the best available is that with the original description (Silvestri, 1898, fig. 2).

Acknowledgments

We thank the following curators for access to preserved samples under their care: R.W. Baumann (BYU), C.E. Griswold (CAS), G.B. Edwards (FSCA), J.A. Coddington (NMNH), R.J. Pupedis (PMNH). R.L. Hoffman provided valuable advice on the literature. Material in BPBM was made available through curation supported by the National Science Foundation.

Literature Cited

- Attems, C. G.** 1898. *System der Polydesmiden. I. Theil*. Vienna. 185 p.
- . 1903. Beiträge zur Myriopodenkunde. *Zool. Jahrb.* **18**: 63–154.
- . 1909. Die Myriopoden der Vega-Expedition. *Arki. Zool.* **5**: 1–84.
- . 1937. Myriapoda 3, Polydesmoidea I, Fam. Strongylosomidae. *Das Tierreich*, **68**: 1–300.
- . 1938a. Myriopoden von Hawai. *Proc. Zool. Soc. Lond. (B)* **108**: 365–87.
- . 1938b. Myriapoda 3, Polydesmoidea II, Fam. Leptodesmidae, Platyrrhacidae, Oxydesmidae, Gomphodesmidae. *Das Tierreich* **69**: 1–487.
- . 1940. VI. Myriopodes. In: *Croisière du Bougainville aux Îles Australes françaises, Mémoires du Muséum* (n.s.) **14**: 271–82.
- Bennett, D.B. & S.H. Kerr.** 1973. Millipedes in and around structures in Florida. *Fla. Entomol.* **56**: 43–47.
- Blower, J.G.** 1985. *Millipedes*. E.J. Brill, London. 242 p.
- Causey, N.B.** 1943. Studies on the life history and the ecology of the hothouse millipede, *Orthomorpha gracilis* (C. L. Koch 1847). *Am. Midl. Nat.* **29**: 670–82.
- Chamberlin, R.V.** 1920. The Myriopoda of the Australian region. *Bull. Mus. Comp. Zool.* **64**: 1–269.
- . 1922. A new Javan chilopod of the genus *Mecistocephalus*. *Psyche* **29**: 178–79.
- . 1923. Two diplopod immigrants taken at Honolulu. *Proc. Biol. Soc. Wash.* **36**: 165–68.
- . 1941. New polydesmoid diplopods intercepted at quarantine. *Proc. Entomol. Soc. Wash.* **43**: 32–35.
- Golovatch, S.I. & H. Enghoff.** 1993. Review of the millipede genus *Tylopus*, with descriptions of new species from Thailand (Diplopoda, Polydesmida, Paradoxosomatidae). *Steenstrupia* **19**: 85–125.
- . 1994. Review of the dragon millipedes, genus *Desmoxytes* Chamberlin, 1923 (Diplopoda, Polydesmida, Paradoxosomatidae). *Steenstrupia* **20**: 45–71.
- Hoffman, R.L.** 1979. An Australian polydesmoid millipede in San Francisco (Paradoxosomatidae). *Wasmann J. Biol.* **37**: 55–58.

- . [1980]. *Classification of the Diplopoda*. Museum d'Histoire Naturelle, Geneva, Switzerland. 237 p.
- Jeekel, C. A. W.** 1963. Diplopoda of Guiana. *Studies on the fauna of Suriname and other Guyanas*: **11**: 1–157.
- . 1967. A revision of the Papuan Paradoxosomatidae (Diplopoda, Polydesmida) in the Museo Civico di Storia Naturale at Genoa. *Tijdschr. Entomol.* **110**: 343–79.
- . 1971. Nomenclator generum et familiarum Diplopodorum: a list of the genus and family-group names in the class Diplopoda from the 10th edition of Linnaeus, 1758, to the end of 1957. *Monogr. Ned. Entomol. Ver.* **5**: 1–412.
- . 1972. The “endemic” paradoxosomatids (Diplopoda, Polydesmida) of the Fiji Islands. *Beaufortia* **20**: 1–6.
- . 1980a. The generic allocation of some little-known Paradoxosomatidae from south-east Asia (Diplopoda, Polydesmida). *Rev. Suisse Zool.* **87**: 651–70.
- . 1980b. Records of Diplopoda of the order Polydesmida from Fiji Islands. *Entomol. Ber.* **40**: 122–27.
- . 1981. Australia Expedition 1980; legit C.A.W. Jeekel and A.M. Jeekel-Rivers. List of collecting stations, together with general notes on the distribution of millipedes in eastern Australia and Tasmania. *Versl. Tech. Gegevens, Inst. Taxon. Zoöl. Univ. Amsterdam* **30**: 1-59 (unpublished technical report).
- . 1982. New records and descriptions of southeast Asian Paradoxosomatidae (Diplopoda, Polydesmida). *Boll. Mus.Civ. Stor. Nat. Verona* **9**: 225–53.
- Karsch, F.** 1880. Über die von Herrn Dr. O. Finsch während seiner polynesischen Reise gesammelten Myriopoden und Arachniden. *Sitzungsber. Ges. Naturforsch. Freunde Berl.* **1880**: 77–84.
- Loomis, H.F.** 1948. Two new millipeds of Jamaica. *J. Wash. Acad. Sci.* **38**: 185–88.
- Mauriès, J.-P.** 1983. Cambalides nouveaux et peu connus d'Asie, d'Amérique et d'Océanie. I. Cambalidae et Cambalopsidae (Myriapoda, Diplopoda). *Bull. Mus. Nat. Hist. Natur. Paris* (4) **5**: 24–76.
- Nishida, G.M.** 1994. Hawaiian terrestrial arthropod checklist. Second edition. *Bishop Mus. Tech. Rep.* **4**: 1-287.
- O'Neill, R.V. & D.E. Reichle.** 1970. Urban infestation by the millipede, *Oxidus gracilis* (Koch). *J. Tenn. Acad. Sci.* **45**: 114–15.
- Pocock, R.I.** 1893. Report upon the Myriopoda of the ‘Challenger’ expedition, with remarks upon the fauna of Bermuda. *Ann. Mag. Nat. Hist.* (6) **11**: 121–42.
- Schubart, O.** 1934. Tausendfüssler oder Myriapoda I: Diplopoda. In: Dahl, F., *Die Tierwelt Deutschlands und der angrenzenden Meeresteile nach ihren Merkmalen und nach ihrer Lebensweise.* **28**: 1–318.
- . 1945. Os Proterospermophora do Distrito Federal (Myriapoda, Diplopoda). *Arg. Mus. Nac.* **38**: 1–156.
- Shear, W.A.** 1992. A new genus and two new species of millipedes from the Cape Range, Western Australia (Diplopoda, Polydesmida, Paradoxosomatidae). *Rec. West. Aust. Mus.* **15**: 777–84.
- Shelley, R.M.** 1978. Millipeds of the eastern Piedmont region of North Carolina, U.S.A. (Diplopoda). *J. Nat. Hist.* **12**: 37–79.
- . 1998. Occurrence of the millipede *Trigoniulus corallinus* (Gervais) on O'ahu and Kaua'i (Spirobolida: Pachybolidae: Trigoniulinae). *Bishop Mus. Occas. Pap.* **56**:

55–57.

———. & S.F. Swift. 1998. The milliped order Julida in the Hawaiian Islands. *Bishop Mus. Occas. Pap.* **56**: 38–43.

Silvestri, F. 1898. Alcuni nuovi Diplopodi della N. Guinea. *Ann. Mus. Civ. Stor. Giacomo Doria* **39**: 441–49.

———. 1904. Myriopoda. *Fauna Hawaiensis* **3**: 323–38.

———. 1935. Myriopoda from the Society Islands. *B.P. Bishop Mus. Bull.* **113**: 131–34.

Verhoeff, K. W. 1944. Zur Kenntnis der Cambaliden und über einige neue Australischeformen derselben. *Zool. Anz.* **145**: 27–45.

Appendix. List of numbered localities referred to in this paper

BM-Berlese numbers:

- 00249 HAWAI'I: Mauna Loa Strip Road, plot no. 19, 28.vi - 5.vii.1971, pitfall trap, M.L. Goff
 00250 HAWAI'I: Mauna Loa Strip road, plot no. 19, 12-20.vii. 1971, pitfall trap, M.L. Goff
 00251 HAWAI'I: Hawai'i Volcanoes National Park (HVNP), Bird Park, plot no. 19, 5-12.vii.1971, pitfall trap, M.L. Goff
 00488 HAWAI'I: HVNP, Kīpuka Pua'ulu, litter at base of mature *Metrosideros*, 31.vii.1971, Berlese, G.A. Samuelson
 00491 HAWAI'I: HVNP, Kīpuka Pua'ulu, nr. pitfall no. 10, 26.viii.1971, grass & *Metrosideros* leaves, Berlese, G.A. Samuelson
 00502 HAWAI'I: HVNP, Kīpuka Pua'ulu, 31.viii.1971, *Pipturus* leaf litter and soil, Berlese, G.A. Samuelson
 00582 HAWAI'I: East slope of Mauna Loa, 2286-2316 m, 21-31.vii.1971, pitfall trap, F.J. Radovsky
 00727 HAWAI'I: East slope of Mauna Loa, 100 yards above marker 38 Kīpuka Ki, 1220 m, 7.iv.1972, pitfall assoc. litter, Berlese, J. Jacobi
 00938 HAWAI'I: East slope of Mauna Loa, Thurston Lava Tube, 1204 m, 14.viii.1972, pitfall assoc. litter, Berlese, J. Jacobi
 01030 HAWAI'I: East slope of Mauna Loa, Bird Park-Kīpuka Pua'ulu, 1220 m, pitfall assoc. litter, Berlese, 16.x.1972, J. Jacobi
 01094 HAWAI'I: East slope of Mauna Loa, Power Line area, 1493 m, pitfall assoc. litter, 18.xi.1972, J. Jacobi
 01142 HAWAI'I: East slope of Mauna Loa, Power Line area, 1493 m, pitfall assoc. litter, Berlese, 13.xii.1972, J. Jacobi
 01166 HAWAI'I: East slope of Mauna Loa, Kīpuka Ki Weather Station, 1220 m, leaf litter, Berlese, 23.i.1973, J. Jacobi
 01178 HAWAI'I: East slope of Mauna Loa, Bird Park-Kīpuka Pua'ulu, 1220 m, pitfall assoc. litter, Berlese, J. Jacobi

Pitfall numbers:

- P-0001 HAWAI'I: East slope of Mauna Loa, 2440 m, pitfall trap, 21-31.vii.1971, F.J. Radovsky
 P-0002 HAWAI'I: East slope of Mauna Loa, 1585 m, pitfall trap, 21-23.vii.1971, F.J. Radovsky
 P-0003 HAWAI'I: East slope of Mauna Loa, 1890 m, pitfall trap, 21-31.vii.1971, F.J. Radovsky
 P-0004 HAWAI'I: East slope of Mauna Loa, 100 yards above marker for 38 Kīpuka Ki, 1220 m, pitfall trap, 21-31.vii.1971, F.J. Radovsky
 P-0008 HAWAI'I: East slope of Mauna Loa, 1280-1341 m, pitfall trap, 20-31.vii.1971, F.J. Radovsky
 P-0009 HAWAI'I: East slope of Mauna Loa, Kīpuka Ki Weather Station, 1220 m, pitfall trap, 20-31.vii.1971, F.J. Radovsky
 P-0013 HAWAI'I: East slope of Mauna Loa, 1200 m, pitfall trap, 30.vii.1971, J. Jacobi
 P-0015 HAWAI'I: East slope of Mauna Loa, Kīpuka Ki Weather Station, 1220 m, pitfall trap, 9.vii.1971, J. Jacobi
 P-0016 HAWAI'I: East slope of Mauna Loa, 1890 m, pitfall trap, 9.vii.1971, J. Jacobi
 P-0018 HAWAI'I: East slope of Mauna Loa, 1280-1341 m, pitfall trap, 30.vii.1971, J. Jacobi
 P-0020 HAWAI'I: East slope of Mauna Loa, 1585 m, pitfall trap, 30.vii.1971, J. Jacobi
 P-0022 HAWAI'I: East slope of Mauna Loa, Kīlauea Forest Reserve, 1646 m, pitfall trap, 30.vii. 1971, J. Jacobi
 P-0023 HAWAI'I: East slope of Mauna Loa, 1280-1341 m, pitfall trap, 23.viii.1971, J. Jacobi
 P-0024 HAWAI'I: East slope of Mauna Loa, Kīlauea Forest Reserve, 1645 m, 30.vii.1971, J. Jacobi
 P-0025 HAWAI'I: East slope of Mauna Loa, 1220 m, pitfall trap, 9.viii.1971, J. Jacobi
 P-0027 HAWAI'I: East slope of Mauna Loa, Bird Park-Kīpuka Pua'ulu, 1220 m, pitfall trap, 9.vii.1971, J. Jacobi