From Siam to Rapa Nui — the identity and distribution of *Geogarypus longidigitatus* (Rainbow) (Pseudoscorpiones: Geogarypidae)

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Summary

Although until now authentically recorded from only the type locality, at Funafuti, Tuvalu, in the Pacific Ocean, *Geogarypus longidigitatus* (Rainbow, 1897) is found to be widely distributed in the Asian and Pacific areas. It is regarded as the senior synonym of the following species-group names, some of which had previously been treated as synonyms of *G. javanus* (Tullgren): *Garypus personatus* Simon, 1900; *Garypus javanus* Tullgren, 1905; *Geogarypus formosanus* Beier, 1931; *Geogarypus (Geogarypus) marquesianus* Chamberlin, 1939; *Geogarypus audyi* Beier, 1952; *Geogarypus (Geogarypus) micronesiensis* Morikawa, 1952; and *Geogarypus (Geogarypus) javanus takensis* Beier, 1967. This wide-ranging species is found across 150° of longitude from Thailand (Siam) to Easter Island (Rapa Nui), and the possibility that humans have aided its transport is suggested.

Introduction

Members of the garypoid family Geogarypidae are common elements of the litter fauna of many islands in the Pacific Ocean and surrounding areas. Several species have been recorded from this region, but the most commonly cited species is *Geogarypus javanus* (Tullgren, 1905), which was recorded from numerous localities by Beier (1957), who divided it into several subspecies based mostly upon morphometric features. Harvey (1988) redescribed *G. javanus* but decided that the subspecies classification was untenable, synonymising several names under *G. javanus*. Since then, numerous specimens of a species referable to *G. javanus* have become available from widespread areas of the Pacific region. These new specimens show that this species is one of the most widespread pseudoscorpion species and that, based upon examination of type material and topotypic material, *G. javanus* is predated by two names, the oldest of which is *G. longidigitatus* (Rainbow, 1897). The purposes of this paper are to record the distribution of the species and to formally synonymise the younger names. In addition, some morphological features are examined and the trichobothrial patterns of all nymphal stages are illustrated for the first time.

Specimens were examined by partial clearing in lactic acid. Terminology follows Chamberlin (1931) and Harvey (1992).

Acronyms for institutions are as follows: Australian Museum, Sydney, Australia (AM); Australian National Insect Collection, CSIRO, Canberra, Australia (ANIC); Natural History Museum, London, UK (BMNH); Bernice P. Bishop Museum, Honolulu, USA (BPBM); California Academy of Sciences, San Francisco, USA (CAS); Ehime University, Matsuyama, Japan (EUM); Muséum d'Histoire Naturelle, Geneva, Switzerland (MHNG); Muséum National d'Histoire Naturelle, Paris (MNHN); Museum Zoologicum Bogoriense, Bogor, Indonesia (MZB); Zoological Museum, University of Turku, Turku, Finland (MZT); Naturhistorisches Museum, Vienna, Austria (NHMW); Museum of Victoria, Melbourne, Australia (NMV); Queensland Museum, Brisbane, Australia (QM); Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands (RMNH); Western Australian Museum, Perth, Australia (WAM); Zoologisches Museum, Museum für Naturkunde, Berlin, Germany (ZMB); Zoologisches Institut und Zoologisches Museum, Hamburg, Germany (ZMH); and Zoological Museum, University of Copenhagen, Copenhagen, Denmark (ZMUC).

Systematics

Geogarypus longidigitatus (Rainbow, 1897) (Figs. 1–9)

Chelifer longidigitatus Rainbow, 1897: 108–109, fig. 2.
Garypus personatus Simon, 1900: 518–519. **New synonymy**.
Garypus javanus Tullgren, 1905: 43–44. **New synonymy**.
Geogarypus formosanus Beier, 1931: 315–316, fig. 10. **New synonymy** [first synonymised with *G. javanus* by Harvey (1988)].
Geogarypus marquesianus Chamberlin, 1939: 208–210, figs. 1a–g. **New synonymy**.
Geogarypus audyi Beier, 1952: 103–105, fig. 6. **New synonymy** [first synonymised with *G. javanus* by Harvey (1988)].
Geogarypus (Geogarypus) micronesiensis Morikawa, 1952: 245, figs. 4, 5c. **New synonymy**.
Geogarypus (Geogarypus) javanus takensis Beier, 1967: 352, fig. 12. **New synonymy** [first synonymised with *G. javanus* by Harvey (1988)].
Note: Full synonymies to 1989 may be found in Harvey (1991).

Types: Chelifer longidigitatus: 2 syntypes, Funafuti [now Fongafale], Tuvalu, Mr Hedley (not in AM, lost).

Garypus personatus Simon: syntype[1] ♂, Kaala Mountains, Oahu, Hawaii, 2000 ft [=610 m], March 1893, Perkins (BMNH 1904.x.24.450).

Garypus javanus Tullgren: holotype ♂, Buitenzorg [now Bogor], Java, Indonesia, Farndetritus, March 1904 (ZMH, examined).

Geogarypus formosanus Beier: holotype ♂, Takao [now Kao-hsiung], Taiwan, 27 January 1907, H. Sauter (ZMB, examined).

Geogarypus marquesianus Chamberlin: holotype ♀, 1 paratype ♀, Vaipee Valley, Puta tauua, Uahuka, Marquesas Islands, 800 ft [=268 m], 21 September 1929, from dead banana leaves, A. M. Adamson (BPBM, JC-820.01001, 820.01003, not examined); 2 paratype ♀, same data as holotype (CAS, JC-820.01002, 820.01004, examined); 1 paratype ♀, Pouau, Hivaoa, Marquesas Islands, 1500 ft [=457 m], 5 March 1929, Mumford and

[1]Judson (1997) considered this specimen to be the holotype, since he was unable to find any further specimens in BMNH or other institutions. However, Simon (1900) began his description of *G. personatus* with "♂ — ♀", probably indicating that he had at least one specimen of each sex. I therefore regard the BMNH specimen as a syntype.

Adamson (CAS, JC-816.01001, examined); 1 paratype ♀, Tovii, Teuanui, Nukuhiva, Marquesas Islands, 2000 ft [=610 m], 27 October 1929, Mumford and Adamson (BPBM, JC-813.01001, not examined).

Geogarypus audyi Beier: holotype ♂, Kuala Lumpur, [Selangor], Malaysia, in nest of *Rattus rattus diardi* (Jentink), 8 December 1949, [J. R. Audy] (NMHW, examined).

Geogarypus (Geogarypus) micronesiensis Morikawa: holotype ♀, Marcus Island, 1–5 May 1952, in the cleft of rocks of the beach, S. Sakagami (EUM, not examined).

Geogarypus (Geogarypus) javanus takensis Beier: holotype ♂, Langs weg var Tak noar Thoen, 65 km var. Tak, Thailand, 5 December 1957, L. D. Brongsersma (RMNH, no. 312, examined).

Other material examined: AUSTRALIA: Queensland: 1♀ (with brood-sac), Milman Islet, 11°10′S, 143°01′E, 27 December 1996, J. D. Miller (WAM 99/1395); 5♂ 6♀, Yam Island, Torres Strait, 28 November–2 December 1986, J. Gallon (QM S6091); 1♀, Stephen Island, Torres Strait, 25–27 November 1986, J. Gallon (QM S6089).

CHINA: Fukien: 1♀, Amoy [now Xiamen], among old papers, 14 May 1923, S. F. Light (CAS, JC-501.01001).

COOK ISLANDS: *Niue*: 1♀, 1 tritonymph, 1 deutonymph, Niue Island, 19°02′S, 169°54′W, 17–23 April 1996, A. van Harten (WAM 99/1396-1398). *Rarotonga*: 6♂ 5♀ (2 with brood-sacs), 4 tritonymphs, 1 deutonymph, 5 protonymphs, 'Arorangi, 9–14 March 1996, A. van Harten (WAM 99/1399-1419); 4♀, Ngatangiia, Avana Stream, 24 March 1988, soft large leaves, P. T. Lehtinen (MZT); 1 tritonymph, same data except large-leaved jungle litter (MZT); 3♂ 1♀, 1 tritonymph, Takitimu D., Papua Stream, 80 m, 23 March 1988, litter around waterfall, P. T. Lehtinen (MZT); 5♂ 3♀, 1 deutonymph, same data except moss and jungle litter (MZT); 1♂, 2 tritonymphs, same data except 80 m, litter around waterfall (MZT); 1♂, 2 tritonymphs, 2 deutonymphs, Waimaanga, 24 March 1988, lowland jungle litter, P. T. Lehtinen (MZT); 1♂ 1♀, 1 tritonymph, same data except 28 March 1988, in vegetation (MZT).

FIJI: *Viti Levu*: 1♂ 1♀, near Deuba [18°16′S, 178°02′E], 31 March 1997, on beach under driftwood, A. van Harten (WAM 99/1420-1421).

HAWAII: *Maui*: 1♂ 3♀, 2 tritonymphs, 1 deutonymph, 1 protonymph, Hana, Waianapanapa State Park, 27 November 1992, *Terminalia catappa* bark, ½–1 m above ground, S. F. Swift (BPBM, WM7859).

HENDERSON ISLAND: 1♂, 1 protonymph, central part 500 m N. of middle island bivouac, 23 March 1991, boles of *Asplenium*, T. Benton (MZT); 1♂ 1♀, 1 protonymph, 800 m S. of North Beach, 25 February 1991, dirty soil and litter, T. Benton (MZT).

INDONESIA: *Krakatau Islands*: 1 tritonymph, Zwarte Hoek, Rakata, 6°09′S, 105°25′E, 31 August 1984 (MZB); 1♂, Sertung, spit, 6°04′S, 105°24′–25′E, beating in transition zone, 18 August 1985 (MZB). *Java*: 1♂ 1♀, Pulau Peucang, Ujung Kulon, 6°45′S, 105°15′E, beating, rainforest, 19 September 1984 (NMV); 1♀, same data except beating *Pandanus* sp. (MZB). *Maluku*: 1♂, Kei-Aferne, Tual [as Toeal], 1922, T. Mortensen (ZMUC, JC-254.01001). *Sulawesi*: 1♀, 5 km W. of Bulukumba, 19 May 1984, E. Holm (ANIC). *Sumba*: 1♀, Kodi, unter Steinen, 8 August 1949, E. Sutter (NMB). *Timor*: 6♂ 2♀, 1 tritonymph, 1 deutonymph, 2 km E. of Camplong, 13 August 1990, lowland monsoon forest, leaf litter, Agosti and Weintraub (WAM 99/1422-1431); 2 tritonymphs, 1 deutonymph, Ainaro, Kabupatan Suai, 17 August 1990, D. Agosti (WAM 99/1432-1434).

EASTER ISLAND (ISLA DE PASCUA): 3♂ 4♀, 1 tritonymph, Anakena Bay, 8 May 1988, litter of *Psidium guajava*, P. T. Lehtinen (MZT).

MALAYSIA: *Sarawak*: 1♀, Semantan Beach, ex litter beneath shrubs on sand, T. E. Woodward, B. H. Voon (QM S355). *Unknown province*: 1♀, intercepted in Australia from orchids and palms (WAM 99/1435).

MARQUESAS ISLANDS: *Hivaoa*: 1♂ 2♀, Atuona, 14 September 1990, litter of secondary forest, P. T. Lehtinen (MZT); 1 deutonymph, same data except litter and soil within tree trunks in garden (MZT); 4♀, 2 protonymphs, Motu'ua, 24 April 1988, litter mixed with mould in a roadside cutting, P. T. Lehtinen (MZT); 1♂, Mt. Temetiu, 1050 m, 27 April 1988, moss in the ground layer of cloud forest, P. T. Lehtinen (MZT); 1♂ 3♀, same data except 650 m, leaf litter in forest slope (MZT); 1 deutonymph, Pa'Auau, 600 m, 24 April 1988, litter of big trees, P. T. Lehtinen (MZT); 1♂, Puamau, 24 April 1988, litter of *Hibiscus orientalis*, P. T. Lehtinen (MZT); 1♂, 1 tritonymph, same data except under bark of decaying trees (MZT); 1♀, same data except litter of ferns (MZT); 3♂ 1♀, 2 tritonymphs, 1 deutonymph, 5 protonymphs, same data except 100 m, litter of *Hibiscus orientalis* (MZT); 9♂ 5♀, 6 tritonymphs, same data except 25 April 1988, litter of *Hibiscus* with many ants (MZT); 1♂ 1♀, Tahauku, 15 September 1990, litter of beach and bush, P. T. Lehtinen (MZT); 1♂ 1♀, same data except *Ipomoea pes-caprae* beach (MZT); 1♂ 1♀, 1 protonymph, same data except litter of bush seashore (MZT). *Nukuhiva*: 1 tritonymph, Te Kou, 1050 m, 14 April 1988, ferns (*Asplenium nidus*) epiphytic on *Pandanus*, P. T. Lehtinen (MZT); 3♂ 1♀, Toovii, 800 m, 11 April 1988, epiphytes on *Weinmannia parviflora*, P. T. Lehtinen (MZT); 1 tritonymph, same data except 780 m, 12 April 1988, mixed litter in pine plantation (MZT); 1♂, same data except 800 m, 14 April 1988, epiphytes in cloud forest (MZT); 5♂ 5♀, 2 protonymphs, same data except moss and epiphytes in cloud forest (MZT). *Uapou*: 2♂ 1♀, 1 tritonymph, 1 deutonymph, base of Mt. Oave, 600 m, 19 April 1988, within decaying tree, P. T. Lehtinen (MZT); 1♂ 1♀, same data except 23 April 1988 (MZT); 2♂ 3♀, 1 tritonymph, same data except 620 m, 19 April 1988, litter of *Hibiscus* (MZT); 9♂ 4♀ (1 with brood-sac), 1 tritonymph, 1 deutonymph, Hakahetau valley, 400 m, 12 September 1990, secondary forest, P. T. Lehtinen (MZT); 1♀, Hohoi, 12 September 1990, ferns and grass in rock slope and roadside, P. T. Lehtinen (MZT); 1♂, same data except 650 m, 22 April 1988, fern litter on mountain crest (MZT); 10♂ 3♀ (1 with brood-sac), 4 tritonymphs, 1 deutonymph, Hohoi, Hakahau, mountain crest, 350 m, 22 April 1988, litter of ferns, P. T. Lehtinen (MZT); 6♂ 8♀, 1 tritonymph, Hohoi, Mt. Tekohepu, 400 m, 21 April 1988, litter of *Artocarpus*, P. T. Lehtinen (MZT); 1♀, Hohoi, road to Mt. Tekohepu, 400 m, 21 April 1988, litter of *Artocarpus*, P. T. Lehtinen (MZT); 1 adult (pedipalps only), Mt. Tekohepu, 21 April 1988, funnel residue, P. T. Lehtinen (MZT); 1 protonymph, same data except 680 m, decaying *Pandanus* (MZT); 1♂, same data except 700 m, under bark of *Casuarina* in *Pandanus* zone (MZT); 5♂ 2♀, 2 tritonymphs, 2 deutonymphs, 1 protonymph, Patinuti, 350 m, 7 September 1990, secondary forest, P. T. Lehtinen (MZT); 2♂ 3♀, Punokeu, 300 m, 20 April 1988, litter of *Acacia* plantation, P. T. Lehtinen (MZT); 1 tritonymph, 1 deutonymph, Tekohepu, 9 September 1990, fern litter at rock wall, P. T. Lehtinen (MZT).

PAPUA NEW GUINEA: 2♀, Ralum, 4 August [18]96 (ZMB); 5 protonymphs, 27 January [18]97 (ZMB).

PHILIPPINES: *Luzon*: 3♂ 1♀, Mt. Makiling [now Mt. Maquiling], C. F. Baker (CAS, JC-503E, F, H, I); 1♀, same locality, 1923–1925, C. F. Baker (CAS, JC-550.03001).

SAMOA: 1♂, Apolima Is., on a hill, 6 August 1980, Dlussky (MHNG).

SINGAPORE: 3 tritonymphs, intercepted in Australia from orchids and palms (WAM 99/1436-1438).

SOCIETY ISLANDS: *Bora Bora*: 1 tritonymph, 1 deutonymph, Mt. Popoti, 245 m, 15 May 1988, under volcanic stones, P. T. Lehtinen (MZT); 14♂ 8♀ (1 with empty brood-sac), 2 protonymphs, Papuaa, 20 m, 15 May 1988, litter of *Hibiscus tiliaceus*, P. T. Lehtinen (MZT); 1♂, 1 tritonymph, 1 deutonymph, Pirio, 75 m, 16 May 1988, litter of *Hibiscus* and *Blechnum*, P. T. Lehtinen (MZT). *Raiatea*: 16♂ 2♀, 3 tritonymphs, 1 deutonymph, 1 protonymph, Tapioi, 300 m, 26 September 1990, secondary forest, P. T. Lehtinen (MZT); 1♀, Taputapu, 14 May 1988, litter of coconut and other garden trees, P. T. Lehtinen (MZT). *Tahiti*: 1♂, 1 deutonymph, Papeari, 6 May 1988, moist slope with ferns (*Blechnum orientale* and *Gleichenia linearis*), P. T. Lehtinen (MZT); 1♂ 1♀ (with brood-sac), 1 deutonymph, Papenoo, Arahoho, 31 August 1990, rock wall with *Blechnum* and litter, P. T. Lehtinen (MZT); 1♂, Papenoo, Faaripo, 1 September 1990, wet rock slope in seashore, P. T. Lehtinen (MZT); 5♂ 1♀, Papenoo, 10 m, 2 April 1988, roadside bush with anthropochorous vegetation, P. T. Lehtinen (MZT).

SOLOMON ISLANDS: 1 deutonymph, at quarantine in Hawaii, alive on orchid leaf, 21 June 1944, D. F. Chong (CAS, JC-2195.01001).

THAILAND: *Kanchanaburi*: 1♂ 1♀, Erawan Waterfalls National Park, 11–16 April 1986, Deeleman (MHNG); 2♂ 1♀, Sarika, Nakhon Nagok, 110 km NE Bangkok, sea level, 27 April 1982, bamboo litter, P. R. Deeleman (MHNG); *Trat*: 2♀, Ko Chang [as Koh Chang], [January], under stone, T. Mortensen (ZMUC); 1♀, same data (BMNH 1907.5.18.52); 1♂ 2♀, Ko Si Chang, in förna, 29 January 1989, M. Andersen, A. R. Rasmussen (ZMUC).

TONGA: *Eua*: 14♂ 12♀, 4 tritonymphs, 6 deutonymphs, 13 protonymphs, Lakufa'anga, 24 July 1992, litter of virgin forest, P. T. Lehtinen (MZT); *Telekitonga*: 1♀, 20 June 1980, forest litter, G. M. Dlussky (MHNG); *Tongatapu*: 2♂ 1♀, 1 deutonymph, Houma, 27 July 1992, litter of coastal *Pandanus*, P. T. Lehtinen (MZT); 2♀ (with eggs), same data except between leafs of *Pandanus* (MZT); 2♂ 1♀, same data except litter of coastal *Pandanus* (MZT); 2 protonymphs, same data except 26 July 1992, succulents on coral rock (MZT); 1♀ (with brood-sac), Nuku'alofa harbour, 26 July 1992, wet grass, P. T. Lehtinen (MZT); *Vavua*: 2♂ 3♀, 1 deutonymph, Holonga 'Utula'aina, 21 July 1992, litter of *Metrosideros* etc., P. T. Lehtinen (MZT); 1♀, same data except forest soil (MZT); 1♂ 1♀, same data except dark moist forest (MZT); 1♂ 1♀, same data except dark moist forest (MZT); 2♂, 2 protonymphs, same data except dry natural forest (MZT); 3 protonymphs, same data except within a decaying tree (MZT); 11♂ 11♀ (1 with brood-sac), 1 deutonymph, Keitahi beach, 21 July 1992, litter of beach vegetation, P. T. Lehtinen (MZT); 5♂ 9♀, 2 deutonymphs, 8 protonymphs, Lake Ano, 22 July 1992, litter of secondary forest, P. T. Lehtinen (MZT); 1♀, same data except lakeshore grass and mangrove (MZT); 4♂ 2♀, 1 deutonymph, Lake Ano, 22 July 1992, bamboo litter, P. T. Lehtinen (MZT); 2♂, 1 tritonymph, 2 deutonymphs, 2 protonymphs, Neiafu-Toiua, 20 July 1992, litter of secondary forest, P. T. Lehtinen (MZT); 1♀, same data except within decaying tree (MZT); 2♂ 5♀, 2 tritonymphs, 1 deutonymph, Tuanuku, 22 July 1992, litter of agave and mangrove vegetation, P. T. Lehtinen (MZT).

TUAMOTU ISLANDS: 1♀, Rangiroa, Avatoru, 22 September 1990, lagoon meadow and bush litter, P. T. Lehtinen (MZT).

TUVALU: 3♀, Funafuti [now Fongafale], [W. J.] Sollas (BMNH 1898.4.4.31-32).

Diagnosis: Carapace brown in anterior half, creamy-white in posterior half (Figs. 1, 6). Pedipalpal segments all brown. Medium-sized species, e.g. pedipalpal femur length 0.465–0.66 (♂), 0.62–0.81 (♀), chela length (with pedicel) 0.82–1.04 (♂), 0.99–1.24 (♀), movable finger 0.47–0.61 (♂), 0.58–0.70 (♀) mm.

Description: *Adults* (supplementary to Harvey (1988)): Colour (Figs. 1, 6): all pedipalpal segments dark brown; carapace brown in anterior half, creamy-white in posterior half, with small brown patches at postero-lateral corners; abdominal tergites with brown lateral margins, tergites I and II with median spots, tergite III without median spot, tergites IV–IX with paired spots. Pedipalps: femur 3.32–4.35 (♂), 3.42–4.67 (♀) times longer than broad, chela (with pedicel) 3.50–4.17 (♂), 3.61–4.23 (♀) times longer than broad; trichobothria (Fig. 2): fixed finger: *ist* and *it* adjacent; movable finger: *b* and *sb* closely spaced, *st* slightly closer to *sb* than to *t*; fixed finger with 3 basal pit-like structures situated near *eb*, *esb* and *est*, movable finger with 1 pit-like structure situated between *st* and *t*; fixed finger with numerous teeth, mostly separated from each other, including *c*. 10–12 accessory teeth; movable finger with numerous teeth, mostly contiguous, lacking accessory teeth. Chelicera with 5 setae on hand, 1 seta on movable finger; galea simple, without rami (♂, ♀); flagellum composed of a single blade. Legs: femora of legs I and II longer than patellae; metatarsi and tarsi not fused; arolium longer than claws.

Dimensions (mm), ♂ (♀): Pedipalps: femur 0.465–0.655/0.123–0.170 (0.620–0.810/0.145–0.200), chela (with pedicel) 0.825–1.030/0.210–0.262 (0.990–1.240/0.245–0.320), movable finger length 0.470–0.610 (0.580–0.700).

Tritonymph: Pedipalps: femur 3.95, patella 2.74, chela (with pedicel) 4.21, hand 1.76 times longer than broad. Chelal teeth on fixed finger generally separated. Trichobothria (Fig. 3): *eb*, *esb*, *est*, *et*, *ib*, *ist*, *it*, *b*, *st* and *t* present; fixed finger with 4 pit-like structures, movable finger with 1 pit-like structure. Chelicera: hand with 5 setae, movable finger with 1 seta; galea long, with 5 distal rami. Legs: metatarsi and tarsi not fused.

Dimensions (mm): Body length 1.18. Pedipalps: femur 0.425/0.11, patella 0.315/0.115, chela (with pedicel) 0.695/0.165, hand length 0.29, movable finger length 0.405. Carapace 0.43/0.50.

Deutonymph: Pedipalps: femur 3.69, patella 2.75, chela (with pedicel) 4.00, hand 1.75 times longer than broad. Chelal teeth on fixed finger generally separated. Trichobothria (Fig. 4): *eb*, *est*, *et*, *ib*, *ist*, *it*, *b*, and *t* present; fixed and movable fingers each with 1 pit-like structure. Chelicera: hand with 5 setae, movable finger with 1 seta; galea long, with 4 distal rami. Legs: metatarsi and tarsi not fused.

Dimensions (mm): Body length 1.10. Pedipalps: femur 0.376/0.102, patella 0.275/0.100, chela (with pedicel) 0.640/0.160, hand length 0.281, movable finger length 0.345. Carapace 0.315/0.336.

Protonymph: Pedipalps: femur 2.91, patella 2.22, chela (with pedicel) 3.98, hand 1.69 times longer than broad. Chelal teeth generally closely spaced. Trichobothria (Fig. 5): *eb*, *et*, *ist* and *t* present; fingers without pit-like structures. Chelicera: hand with 4 setae, movable finger without seta; galea long, with 3 distal rami. Legs: metatarsi and tarsi not fused.

Dimensions (mm): Body length 0.90. Pedipalps: femur 0.262/0.090, patella 0.200/0.090, chela (with pedicel) 0.506/0.127, hand length 0.214, movable finger length 0.289. Carapace 0.315.0.336.

Remarks: The specimens here listed under the name *G. longidigitatus* have been reported under a variety of names since the species was first described by Rainbow

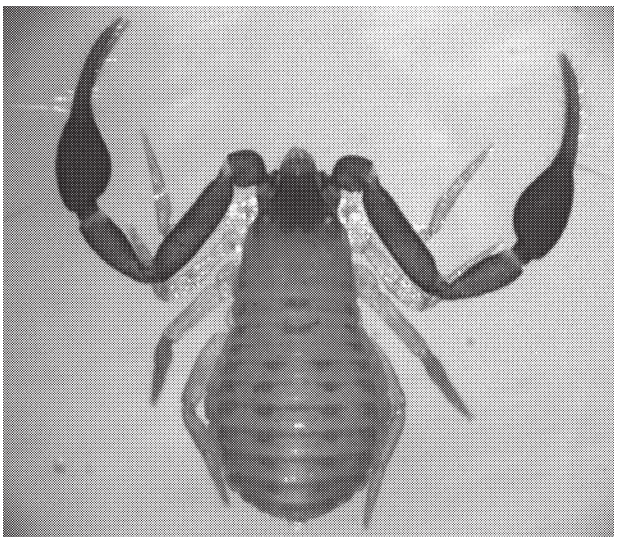
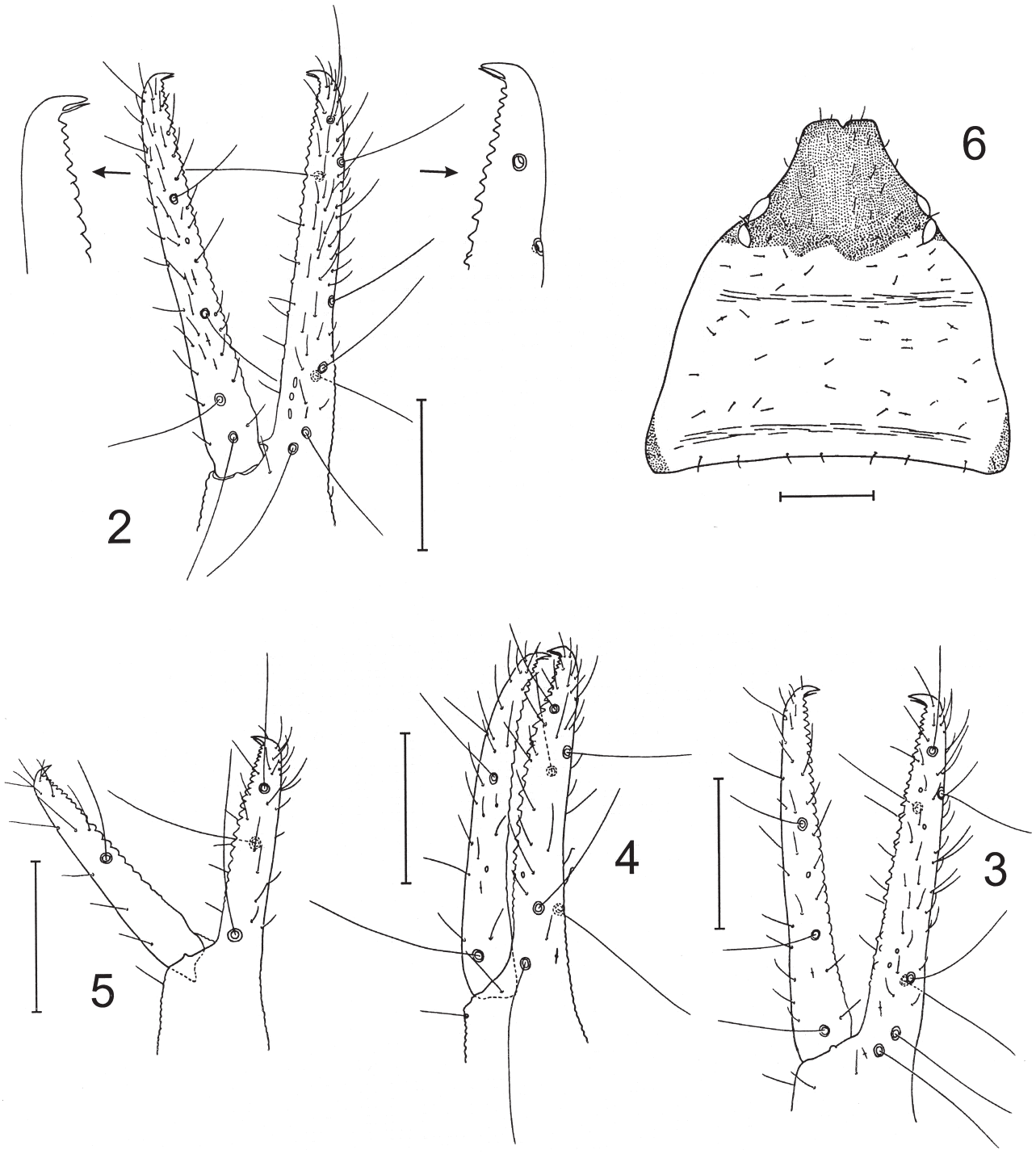


Fig. 1: *Geogarypus longidigitatus* (Rainbow), male from Tonga.

(1897). However, detailed examination of the numerous specimens at hand indicates that only one species is involved, the other names being synonyms. Authors have generally based their taxonomic decisions on minor differences in morphometric features, particularly in the size and relative thickness of the pedipalpal segments. Beier (1932) summarised the data pertaining to those species described up until that date, and his key to species of *Geogarypus* grouped all of the then known species synonymised here into one part of the key. Species added later — *G. (G.) marquesianus* Chamberlin, 1939, *G. audyi* Beier, 1952, *G. (G.) micronesiensis* Morikawa, 1952, and *G. (G.) javanus takensis* Beier, 1967 — were usually compared by their authors with *G. javanus* or one of the other synonyms.

Beier (1957) was the first to recognise the problem of assigning specimens to these previously described species, and he relegated many of them to subspecies status under *G. javanus*. Morikawa (1963) extended the number of subspecies within *G. javanus* by placing *G. micronesiensis*, a species he had previously described from Marcus Island (Morikawa, 1952), and *G. longidigitatus* as subspecies of *G. javanus*. Somewhat inexplicably, he retained *G. javanus* as the valid specific name, even though *G. longidigitatus* has precedence over *G. javanus*. Harvey (1988) synonymised *G. formosanus*,



Figs. 2–6: *Geogarypus longidigitatus* (Rainbow), from 'Arorangi, Rarotonga, Cook Islands. **2–5** Left chelal fingers, lateral view: **2** Adult male; **3** Tritonymph; **4** Deutonymph; **5** Protonymph. **6** Carapace, male. Scale lines = 0.2 mm.

G. audyi and *G. javanus takensis*, as there appeared to be insufficient differences between them to maintain a workable subspecies classification. However, Harvey (1988) did not mention *G. longidigitatus* or *G. irrugatus* (Simon), and Schawaller (1994, 1995) raised the possibility that *G. javanus* may be synonymous with *G. irrugatus*. Schawaller (1985) also noted that the specimens identified as *G. irrugatus* by Mahnert (1977) were referable to *G. continentalis* (Redikorzev), a correction that was overlooked by Harvey (1991). Other specimens have been erroneously identified as *G. irrugatus* (Chamberlin, 1930; With, 1906), but I have examined all of the specimens in question, and found that they conform to *G. longidigitatus* as here defined. I have also examined the syntypes of *G. irrugatus* lodged in MNHN, and found that they are quite dissimilar to *G. longidigitatus* (Harvey, in preparation).

During the course of this study, I have examined type specimens of all of the species listed above, except for those of *Chelifer longidigitatus* and *Geogarypus (G.) micronesiensis*. The two syntypes of *C. longidigitatus* are not present in the Australian Museum, Sydney and are presumed to be lost (G. Milledge, in litt.). These two specimens were collected by Mr Hedley as part of the Royal Society and British Association expedition to Funafuti, and further specimens of the same species were obtained during the same expedition on Funafuti by Prof. W. J. Sollas and examined by Pocock (1898), who transferred the species to the genus *Garypus*. These topotypical specimens, lodged in the BMNH, do not differ in any substantial way from the other specimens here attributed to *G. longidigitatus*.

The holotype of *Geogarypus (G.) micronesiensis* is probably deposited in Prof. Morikawa's collection at Ehime University, but it has not been available for study. Morikawa (1952) separated this species from other Asian species by differences in the proportions of the pedipalpal femur, the number of accessory teeth on the fixed chelal finger and in the overall size. He later (Morikawa, 1963) suggested that it was a subspecies of *G. javanus*. There is nothing in the original description to suggest that the population on Marcus Island is taxonomically distinct from *G. longidigitatus*, and I hereby synonymise the species. Beier (1957) separated *G. micronesiensis* from similar species of the genus based upon the presence of a uniformly pale carapace with only a small dark median spot between the eyes. I have found that the colour pattern of some pale *Geogarypus* species can be misconstrued in slide-mounted material if the dorsal portion of the body is not separated from the ventral portion, as the colour of the underlying cuticle can be misinterpreted. Chamberlin (1939) stated that the carapace of *G. marquesianus* was "unicolorous throughout", but close examination of two paratypes shows that the typical bicolorous pattern found in *G. longidigitatus* is also present in these specimens, but is partly obscured by the colour showing through from the coxae. Similarly, the colour pattern of *G. micronesiensis* may have been misinterpreted by Morikawa (1952).

Detailed examination of all of the type specimens available to me, along with the abundant new material,

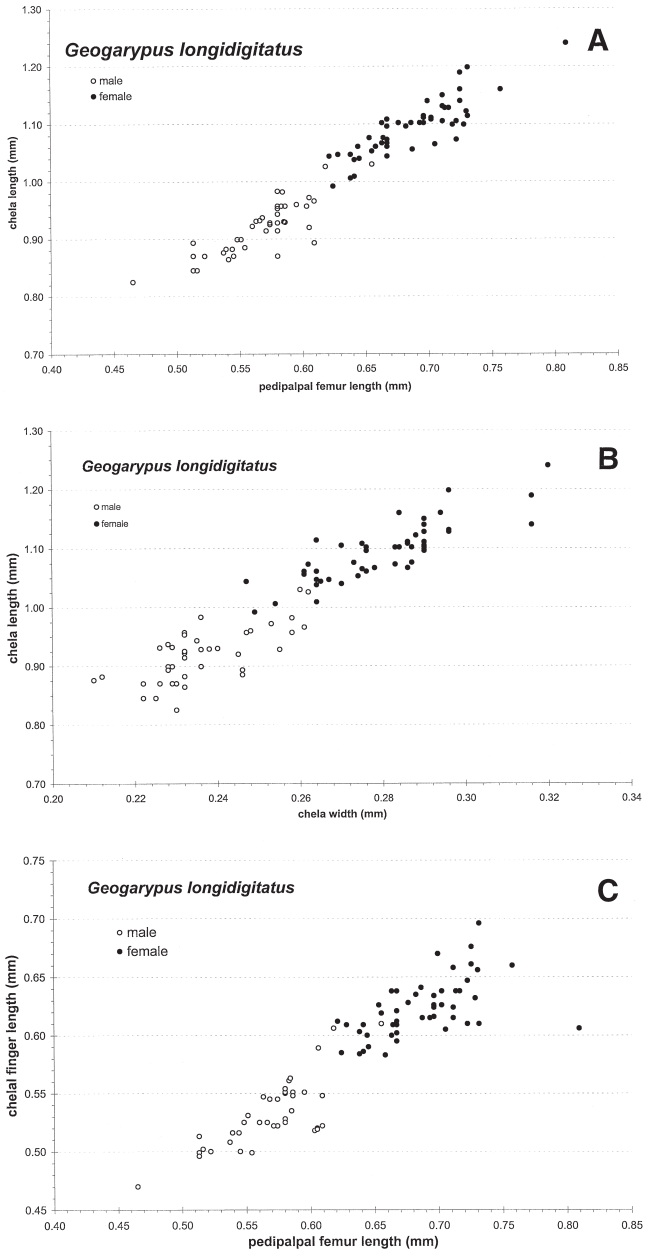


Fig. 7: Graphs depicting pedipalpal size variation in *Geogarypus longidigitatus*: **A** Chela (with pedicel) length versus femur length; **B** Chela (with pedicel) length versus width; **C** Chelal finger length versus femur length.

clearly indicates that there is little to distinguish between them, and that they all represent a single species to which I here apply the oldest name, *G. longidigitatus*. Beier (1957) utilised several different morphological and morphometric features to separate the various species and subspecies which possessed a "partially whitish" carapace. Many of the features he used in his key have been found in the present study to be too variable to be relied upon as valid taxonomic discriminators. For example, he relied heavily upon the number of marginal and accessory teeth on the chelal fingers, which I have found to vary enough to cast doubt upon the utility of this feature. Other structures, such as the presence or absence of a flat laterodistal tubercle on the pedipalpal trochanter, and the nature of the pedicle of

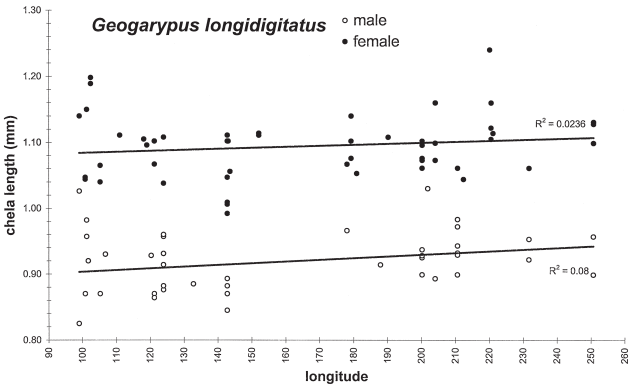


Fig. 8: *Geogarypus longidigitatus* (Rainbow). Chela (with pedicel) length versus longitude (degrees east) with separate linear regression lines added for males and females.

the pedipalpal femur, are also unreliable and are here disregarded.

Despite the wide geographical range of *G. longidigitatus* (Fig. 9), it is impossible to distinguish populations from each other morphologically. Considerable size variation was found within individual populations, and no distinct evidence of clinal variation was apparent when the size of specimens was plotted against longitude (Fig. 8), even though there is a slight tendency for the populations to increase in size further east. However, the linear regression lines fitted to the data are not significant ($p>0.05$) for either the male or the female populations. The data were also analysed for latitudinal gradients, but once again no significant differences were detected.

Several specimens possess pedipalpal dimensions outside of the normal range of variation for this species (Fig. 7). The holotype male of *G. (G.) javanus takensis* from Thailand (chela length 0.825 mm) is slightly smaller than all other males, although a male from northern Queensland was only slightly larger. One of the female paratypes of *G. marquesianus* from the Marquesas Islands is larger than other females [the dimensions of this specimen, which is lodged in BPBM, have not been checked personally and were taken from Chamberlin (1939)]. In each case, I can only assume that these are aberrant specimens, since they are referable to *G. longidigitatus* in all other respects.

Some specimens have been misidentified as *G. javanus* in the past, including the specimens from Kunming, Yunnan Province, China identified by Schawaller (1995). These two specimens (1♂ 1♀, MHNG) possess a uniformly brown carapace and are much larger than most of the specimens examined in this study. It is most likely that they represent *G. continentalis* (Redikorzev), as they are within the size range of that species and possess the anterior projection on the pedipalpal femur (see Dashdamirov, 1993), but a detailed review of the Asian Geogarypidae is needed to confirm their identity. Specimens from Kaeng Krachan National Park and Doi Sutep, Thailand reported by Schawaller (1995) possess a carapace with lateral brown markings and the larger of the two males from the former locality also possesses a median brown spot. These specimens are excluded from *G. longidigitatus*, but without a full review of the Asian species of *Geogarypus*, it is impossible to determine whether or not they represent a new species.

Affinities: Without a more detailed revision of the Asian species of Geogarypidae, it is difficult to ascertain the relationships of *G. longidigitatus*. However, as noted by Mahnert (1978), it bears a striking resemblance to *G. ocellatus* Mahnert from the Seychelles Islands, as both exhibit the same, distinctive pattern of coloration of the carapace. The pedipalpal chela of *G. ocellatus* is somewhat thinner than that of *G. longidigitatus*, and the two species are certainly distinct. I have examined a male of *G. ocellatus* collected under bark at La Passe, Silhouette, on 8 January 1999 by J. Gerlach, lodged in WAM (registration no. 99/2163).

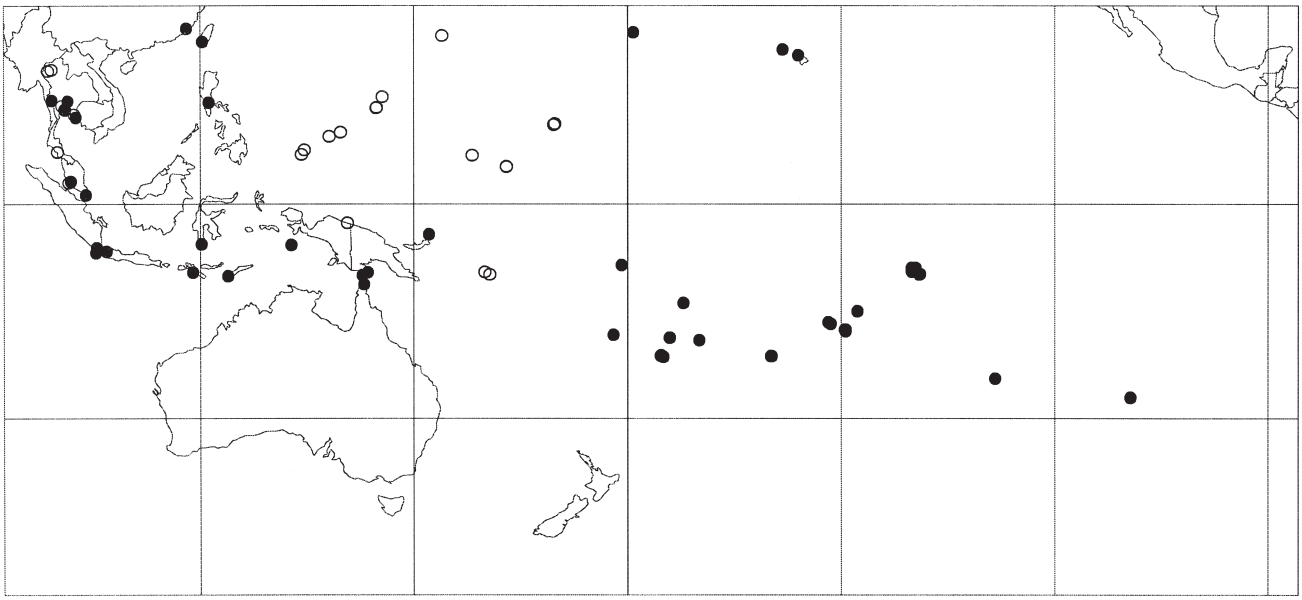


Fig. 9: Known distribution of *Geogarypus longidigitatus* (Rainbow). Open circles represent literature records, closed circles represent specimens examined during this study.

The other geogarypid species found in the Asian-Australian-Pacific region are also distinct from *G. longidigitatus*, since none possesses the characteristic bicoloured carapace. These other species also differ as follows: *Geogarypus albus* Beier from Malaysia and Java possesses a completely white carapace (Beier, 1963; Harvey, 1988); *G. elegans* (With) from Malaysia and *G. nepalensis* Beier from Nepal possess a completely brown carapace (Beier, 1974; With, 1906); *G. irrugatus, G. palauanus* Beier from Palau, *G. sagitattus* Beier, 1965 from Irian Jaya and Papua New Guinea, and *G. pisinnus* Harvey from northern Australia are small species which possess a distinct constriction on the internal margin of the chelal hand (Beier, 1957, 1965; Harvey, 1986); *G. rhantus* Harvey from north-east Queensland possesses a white pedipalpal trochanter (Harvey, 1981, 1986); *G. taylori* Harvey from southern Australia possesses curved teeth on the fixed chelal finger (Harvey, 1986); *G. exochus* Harvey from Australia possesses a differently shaped chelal hand (Harvey, 1986); *G. connatus* Harvey from south-eastern Australia and *G. bucculentus* Beier from Juan Fernandez Islands possess a uniformly brown carapace (Harvey, 1986, 1987). Furthermore, none of the species described from India or Sri Lanka (e.g. Beier, 1973; Chamberlin, 1930; Murthy & Ananthakrishnan, 1977; Sivaraman, 1980) can be attributed to *G. longidigitatus*.

Distribution: *Geogarypus longidigitatus* is now known to have an extremely wide distribution, spanning 150° of longitude from Thailand to Easter Island (Isla de Pascua, which is also known as Rapa Nui) (Fig. 9). Indeed, it has been found within nearly every 10° arc of longitude between these two localities. Its latitudinal range is largely within the tropics, with the most northerly occurrences at China, Marcus Island and Hawaii on the Tropic of Cancer, and the most southerly at Easter Island in the south-east Pacific below the Tropic of Capricorn. Specimens have been collected from a wide variety of habitats, from coastal vegetation to the summits of mountains, as well as in synanthropic situations on many islands.

This species, and its numerous synonyms, has been recorded from many localities (see Benton & Lehtinen, 1995a,b; Harvey, 1991; Schawaller, 1994, 1995) and the new locality records presented here (e.g. Society Islands, Easter Island, Fiji, Tonga, Niue, Tuamotu, Samoa and Australia) considerably extend this distribution. The specimens from Henderson Island (Benton & Lehtinen, 1995a,b) and Isla de Pascua are the only pseudoscorpions to be recorded from these islands (Harvey and Lehtinen, unpublished data) and exemplify the capacity of this small species to colonise far-flung localities. Although the mode of colonisation is not known, it is tempting to suspect that humans may be in part responsible for the widespread distribution of *G. longidigitatus*. Polynesians have long travelled throughout the Pacific with the use of double canoes (Fagan, 1996) stocked with cultivated plants and domestic animals, and it is conceivable that this small pseudoscorpion has been transported in soil or vegetation in these canoes. The settlement of Micronesia and Polynesia took place from Melanesia between 4,000 and 1,000 years ago, and far-flung islands such as Hawaii and Easter Island were settled *c*. AD 400 (Fagan, 1996). Wilson & Taylor (1967) list a number of ''tramp'' ant species considered to have been distributed across the Pacific by human activity, and Austin (1999) suggests that the skink *Lipinia noctua* (Lesson), which is native to New Guinea, has been transported to Polynesia by unwitting human agency over a very short time period during the expansion of human populations during the past 4,000 years. Cooke & Kondo (1960) suggest that several species of terrestrial snails with pan-Pacific distributions have been transported by human agency. Shelley & Lehtinen (1998) record several species of introduced paradoxosomatid millipedes from various Pacific islands, with *Oxidus gracilis* (C. L. Koch) and *Asiomorpha coarctata* (Saussere) the most widespread, the former extending as far as Juan Fernandez Islands.

It is not inconceivable that the wide distribution of *G. longidigitatus* is also the product of human transportation, and joins other widely distributed pseudoscorpions, such as *Chelifer cancroides* (Linnaeus), *Lamprochernes savignyi* (Simon) and *Withius piger* (Simon), in human-aided journeys. This assumption is also supported by the capture at quarantine points in Australia and Hawaii of specimens from imported orchids or palms which originated in Malaysia, Singapore and the Solomon Islands.

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