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Wolf spiders of the Pacific region: the genus *Zoica* (Araneae, Lycosidae)

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Abstract. The wolf spider genus *Zoica* Simon 1898 is currently known only from the Indo-Australasian region, including India in the west to northern Western Australia and Papua New Guinea in the east. Here we extend the known distribution of the genus into the Pacific region by describing two new species, *Z. carolinensis* new species from the Caroline Islands, Federated States of Micronesia, and *Z. pacifica* new species from the Republic of the Marshall Islands.

Keywords: Zoicinae, taxonomy, Marshall Islands, Caroline Islands, Micronesia

Our knowledge of the wolf spider fauna of the Pacific is only fragmentary. The fauna of New Caledonia and Vanuatu (e.g., Berland 1924, 1938) and Hawaii (Karsch 1880; Simon 1899, 1900; Gertsch 1973) have received some attention, although most species were described in the late 1800s to early 1900s. Modern taxonomic descriptions that allow accurate species identifications do not exist and, in most cases, identification of species is impossible without recourse to type material. In addition, generic classification of most Pacific wolf spider species does not follow phylogenetic guidelines but is based on perceived similarities of species with genera originally described from the Northern Hemisphere, mainly Europe, where most arachnologists were then based.

The Pacific islands wolf spider fauna currently includes representatives of three subfamilies (cf. Dondale 1986; Murphy et al. 2006). The Lycosinae Sundevall 1833, which include genera such as *Lycosa* Latreille 1804, *Hogna* Simon 1885, *Adelocosa* Gertsch 1973 and *Venatrix* Roewer 1960, dominate the wolf spider fauna of the Pacific islands both in diversity and local abundance (e.g, Simon 1899, 1900; Framenau 2006, unpublished data); however, many Pacific lycosines are clearly misplaced at the genus level. The Artoriinae Framenau 2007 are represented by *Artoria* Thorell 1877, *Lycosella* Thorell 1890, and *Syroloma* Simon 1900 and are currently reported from New Caledonia, Vanuatu, Hawaii, Samoa, and French Polynesia (e.g., Simon 1900; Berland 1929, 1934; Framenau 2007). Two species of *Venonia* Thorell 1894 in the subfamily Venoniinae Lehtinen & Hippa 1979 have been reported from Palau (Yoo & Framenau 2006). It appears that the lycosid fauna of the Pacific has strong affinities with Australia and Southeast Asia as, for example, Venoniinae and Artoriinae do not occur in the Americas to the east.

The wolf spider subfamily Zoicinae Lehtinen & Hippa 1979 has so far not been reported from the Pacific. Dondale (1986) synonymized this subfamily with the Venoniinae; however, this synonymy was rejected & the subfamily revalidated in a recent revision of *Venonia* (Yoo & Framenau 2006). Zoicinae include five genera from the Indo-Australasian region: *Zoica* Simon 1898, *Lysania* Thorell 1890, *Zantheres* Thorell 1887, *Margonia* Hippa & Lehtinen 1983, and *Shapna* Hippa & Lehtinen 1983 (Hippa & Lehtinen 1983; Yoo & Framenau 2006). Lehtinen & Hippa (1979; p. 2, table 1) proposed a number of diagnostic characters for the Zoicinae, two of which, regarding the male pedipalp, clearly represent synapomorphies for the subfamily: the lack of a median (= tegular) apophysis and the distal origin of the embolus.

With a body length of generally not more than 2.5 mm, members of the genus *Zoica* are amongst the smallest of all wolf spiders. The genus, with *Z. parvula* (Thorell 1895) as type species, was established by Simon (1898) replacing *Zobia* Thorell 1895, preoccupied by *Zobia* Saalmueller 1891, a butterfly genus. *Zoica* was revised by Lehtinen & Hippa (1979) who reported six species from India and Sri Lanka in the West, throughout Southeast Asia (Myanmar, Malaysia, Thailand, Indonesia) including Papua New Guinea to the east. More recently, a single species of *Zoica* was described from Bhutan (Buchar 1997). The genus also occurs in northern Western Australia and the tropical parts of the Northern Territory and Queensland (Australia) (McKay 1979; Platnick 2008; VWF unpublished data).

This study reports the subfamily Zoicinae for the first time from the Pacific region by describing two new species of *Zoica* from the Federated States of Micronesia and the Republic of the Marshall Islands (see Fig. 13).

METHODS

A large collection of spiders (“BB” collection, presently housed at Southern Illinois University, Carbondale, Illinois, USA) was made by J.W. Berry, E.R. Berry, and J.A. Beatty in a series of collecting trips into the Pacific region: Marshall Islands (1968, three months; 1969, 3 mo); Palau (1973, 6 mo); Guam, Yap, Truk (= Chuuk), Ponape (= Pohnpei), Taiwan (1973, 1–2 wk each); Yap (1980, 6 mo); Marquesas Islands, Tuamotu, Society, Cook and Fiji Islands (1987 & 2004, 6 mo in total); Cook Islands (2002, 6 wk); and the Hawaiian islands (1995, 1997 & 1998, 3 mo in total). The collections reported herein are from the 1973 trip to the Caroline Islands, and 1968, 1969, and 1980 visits to the Marshall Islands. Spiders were generally hand collected.

Descriptions are based on specimens preserved in 70% ethanol. Female epigyna were prepared for examination by submersion in 10% KOH for 10 min. For clarity, the

illustrations of male pedipalps and female epigyna omit setae. The morphological nomenclature follows Lehtinen & Hippa (1979), Hippa & Lehtinen (1983) and Yoo & Framenau (2006). Lehtinen & Hippa (1979) introduced the term ''truncus'' in the Lycosidae for a sclerite of the male pedipalp that originates basally between the subtegulum and the tegulum in replacement of Kronestedt's (1975) ''terminal part'' [erroneously termed ''terminal apophysis'' in Lehtinen & Hippa (1979; p. 3)]. Consequently, they also called the distinct lateral apophysis originating at the truncus, ''lateral truncal apophysis'' but replaced this term later (Hippa & Lehtinen 1983) with ''lateral apophysis'' as this structure is referred to here (see Figs. 5, 9). The term ''truncus'' for the apical section of the male bulb has not been used in the lycosid morphology since Lehtinen & Hippa's (1979) and Hippa & Lehtinen's (1983) initial studies and was referred to as ''embolic division'' in Yoo & Framenau (2006). All measurements are given in millimeters (mm).

Images were taken with a Leica DFC500 digital camera that was attached to a Leica MZ16A stereomicroscope. Photographs were taken in different focal planes (ca. 10–15 images) and combined with the Leica Application Suite version 2.5.0R1.

Abbreviations.—*Collections*: BB, Berry-Beatty collection, presently at Southern Illinois University; BPBM, Bernice P. Bishop Museum, Honolulu (Hawai'i); WAM, Western Australian Museum (Perth). *Morphology*: AE (AME, ALE), anterior (median, lateral) eyes; AL (AW), abdomen length (width); CL (CW), carapace length (width); PE (PME, PLE), posterior (median, lateral) eyes; TL, total length.

SYSTEMATICS

Family Lycosidae Sundevall 1833
Subfamily Zoicinae Lehtinen & Hippa 1979
Zoica Simon 1898

Zobia Thorell 1895:53–54 (preoccupied by the butterfly genus *Zobia* Saalmüller 1891).

Zoica Simon 1898:248 (replacement name for *Zobia* Thorell 1895).

Type species.—*Zobia parvula* Thorell 1895, by original designation (Thorell 1895).

Diagnosis.—Within the Zoicinae, *Zoica* is most closely related to *Lysania*, based on the overall structure of the male pedipalp and absence of glistening setae on the abdomen (present in all other genera of the subfamily) (Hippa & Lehtinen 1983). However, *Zoica* is generally smaller, (TL 1.5–2.3) than *Lysania* (TL 2.2–3.0), although sizes may overlap. The cephalic area of *Zoica* is gently sloping laterally, whereas it is steep in *Lysania* (and in all other genera of the Zoicinae). *Lysania* show distinct color patterns of white anterolateral abdominal bands and light annulations of the legs, whereas members of *Zoica* are uniformly yellow-brown to brown. In addition, *Lysania* build horizontal, sheet-like webs, whereas *Zoica* are vagrant (Lehtinen & Hippa 1979).

Description.—Minute to small spiders (TL 1.5–2.3); uniformly yellow-brown to dark grey; cephalic area gradually sloping laterally; row of AE recurved to slightly procurved; PME never more than half their diameter apart; leg formula IV > I > II > III; male pedipalp without articulated tegular apophysis; lateral apophysis present; embolus a thin, curved spine and mostly covered by tegulum in ventral view; epigynum variable, often protruding scape-like posteriorly.

The gently sloping margins of the cephalic area, small size and the lack of a distinct color pattern are here considered synapomorphies for *Zoica*. Lehtinen & Hippa (1979) reported a dorsal abdominal scutum in males, which we cannot confirm for the species described here or for any of the three species known from Australia (McKay 1979; VWF unpublished data).

Zoica carolinensis new species
(Figs. 1, 2, 5–8, 13)

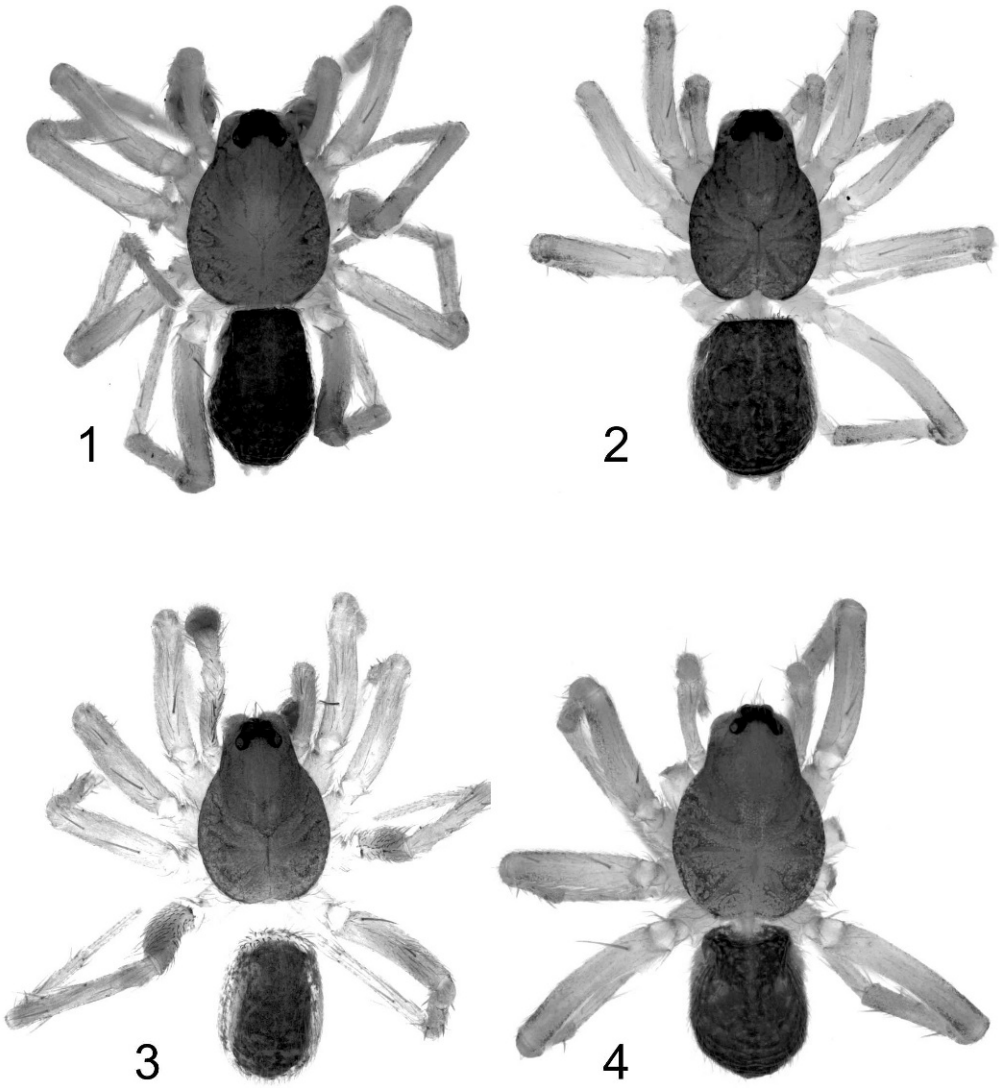
Types.—Holotype male, Federated States of Micronesia, Caroline Islands, Ponape (= Pohnpei), E of Kolonia, 6°57′50″S, 158°12′30″E, 7 June 1973 J.A. Beatty, J.W. Berry (BPBM); paratype female, data as holotype (BPBM).

Other material examined.—FEDERATED STATES OF MICRONESIA: Caroline Islands: 1 female, Pohnpei, E of Kolonia, 6°57′N, 158°15′E, 7 June 1973; 2 males, 9 females, 2 females with eggsac, 5 juveniles, Pohnpei, Sokehs Island, 6°57′N, 158°11′E, 8 June 1973, J.A. Beatty, J.W. Berry (BB); 1 male, 3 females, same data (WAM T80644).

Diagnosis.—*Zoica carolinensis* is similar to *Z. wauensis* Lehtinen & Hippa 1979 from Papua New Guinea as illustrated in Lehtinen & Hippa (1979), in particular in regard to the structure of the male pedipalp. However, the basal part of the embolus is more exposed in *Z. wauensis* and the median tegular lobe is narrower and longer than that in *Z. carolinensis*. Both species differ considerably in the shape of the female epigynum, which is highly prominent in *Z. wauensis* (see Lethinen & Hippa 1979), but is flat in *Z. carolinensis*. Unfortunately, we were not able to compare specimens of both species as material of *Z. wauensis*, including the type material, could not be located in the Zoological Museum, University of Turku, Finland, where it is supposed to be housed (S. Kopponen, personal communication to VWF). *Zoica carolinensis* differs from *Z. pacifica*, the second species described here, by the presence of a median tegular lobe in the male pedipalp (absent in *Z. pacifica*) and the lack of a posterior lip of the epigynum (present in *Z. pacifica*).

Description.—*Male (based on holotype):* Carapace: dorsal profile straight in lateral view; uniformly yellow-brown with gray pigmentation, centrally somewhat lighter, black around eyes (Fig. 1). Eyes: row of AE as wide as row of PME; row of AE very slightly procurved. Sternum: yellow, with some gray pigmentation marginally; brown macrosetae mainly marginally. Labium: yellow-brown. Chelicerae: yellow-brown with indistinct gray pigmentation, basally slightly darker; few whitish setae. Pedipalp (Figs. 5, 6): lateral apophysis tapering and bent dorsally at tip; embolus covered by terminal apophysis both of which are behind median tegular lobe (Fig. 5). Abdomen: yellow-brown with dense olive-gray pigmentation (Fig. 1); venter yellow. Legs: leg formula IV > I > II > III; uniformly yellow; spination of leg I: femur: 2 dorsal (only 1 on right leg), 1 apicoprolateral; tibia: 2 ventral pairs; metatarsus: 3 ventral pairs.

Female (based on paratype): In all details like male (Fig. 2), except row of AE straight. Epigynum (Figs. 7, 8): ventral view:



Figures 1–4.—*Zoica* spp. 1. *Z. carolinensis*, holotype male from Ponape, E of Kolonia (Caroline Islands, Micronesia) (BPBM); 2. *Z. carolinensis*, paratype female from Ponape, E of Kolonia (Caroline Islands, Federated States of Micronesia) (BPBM); 3. *Z. pacifica*, holotype male from Majuro Islet (Majuro Atoll, Marshall Islands) (BPBM); 4. *Z. pacifica*, female from Majuro Islet (Majuro Atoll, Marshall Islands) (BPBM). TL: (1) 1.63 mm; (2) 1.77 mm; (3) 1.92 mm; (4) 1.84 mm.

weakly sclerotized with narrow posterior openings (Fig. 7); dorsal view: fertilization ducts form slightly bent tubes (Fig. 8).

Measurements: Male holotype (female paratype): TL 1.63 (1.77), CL 0.90 (0.92), CW 0.65 (0.65). Eyes: AME 0.02 (0.03), ALE 0.03 (0.04), PME 0.06 (0.08), PLE 0.06 (0.06). Row of eyes: AE 0.15 (0.17), PME 0.14 (0.17), PLE 0.24 (0.26). Sternum (length/width) 0.54/0.42 (0.46/0.44). Labium (length/width) 0.10/0.12 (0.15/0.10). AL 0.79 (0.81), AW 0.73 (0.63). Legs: lengths of segments (femur, patella/tibia, metatarsus, tarsus = total length): Pedipalp 0.38, 0.31, - , 0.36 = 1.06; leg I 0.63, 0.77, 0.48, 0.36 = 2.25; leg II 0.60, 0.67, 0.44, 0.35 = 2.05; leg III 0.56, 0.60, 0.48, 0.33 = 1.96; leg IV 0.77, 0.90, 0.73, 0.40 = 2.80 (Pedipalp 0.31, 0.38, - , 0.32 = 1.01; leg I 0.69, 0.83, 0.48, 0.36 = 2.36; leg II 0.65, 0.69, 0.44, 0.35 = 2.13; leg III 0.60, 0.63, 0.46, 0.33 = 2.02; leg IV 0.79, 1.02, 0.69, 0.38 = 2.88).

Variation: ♂ (♀) (range, mean ± SD): TL 1.61–1.82, 1.73 ± 0.11; CL 0.88–0.96, 0.92 ± 0.04; CW 0.63–0.69, 0.67 ± 0.03; n = 3 (TL 1.73–2.28, 2.00 ± 0.17; CL 0.90–1.15, 1.00 ± 0.07; CW 0.65–0.84, 0.75 ± 0.05; n = 12).

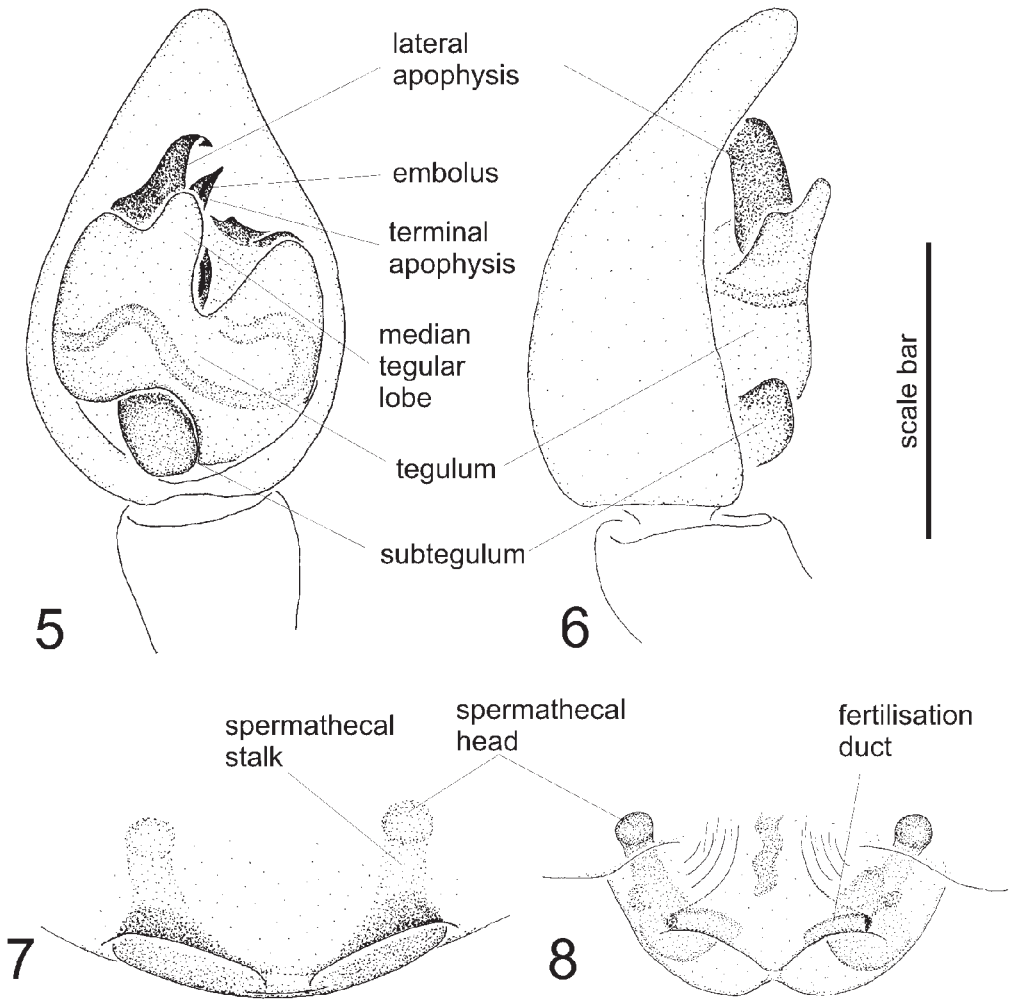
Etymology.—The specific epithet is an adjective derived from the Caroline Islands, where the species is found.

Distribution.—Known only from Ponape (= Pohnpei) in the Caroline Islands, Federated States of Micronesia (Fig. 13).

Zoica pacifica new species
(Figs. 3, 4, 9–13)

Types.—Holotype male, Republic of the Marshall Islands, Majuro Atoll, Majuro Islet, 7°05′N, 171°08′E, 2 August 1969, J.W. Berry, breadfruit/coconut litter (BPBM); paratype female, same data as holotype (BPBM).

Other material examined.—REPUBLIC OF THE MARSHALL ISLANDS: Majuro Atoll: 1 male, 3 females, 5



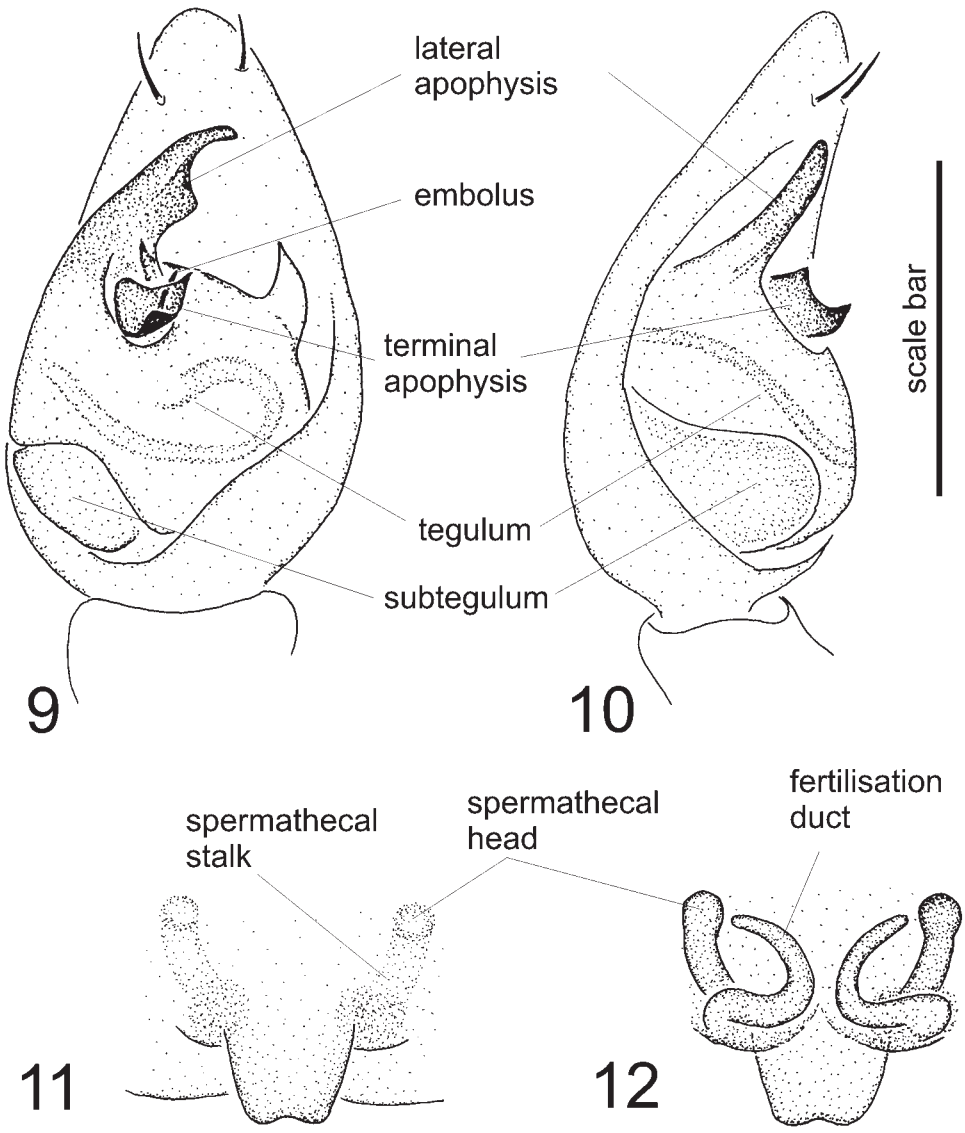
Figures 5–8.—*Zoica carolinensis* new species. Male holotype and female paratype from Ponape, E of Kolonia (Caroline Islands, Federated States of Micronesia) (BPBM). 5. Left pedipalp, ventral; 6. Left pedipalp, retrolateral; 7. Epigynum, ventral view; 8. Epigynum, dorsal view. Scale bars: (5, 6) 0.26 mm; (7, 8) 0.17 mm.

juveniles, 7°07′N, 171°21′E, 30 July 1969, J.W. Berry, grassy meadow (BB); 1 male, 2 females, 4 juveniles, Arniel Islet, 7°06′N, 171°22′E, 1 August 1969, J.W. Berry, grassy area in coconut forest, litter (BB); 1 male, 2 females, 5 juveniles, Dalap Islet, 7°06′N, 171°22′E, 1 August 1969, J.W. Berry, coconut/pandanus litter (BB); 1 male, 2 females, 5 juveniles, Long Island, 6 mi from Laura, 7°05′N, 171°08′E, 24 March 1980, J.A. Beatty, under coconut husks (BPBM); 1 female, 1 juvenile, Long Island, 6 mi from Laura, 7°05′N, 171°08′E, 24 March 1980, J.A. Beatty, from dead coconut leaves (BPBM); 2 females, 5 juveniles, Majuro Islet, 7°05′N, 171°08′E, 2 August 1969, J.W. Berry, breadfruit/coconut litter (BB); 3 females, Majuro Village, 7°06′N, 171°22′E, 24 July 1968, J.W. Berry, wet tropical forest, litter (BB); 1 female, 2 juveniles, Uotjaa Islet, 7°07′N, 171°21′E, 26 July 1968, J.W. Berry, *Scaevola* litter (BPBM); 2 females, 3 juveniles, Uotjaa Islet, 7°07′N, 171°21′E, 26 July 1968, J.W. Berry, coconut litter (BPBM); 2 females, 1 juvenile, Uotjaa Islet, 7°07′N, 171°21′E, 26 July 1968, J.W. Berry, grass litter (BB); 6 females, 6 juveniles, Uotjaa Islet, 7°07′N, 171°21′E, 25 July 1968, J.W. Berry, under coconut litter (BB).

Diagnosis.—*Zoica pacifica* differs from all other species of *Zoica* by the absence of a median tegular lobe in the male pedipalp and the presence of a long posterior lip of the female epigynum.

Description.—*Male (based on holotype):* Carapace: dorsal profile straight in lateral view; uniformly yellow-brown with gray pigmentation, black around eyes (Fig. 3); light-brown macrosetae around eyes, one large bristle that is bent dorsally centrally below AME, two macrosetae below ALE. Eyes: row of AE as wide as row of PME; row of AE straight. Sternum: long yellow-brown macrosetae mainly marginally. Labium: yellow-brown. Chelicerae: yellow-brown. Pedipalp (Figs. 9, 10): cymbium tip with two ventral macrosetae, lateral apophysis with mesal protrusion (Fig. 9); terminal apophysis with two round lobes and a pointed tip. Abdomen: yellow-brown with dense olive-gray pigmentation (Fig. 3); venter yellow. Legs: leg formula IV > I > II > III; uniformly yellow; spination of leg I: femur: 2 dorsal (only 1 on right leg), 1 apicoprolateral; tibia: 2 ventral pairs; metatarsus: 1 ventral.

Female (based on paratype): In all details like male (Fig. 4), except leg spination: femur: 2 dorsal, 1 apicoprolateral; tibia: 2



Figures 9–12.—*Zoica pacifica* new species. Male holotype and female paratype from Majuro Islet (Majuro Atoll, Marshall Islands) (BPBM). 9, Left pedipalp, ventral; 10, Left pedipalp, retrolateral; 11, Epigynum, ventral view; 12, Epigynum, dorsal view. Scale bars: (9, 10) 0.20 mm; (11, 12) 0.19 mm.

ventral pairs; metatarsus: 3 ventral pairs. Epigynum (Figs. 11, 12): ventral view: weakly sclerotized with long posterior lip (Fig. 11); dorsal view: spermathecal heads slightly wider than spermathecal stalks, fertilization ducts long and curved (Fig. 12).

Measurements: Male holotype (female paratype): TL 1.92 (1.84), CL 0.98 (1.00), CW 0.71 (0.73). Eyes: AME 0.02 (0.03), ALE 0.03 (0.03), PME 0.07 (0.08), PLE 0.06 (0.07). Row of eyes: AE 0.16 (0.17), PME 0.16 (0.17), PLE 0.25 (0.27). Sternum (length/width) 0.46/0.44 (0.54/0.48). Labium (length/width) 0.12/0.16 (0.12/0.16). AL 0.79 (1.02), AW 0.56 (0.65). Legs: lengths of segments (femur, patella/tibia, metatarsus, tarsus = total length): Pedipalp 0.38, 0.34, - , 0.36 = 1.09; leg I 0.71, 0.81, 0.54, 0.40 = 2.46; leg II 0.69, 0.75, 0.50, 0.35 = 2.28; leg III 0.63, 0.69, 0.52, 0.33 = 2.17; leg IV 0.83, 1.00, 0.75, 0.42 = 3.00 (Pedipalp 0.29, 0.34, - , 0.31 = 0.94; leg I 0.71, 0.81, 0.50, 0.38 = 2.40; leg II 0.65, 0.75, 0.46, 0.36 = 2.23; leg III 0.63, 0.69, 0.48, 0.35 = 2.15; leg IV 0.81, 1.06, 0.73, 0.44 = 3.03).

Variation: ♂ (♀) (range, mean ± SD): TL 1.65–1.92, 1.76 ± 0.11; CL 0.90–0.98, 0.94 ± 0.04; CW 0.65–0.71, 0.68 ± 0.03; n = 4 (TL 1.77–2.30, 2.03 ± 0.18; CL 0.92–1.11, 1.02 ± 0.05; CW 0.69–0.81, 0.75 ± 0.03; n = 12).

Etymology.—The specific epithet is an adjective derived from *pacificus* (Latin – peaceful) and refers to the Pacific region, where the species is found.

Distribution.—Only known from Majuro Atoll in the Republic of the Marshall Islands (Fig. 13).

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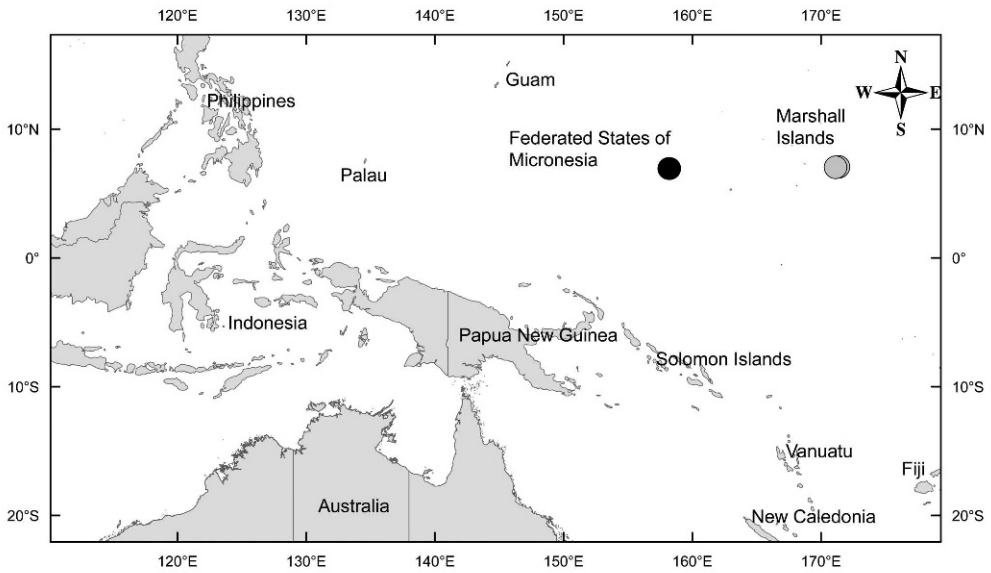

Figure 13.—Records of *Zoica carolinensis* new species (black circle) and *Zoica pacifica* new species (gray circle).

funds for the work in the Marshall Islands. Two travel grants from the Indiana Academy of Science to JWB were of material assistance. Elizabeth Ramsey Berry's contribution to all phases of the fieldwork in the Pacific and at home have been invaluable. The staff at the Bishop Museum, Honolulu, has been of assistance in many ways over a period of decades. This study was compiled while VWF received funds through the Australian Biological Resources Study (ABRS) to Mark Harvey (Western Australian Museum) and Andy Austin (The University of Adelaide) for a revision of the wolf spider fauna of Australia (2002–2005) and to VWF and Nikolaj Scharff (University of Copenhagen) for a revision of the orb-weaving spider fauna (Araneinae) of Australia. The senior author acknowledges, in particular, the support of his mentor Mark Harvey during studies at the Western Australian Museum.

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