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On a Collection of Rocky Intertidal Xanthid Crabs (Crustacea, Decapoda, Xanthidae) from Taiwan, with Description of a New Species of *Cyclodius* Dana 1851

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Over 110 specimens of xanthid crabs collected from rocky intertidal habitats in Taiwan and its offshore islands over the past 25+ years were examined in the present study. As a result, 24 species were recognized, distributed across seven subfamilies and 16 genera including one new genus record (*i.e.*, *Lioxanthodes* Calman, 1909) for Taiwan. Of these recognized species, 14 have been previously reported from Taiwan, whereas five are new records for Taiwan, one new to science, and four unnamed species. The five newly recorded species are *Chlorodiella barbata* (Borradaile, 1900), *Etisus frontalis* (Dana, 1852), *Lioxanthodes* alcocki Calman, 1909, and *Macromedaeus quinquedentatus* (Krauss, 1843), and *Pilodius nigrocrinitus* Stimpson, 1859. The new species, *Cyclodius taiwanensis* sp. nov., is herein described.

Key words: Brachyuran crabs, Actaeinae, Chlorodiellinae, Etisinae, Euxanthinae, Liomerinae, Xanthinae, Zosiminae, Taxonomy

BACKGROUND

Xanthid crabs are among the most diverse taxon groups within the brachyurans (Ng et al. 2008; Lai et al. 2011; Mendoza 2021). Surveys on brachyuran diversity in Taiwanese waters have been conducted over 70 years, resulting in annotated checklists documenting the region's brachyuran crabs. Ng et al. (2001) reported a total of 548 species from Taiwan, representing 36 families, of which 107 species belong to the Xanthidae MacLeay, 1838, distributed across 11 subfamilies and 42 genera. An updated annotated checklist by Ng et al. (2017) increased the number of reported species in Taiwanese waters to 803, spanning 74 families. Of these 803 species, 130 belong to the Xanthidae, distributed across 12 subfamilies and 53 genera. Ng et al. (2017) concluded that more brachyuran species were likely to be discovered in Taiwan's complex reef habitats. This expectation was supported by a recent report by the author, documenting one new record genus and new species, *Garthasia ludaoensis* Hsueh, 2020 (family Xanthidae MacLeay, 1838, subfamily Kraussiinae Ng, 1993), and one newly recorded species, *Zosimus maculatus* (de Man, 1887) (family Xanthidae MacLeay, 1838, subfamily Zosiminae Alcock, 1898), from coral reef habitats in Taiwan (Hsueh 2020).

In this study, the authors examined over 110 specimens of xanthid crabs collected during ecological surveys of rocky intertidal habitats in Taiwan over the past 25+ years. A total of 24 species were identified, 14 of which had been previously reported from Taiwan (Table 1). The remaining 10 species included five newly

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recorded species, one species new to science, and four unnamed species (Table 1). The unnamed species were primarily female juveniles, with one juvenile male *Etisus*. Due to the lack of adult features and unknown degrees of variation and ontogenetic changes, these juveniles could not be identified to the species level. The new species, *Cyclodius taiwanensis* sp. nov., is described herein.

MATERIALS AND METHODS

Specimens of xanthid crabs were collected from rocky intertidal habitats of Taiwan and nearby offshore islands during ecological surveys conducted over the past 25+ years. Sampling was performed using hammers and chisels at the intertidal collection sites (Fig. 1; see Table 2 for coordinates of the collection sites). The collected specimens were stored in 70% ethanol. The specimens were examined under a stereo microscope (Leica MZ12.5) and a compound microscope (Leica DM2500). Photographic images of the specimens and their body parts were captured using digital cameras (Sony α 200, 10.2 megapixels; Canon EOS 6D Mark II, 26.2 megapixels; and Canon EOS 7D Mark II, 20 megapixels) and enhanced using computer software (Helicon Focus 7.0.2 and PhotoImpact 8). Drawings were created by tracing the outlines of examined body parts and appendages from digitized images using CorelDRAW 2020.

The terminology for carapace regions followed Dana (1852b), while the terminology for brachyuran body parts adhered to Davie et al. (2015). Measurements were taken for carapace width and carapace length in millimeter. The abbreviations used include: CW for carapace width; G1 and G2 for the first and second gonopods of males; and P1–P5 for the first to fifth pereiopods (with P1 also referred to as chelipeds and

Table 1. Xanthidae taxa identified in the present study. Information on the first record of a given species from Taiwan is based on Ng et al. (2017)

Taxon	First Record
Actaeinae Alcock, 1898	
Actaeodes tomentosus (H. Milne Edwards, 1834)	Sakai 1939
Chlorodiellinae Ng and Holthuis, 2007	
Chlorodiella barbata (Borradaile, 1900)	present study
Chlorodiella cytherea (Dana, 1852)	Miyake 1938
Chlorodiella nigra (Forskål, 1775)	Horikawa 1940
Cyclodius taiwanensis sp. nov.	present study
Liocarpilodes harmsi (Balss, 1934)	Hsueh et al. 2009
Liocarpilodes sp.	present study
Luniella scabriculus (Dana, 1852)	Hsueh et al. 2009
Pilodius nigrocrinitus Stimpson, 1859	Hsueh et al. 2009
Etisinae Ortmann, 1893	
Etisus frontalis (Dana, 1852)	present study
Etisus sp. A	present study
Etisus sp. B	present study
Euxanthinae Alcock, 1898	
Psaumis cavipes (Dana, 1852)	Sakai 1939
Liomerinae T. Sakai, 1976	
Liomera bella (Dana, 1852)	Suzuki 1985
Liomera rugata (H. Milne Edwards, 1834)	Ho et al. 2000
Xanthinae MacLeay, 1838	
Atergatis floridus (Linnaeus, 1767)	Maki and Tsuchiya 1923
Leptodius sanguineus (H. Milne-Edwards, 1834)	Parisi 1916
Lioxanthodes alcocki Calman, 1909	present study
Macromedaeus crassimanus (A. Milne-Edwards, 1867)	Ho et al. 2000
Macromedaeus quinquedentatus (Krauss, 1843)	present study
Macromedaeus sp. A	present study
Paraxanthias notatus (Dana, 1852)	Lin 1949
Xanthias lamarckii (H. Milne-Edwards, 1834)	Horikawa 1940
Zosiminae Alcock, 1898	
Zozymodes pumilus (Hombron and Jacquinot, 1846)	Hsueh et al. 2009

The name of specimen collector was indicated only when the specimen was not collected by the first author. All specimens were deposited at the National Museum of Natural Science (NMNS), Republic of China.



Fig. 1. Sampling locations (in closed circles) of the present study.

Table 2. Name and coordinate	of col	lection	sites
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Collection site	Coordinates
Jialulan	22°48.17'N 121°11.95'E
Jihuei	23°06.87'N 121°24.21'E
Linshanbi	25°17.12'N 121°30.33'E
Longtou	22°00.24'N 121°35.63'E
Shadao	21°54.71'N 120°50.83'E
Shanfu	20°20.56'N 120°21.57'E
Shihmen	25°17.84'N 121°34.23'E
Shitiping	23°28.96'N 121°30.78'E
Wanlitong	21°59.77'N 120°42.27'E
Youzaihu	21°59.77'N 120°42.27'E

TAXONOMY

Family Xanthidae MacLeay, 1838 Subfamily Actaeinae Alcock, 1898 Genus Actaeodes Dana, 1851

Actaeodes tomentosus (H. Milne Edwards, 1834) (Fig. 2A)

Actaeodes tomentosus Heller 1861a: 9; 1861b: 32; A. Milne Edwards 1865: 262; Richters 1880: 145; Miers 1879: 486; Guinot 1967a: 553, 561; 1969: 237; 1971: 1072; 1976: 244, figs. 38 D, 41 C, pl. 15, fig. 1, 1a; Serène 1968: 79; 1977: 50; Serène 1984: 134, fig. 78, pl. XVIII A (for complete synonymy); Takeda and Hayashi 1973: 72; Serène et al. 1974: 22; Sakai 1976: 447, fig. 239; Peyrot-Clausade 1977a: 26; Ribes 1978: 126; Thomassin 1978: 64; Kensley 1981: 43; Ng et al. 2008: 195 [List]; Ng et al. 2017: 87 (for complete collection records from Taiwan).

Material examined: 4 ♀, NMNS 8772-1–3, 6.9–12.4 × 4.6–8.0, Jihuei, Taitung County, 4–6 May 2005; 2♀, NMNS 8772-4, 7.6–10.7 × 4.8–6.0, Shanfu, Liuqiu Township, Pingtung County, 4 May 2007; 4♀, NMNS 8772-5, 3.2–4.5 × 2.0–2.6, Wanlitong, Pingtung County, 16 December 2007; 3♀, NMNS 8772-6, 7.7–8.2 × 4.9–5.3, Wanlitong, Pingtung County, 13 May 2009; 2♀, NMNS 8772-7, 4.5–10.4 × 2.9–6.6, Jihuei, Taitung County, 17 October 2009; 1♀, NMNS 8772-8, 5.5 × 3.1, Jihuei, Taitung County, 9 October 2010; 2♀, NMNS 8772-9, 3.8–4.2 × 2.6–2.7, Jihuei, Taitung County, 27 September 2014; 3♀, NMNS 8772-10, 3.4–8.0 × 2.3–6.5, Jihuei, Taitung County, 29 April 2017.

Distribution: Indo-West Pacific; Red Sea; Hawaii Islands (Serène 1984).

Remarks: Actaeodes tomentosus (H. Milne Edwards, 1834) (Fig. 2A) is commonly found in reef habitats in Taiwan. There are numerous reports noting the presence of this species in Taiwanese waters (Ng et al. 2017).

Subfamily Chlorodiellinae Ng and Holthuis, 2007 Genus Chlorodiella Rathbun, 1897

Chlorodiella barbata (Borradaile, 1900) (Fig. 2C–G)

Chlorodiella barbata Rathbun 1911: 225; Balss 1934: 515; 1938: 53; Ward 1932: 250; 1939: 10; 1942: 97; Tweedie 1950: 121; Holthuis 1953: 14; Barnard 1954: 98; Forest and Guinot 1961: 96, figs. 93, 94, 99, 100; Michel 1964: 23; Guinot 1967b: 262 [List]; Serène 1968: 81 [List]; 1984: 260, fig. 170, pl. XXXVI A (for complete synonymy); Takeda and Nunomura 1976: 74; Peyrot-Clausade 1977a: 26; 1977b: 213; 1989: 112; Chen and Lan 1978: 270, figs. 4, 7 (4–5), pl. 1, fig. 4; Ribes 1978: 126;



Fig. 2. Actaeodes tomentosus (H. Milne Edwards, 1834) (female, CW 6.9 mm; NMNS 8772-1), A; *Psaumis cavipes* (Dana, 1852) (female, CW 8.6 mm; NMNS 8772-45), B; *Chlorodiella barbata* (Borradaile, 1900) (male, CW 4.1 mm; NMNS 8772-11), C–G: A–C, habitus, dorsal view; D, right chela, external view; E, left chela, external view; F, G1, right, external view; G, G1, right, distal area, external view. Scale bars: A-B = 2.0 mm; C = 1.0 mm; D-E = 0.5 mm; F–G = 0.1 mm.

Thomassin, 1978: 3, 64; Dai et al. 1986: 314, fig. 168 (1), pl. 45 (3) [Review]; Dai and Yang 1991: 339, fig. 168 (1), pl. 45 (3); Davie 2002: 518 [Review]; Ng et al. 2008: 196 [List]; Lasley et al. 2015: 171.

Material examined: 1 \diamond , NMNS 8772-11, 4.1 × 2.5, Wanlitong, Pingtung County, 13 May 2009.

Distribution: Indo-West Pacific; French Polynesia (Serène 1984; Poupin 1996).

Remarks: The morphology of the present specimen (Fig. 2C–G) matches key characters of *Chlorodiella barbata* (Borradaile, 1900) as described by Serène (1984: 257, fig. 170, pl. XXX VI A). Serène noted that this species can be easily distinguished from its congeners by the presence of a tuft of numerous setae on the external surface of the chelae at the articulation of the finger and a relatively simple, truncate tip of G1. This is the first report of this species from Taiwan.

Chlorodiella cytherea (Dana, 1852) (Fig. 3A, B, D, E)

Chlorodiella cytherea Holthuis 1953: 14; Forest and Guinot 1961: 95, figs. 90–92, 98a, b; Guinot 1962a: 238; 1964b: 70; 1967b: 262 (part) [List]; Michel 1964: 24; Serène 1968: 81 [List]; 1984: 259, fig. 169, pl. XXXVI C (for complete synonymy); Garth 1973: 320; Serène et al. 1976: 18; Takeda and Nunomura 1976: 74; Sakai 1976: 466, fig. 2, pl. 166; Takeda and Miyake 1976: 108; Takeda and Kurata 1977: 94; Peyrot-Clausade 1977a: 26; 1977b: 213; 1989: 112; Chen and Lan 1978: 270; figs. 5, 7 (1–3), pl. 2, fig. 5; Ribes 1978: 126; Thomassin 1978: 64; Dai et al. 1986: 316, pl. 45(6), fig. 169(4) [Review]; Titgen 1987: 107, fig. 1a–d; Holthuis 1953: 14; Peyrot-Clausade 1989: 112; Dai and Yang 1991: 340, pl. 45(6), fig. 169(4); DeFelice et al. 1998: 16; Ng et al. 2008: 197 [List]; Castro 2011: 87 [List]; Lasley et al. 2015: 171; Ng et al. 2017: 88 (for complete collection records from Taiwan).

Material examined: $1 \Leftrightarrow$, NMNS 8772-12, 5.7 × 3.7, Shanfu, Liuqiu Township, Pingtung County, 24 October 2008; $1 \Leftrightarrow 3 \Leftrightarrow$, NMNS 8772-13, 8.4–11.0 × 5.3–6.6, Wanlitong, Pingtung County, 13 May 2009; $1 \Leftrightarrow$, NMNS 8772-14, 7.2 × 4.4, Wanlitong, Pingtung County, 13 November 2009; $2 \Leftrightarrow$, NMNS 8772-15–16, 3.5–5.2 × 2.4–3.2, Shadao, Hengchun Township, Pingtung County, coll. H.-T. Hung, 16–17 October, 2020.

Distribution: Indo-West Pacific; Red Sea; Hawaii Islands; French Polynesia (Serène 1984; Poupin 1996).

Remark: The morphology of the present specimens (Fig. 3A, B, D, E) matches the description of *Chlorodiella cytherea* (Dana, 1852) (Dana 1852b: 213–214). Ng et al. (2017: 87) cited Sasaki (1976) as the first report of *Chl. cytherea* from Taiwan. However, Serène (1984) noted *Chl. laevissima*, as reported by Miyake (1938), is a junior synonym of *Chl. cytherea*. Thus, Miyake (1938), rather than Sasaki (1976), should be

considered the first report of this species from Taiwan.

Chlorodiella nigra (Forskål, 1775) (Fig. 3C)

Chlorodiella nigra Rathbun 1897: 157 [Nomenclature]; 1911: 225; 1923: 108; Grant and McCulloch 1906: 12; Balss 1924: 10; De Man 1929a: 1; 1929b: 4; McNeill and Ward 1930: 383; Montgomery 1931: 441; Ward 1932: 249; Gordon 1934: 50; Shen 1936: 67; Miyake 1936: 508; Sakai 1936: 166; 1939: 508, pl. 97, fig. 1; 1965: 150, pl. 75, fig. 2; 1976: 465, pl. 166, fig. 1; Chopra and Das 1937: 402, pl. 6, fig. 2; Ramadan 1936: 32; Monod 1938: 132; Barnard 1950: 213; 1955: 29, fig. 10; Holthuis 1953: 15; Guinot 1962a: 238; 1964a: 12; 1964b: 69; 1967b: 262 [List]; Forest and Guinot 1961: 95, figs. 87-89, 97a, b; Sankarankutty 1966a: 351; 1966b: 50; Michel 1964: 24; Serène 1968: 81 [List]; 1977: 51; 1984: 258-259, fig. 168, pl. XXXVI B (for complete synonymy); Serène et al. 1976: 18; Takeda and Nunomura 1976: 74; Takeda and Miyake 1976: 108; Peyrot-Clausade 1977a: 26; 1977b: 213; Chen and Lan 1978: 268, figs. 1, 7 (6-7), pl. 1, fig. 1; Ribes 1978: 126; Takeda 1978: 40; Kensley 1981: 44 [List]; Garth and Kim 1983: 687; Dai et al. 1986: 315, pl. 45(5), fig. 169(2) [Review]; Dai and Yang 1991: 339, pl. 45(5), fig. 169(2) [Review]; Davie 2002: 519 [List]; Ng et al. 2008: 197 [List]; Lasley et al. 2015: 171, fig. S4A; Ng et al. 2017: 88 (for complete collection records from Taiwan).

Material examined: $1 \Leftrightarrow$, NMNS 8772-17, 8.5 × 6.0, Linshanbi, Shihmen District, New Taipei City, 18 December 2011.

Distribution: Indo-West Pacific; Hawaii Islands; French Polynesia (Serène 1984; Poupin 1996).

Remarks: *Chlorodiella nigra* (Forskål, 1775) (Fig. 3C) is commonly found in reef habitats in Taiwan. Numerous reports have noted the presence of this species along the coasts of eastern and southern Taiwan (Ng et al. 2017). This study reports the occurrence of this species in northern Taiwan, where the annual surface seawater temperature in January is over 5°C lower than that of eastern and southern Taiwan (Central Weather Bureau 2023).

Genus Cyclodius Dana, 1851

Cyclodius taiwanensis sp. nov. (Figs. 4A–H, 5A–D, 6A–D, 7A–F) urn:lsid:zoobank.org:act:9BC4D0FC-A342-413D-98EF-FA819C794785

Material examined: Holotype, NMNS 8772-18, \$, 8.9 × 6.2, Jihuei, Taitung County, 9 October 2010. Paratypes: 1 \clubsuit , NMNS 8772-19, 6.6 × 4.2, Wanlitong, Pingtung County, 13 November 2009; 1 \$, NMNS 8772-20, 4.8 × 3.3, Jihuei, Taitung County, 7 October 2010; 1 \clubsuit , NMNS 8772-21, 4.3 × 2.7, Jihuei, Taitung County, 27 September 2014; 1 \$ 1 \clubsuit , NMNS 8772-22–23, 7.2–9.6 × 4.6–6.2, Jihuei, Taitung County, 28 April 2017. *Etymology*: The name is derived from Taiwan, the island where the specimens were collected.

Description: Holotype, carapace (Figs. 4A, B, 6A, B) transversely hexagonal, width about 1.44 length; dorsal surface granulate, covered with long and short simple light-colored setae; regions weakly defined. Front moderately convex, about 0.27 times carapace width, strongly deflexed ventrally, margin granulate; divided into two lobes by wide V-shaped notch, continuing posteriorly as shallow median groove on dorsal carapace. Anterolateral margin with anterolateral direct spinose teeth, separated by concave gaps; tooth 1 with 2 emergent spines, larger than supraorbital tooth, tooth 2 and 3 subequal in size, both with 2 large and 1 small anterolateral pointed spine, tooth 4 with 1 large spine and secondary spines. Posterolateral margin longer than anterolateral margin, slightly convex medially.

Orbits (Figs. 4A-C, 6A, B) suboval, margins

denticulate, supraorbital margin with 2 small notches medially; inner pre-frontal supraorbital and exorbital tooth weakly developed. Eyes well developed, eyestalks short, stout, corneas large. Antennular fossae transversely oval; antennules folding transversely. Basal antennal article with small lateral flange, entering less than halfway into orbital hiatus. Antennae freely entering orbital hiatus.

Third maxillipeds (Figs. 4C, D, 7A) subrectangular, length to width ratio about 1.55; palp tapering distally, articles subcylindrical; merus subquadrate, length to width ratio about 0.55, anterolateral angle concave, anterior margin sinuous and granulate, few stout and simple setae; external surface with scattered granules; ischium subrectangular, about 2.58 times longer than merus, sulcate submedially, mesial margin cristate, serrated, lined with submarginal setae; exopod stout, external margin straight, internal margin denticulate,



Fig. 3. Chlorodiella cytherea (Dana, 1852) (female, CW 7.2 mm; NMNS 8772-14), A; Chlorodiella cytherea (Dana, 1852) (male, CW 10.5 mm; NMNS 8772-13(1)), B, D, E; Chlorodiella nigra (Forskål, 1775) (female, CW 8.5 mm; NMNS 8772-17), C: A–C, habitus, dorsal view; D, G1, right, internal view; E, G1 distal area, right, internal view. Scale bars: A-C = 2.0 mm; D = 0.5 mm; E = 0.01 mm.

tapering slightly toward distal end, distal end concave.

Thoracic sternum (Figs. 4G, 7B) margins cristate; sternites 1, 2 fused with low of transverse granules on suture; sternites 2, 3 separated by narrow, deep suture, margins smooth; sternites 3, 4 mostly fused, with remnants of suture only at lateral edges; sternite 4 with prominent median longitudinal line extending through entire exposed length, lateral margins slightly convex; sutures 4/5, 5/6 joining toward median longitudinal axis of thoracic sternum; small, central, triangular, noncalcified area present between sternites 6, 7 within sternopleonal cavity; press-button on anterior half of sternite 5.

Chelipeds (Figs. 4E, F, 6C) subequal, moderately robust, external surfaces granulate covered with long and short simple, light-colored setae. Meri moderate long, distal end extending slightly beyond carapace anterolateral margin in dorsal view, upper margin unarmed, lower margin denticulate. Carpi rhombicshaped, covered with rows of granules. Palm external surface covered with row of granules. Fingers thick, tips hemi-cupuliform, pigmentation restricted to fingers; dactylus gently curved toward distal end, dorsal margin with 2 rows of granules proximally, 3 large teeth on cutting edge; pollex straight proximally, slightly curved upward distally, 3 or 4 large teeth on cutting edge.

Ambulatory legs (Figs. 4A, H, 6D) flattened, broad, moderate in length, P3, P4 longest, P5 shortest; surfaces entirely granulate, covered with long and short simple, light-colored setae; anterior margin of meri, carpi, propodi, dactyli denticulate; posterior margin of meri, propodi, dactyli denticulate; dactyli single-tipped. P5 merus subrectangular, median length about 1.86 times greatest width; carpus curved, distal end distinctly wider than proximal end, median length about 1.11 times greatest width; propodus subrectangular, median length about 0.91 times greatest width; dactylus longer than propodus, stout proximally, tapering distally, terminating in robust, short chitinous claw with length 1.43 times greatest width.

Pleon (Figs. 4G, 7C) moderate long relative to thoracic sternum, tip of telson reaching level slightly lower to sternal condyles of P1 coxae; somite 1 trapezoidal with anterior margin strongly concave, somite 2 trapezoidal, as wide as somite 1 with anterior margin strongly concave and posterior margin strongly convex; somites 3–5 fused with residue sutures reaching 1/3 to median line, base of somite 3 widest, distal somites progressively narrower, combined lateral margin gently concave; somite 6 subquadrate, width about 1.56 times length, anterior margin slightly concave, lateral margins and posterior slightly sinuous; telson subtriangular, angles round, basal width about 1.71 times median length. G1 (Figs. 5A, B, 7D–F) moderate in length, stout, distal half acutely bent lateroventrally with 5 long and 6–8 short, simple, subdistal setae, numerous short spines; distal tip lobe ovate with round-tipped. G2 sigmoidal in shape, about one-third length of G1.

Female morphology: The immature female (Figs. 5C, D, 7G) is morphologically similar to the male in most body parts, except for the sexual characteristics. The pleon of the female is generally wider and more elongate-oval in shape compared to that of the male. The vulvae are oval, lack an operculum, and are located on the mesial fourth of sternite 5.

Distribution: Known only from type locality and Wanlitong, Pingtung County.

Remarks: The genus *Cyclodius* Dana, 1851 was synonymized as a junior name of *Phymodius* by A. Milne-Edwards (1863) but was resurrected by Davie (2002) and had been used since (Lasley et al. 2015: 173). The current recognized species within the genus include: *Cyclodius drachi* (Guinot, 1964), *Cyc. granulatus* (Targioni-Tozzetti, 1877), *Cyc. granulosus* de Man, 1888; *Cyc. nitidus* (Dana, 1852), *Cyc. obscurus* (Hombron and Jacquinot, 1846), *Cyc. paumotensis* (Rathbun, 1907), *Cyc. perlatus* (Nobili, 1905), and *Cyc. ungulatus* (H. Milne Edwards, 1834) (Lasley et al. 2015: 173). The present study introduces a new member to the genus.

The present species exhibits a basal antennal article (Figs. 4C, 6B) similar to that of Cyclodius Dana, 1851, where the basal antennal article has a distolateral extension occluding less than half the length of the orbital hiatus (Serène 1984: 233; Ng and Yang 1998: 1693, fig. 5B; Clark and Ng 1999: 354, 359, fig. 6C, tabl. 1; Lai et al. 2011: 433; Lasley et al. 2015: 173, fig. S5B, D). Among known Cyclodius species, only Cyc. paumotensis (Rathbun, 1907) shares the characteristic of having the carapace and external surfaces of chelipeds covered in long and short simple, light-colored setae (Figs. 4A, B. E, F, 5C; Serène 1984: 233; Clark and Galil 1993: 1143, figs. 35B, 43A; Lasley et al. 2015: 173, fig. S1C). However, Cyc. taiwanensis sp. nov. can be distinguished from Cyc. paumotensis by: 1) weakly defined carapace regions (versus well-defined) (Figs. 4A, B, 5C; Serène 1984: 241, pl. XXXIII D; Clark and Galil 1993: 1145, fig. 35B; Lasley et al. 2015: 173, fig. S1C); 2) an anterolateral margin without apical or accessary spines (versus with apical or accessory spines) (Figs. 4A, B, 5C; Serène 1984: 241, fig. 143d; Clark and Galil 1993: 1145, fig. 10A, 35B; Lasley et al. 2015: 173, fig. S1C); 3) a greater basal width to median length ratio of the 6th somite and telson (1.63 and 1.80 versus 1.34 and 1.34, respectively) (Figs. 4G, 7C; cf. Rathbun 1907: 52, pl. 2b); and 4) the G1 acutely bent subdistally with a round-tipped distal lobe (versus gently curved



Fig. 4. *Cyclodius taiwanensis* sp. nov., holotype (male, CW 8.9 mm; NMNS 8772-18): A, habitus, dorsal view; B, carapace, dorsal view; C, habitus, frontal view; D, 3^{rd} maxilliped; E, right chela, external view; F, left chela, external view; G, thoracic sternum and pleon; H, P5, right, dorsal view. Scale bars: A = 2.0 mm; B–H = 1.0 mm.

subdistally with a sharp distal lobe) (Figs. 5A, B, 7D–F; Serène 1984: 241, fig. 145; Clark and Galil 1993: 1143, fig. 10D–G; Lasley et al. 2015: 173, fig. S3B).

The G1 structure is considered a reliable distinguishing characteristic among *Cyclodius* species (Lasley et al. 2015: 173). Although the G1 form in *Cyc*. *taiwanensis* sp. nov. is unique within the genus, it shows some resemblance to that of *Pilodius luomi* Serène, 1971 (= *Pilodius miersi* (Ward, 1936)), as described by Serène (1971: 914–914) (Figs. 5A, B, 7D–F; Serène and Van Luom 1959: 307, fig. 2E, F; Serène 1971: 58; Serène 1984: 245, figs. 153–158; Clark and Galil 1993:



Fig. 5. Cyclodius taiwanensis sp. nov., holotype (male, CW 8.9 mm; NMNS 8772-18), A, B; paratype (female, CW 7.2 mm; NMNS 8772-23), C, D: A, G1, external view; B, G1 distal area, internal view; C, carapace, dorsal view; D, thoracic sternum and pleon. Scale bars: A, D = 0.5 mm; B = 0.01 mm; C = 1.0 mm.

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Fig. 6. *Cyclodius taiwanensis* sp. nov., holotype (male, CW 8.9 mm; NMNS 8772-18): A, carapace right margin, dorsal view; B, habitus, anterior view; C, right chela, external view; D, P5, right, dorsal view. Scale bars: A-D = 1.0 mm.



Fig. 7. *Cyclodius taiwanensis* sp. nov., holotype (male, CW 8.9 mm; NMNS 8772-18), A–F; paratype (female, CW 7.2 mm; NMNS 8772-27), G: A, right 3^{rd} maxilliped, external view; B, male thoracic sternum and pleon; C, male pleon; D, G1, right, external view; E, G1, right, distal area, external view; F, G1, right, distal area, internal view; G, female pleon. Scale bars: A–D, G = 1.0 mm; E, F = 0.5 mm.

1136–1137; Lasley et al. 2023: 6, fig. 2). Both species exhibit a G1 with a round-tipped distal lobe; however, *Cyc. taiwanensis* sp. nov. has a subdistally acutely bent G1, an apical area without short spines, and few long, simple setae subapically; whereas *P. luomi* has a G1 that gently curves subdistally, with an apical area featuring many short spines and numerous long, simple setae (Figs. 5A, B, 7D–F; Serène and Van Luom 1959: 307, fig. 2E, F).

Cyclodius taiwanensis sp. nov. can be further distinguished from *P. luomi* by: 1) weakly defined carapace regions (versus well-defined) (Figs. 4A, B, 5C; Serène and Van Luom 1959: 307, pl. 1D); 2) an anterolateral margin without apical or accessary spines (versus with spines) (Figs. 4A, B, 5C; Serène and Van Luom 1959: 307, pl. 1D); 3) dark pigmentation of fingers not expanding onto the palm (versus expanding onto the palm) (Figs. 4A, E, F, 6C; Serène and Van Luom 1959: 307, pl. 1D); and 4) the 6th somite of the male pleon having nearly equal proximal and distal margins length (versus a longer distal margin) (Figs. 4A, E, F, 6C; Serène and Van Luom 1959: 307, fig. 2A).

Similarly, Cyc. taiwanensis sp. nov. differs from P. miersi in these traits: 1) weakly defined carapace regions (versus well-defined) (Figs. 4A, B, 5C; Clark and Galil 1993: 1137, fig. 34A); 2) a deep, V-shaped notch between the frontal lobes (versus a U-shaped indentation) (Figs. 4A, B, 5C; Clark and Galil 1993: 1137, figs. 7A, 34A); 3) an anterolateral margin without spines (versus with spines) (Figs. 4A, B, 5C; Serène and Van Luom 1958: 93: 307; Clark and Galil 1993: 1137, figs. 7B, 34A); 4) dark pigmentation of fingers not expanding onto the palm (versus expanding) (Figs. 4A, E, F, 6C; Serène and Van Luom 1958: 93; Clark and Galil 1993: 1137, fig. 34A); 5) ambulatory legs lacking dactyl-propodal locks (versus present) (Figs. 4H, 6D; Clark and Galil 1993: 1137, fig. 7C); and 6) a G1 subdistally bent acutely, with an apical area without short spines and few subapical setae (versus gently curving subdistally, with an apical area containing many short spines and numerous subapical setae) (Figs. 5A, B, 7D-F; Clark and Galil 1993: 1137, fig. 7D-F).

Genus Liocarpilodes Klunzinger, 1913

Liocarpilodes harmsi (Balss, 1934) (Fig. 8A–C)

Liocarpilodes harmsi Serène 1971: 914; 1984: 230, fig. 175, pl. XXXVII B (for complete synonymy); Takeda and Nunomura 1976: 72; Ng et al. 2008: 197 [List]; Hsuch et al. 2009: 1026; Ng et al. 2017: 88.

Material examined: 1 ♀, NMNS 8772-24, 4.5 × 2.8, Shanfu, Liuqiu Township, Pingtung County, 4

May 2007; 3 \Leftrightarrow , NMNS 8772-25, 4.8–5.2 × 3.2–3.6, Shanfu, Liuqiu Township, Pingtung County, 24 October 2008; 2 \diamond 2 \Leftrightarrow , NMNS 8772-26–29, 3.7–4.4 × 2.4– 2.8, Wanlitong, Pingtung County, 13 May 2009; 1 \diamond 3 \Leftrightarrow , NMNS 8772-30, 4.5–7.2 × 2.8–4.5, Wanlitong, Pingtung County, 13 November 2009; 1 \Leftrightarrow , NMNS 8772-31, 4.8 × 3.1, Jihuei, Taitung County, 7 October 2010; 1 ovigerous \Leftrightarrow , NMNS 8772-32, 3.7 × 2.2, Shitiping, Hualien County, coll. Y.-W. Tzeng, 20 August 2012; 2 \diamond 5 \Leftrightarrow , NMNS 8772-33, 4.4–8.1 × 2.9–4.6, Jihuei, Taitung County, 27 September 2014; 1 \Leftrightarrow , NMNS 8772-34, 5.8 x 3.8, Jihuei, Taitung County, 28 April 2017.

Distribution: Indo-West Pacific; French Polynesia (Serène 1984).

Remarks: The morphology of the present specimens (Fig. 8A–C) aligns with the diagnosis of *L*. *harmsi* (Balss, 1934) as described by Serène (1984: 263, fig. 175, pl. XXV B). Hsuch et al. (2009) documented the first record of this species in Taiwan from a specimen collected in Wanlitong, southern Taiwan. The current findings suggest that this species also inhabits offshore island of southwestern Taiwan and the eastern coast of Taiwan.

Liocarpilodes sp.

(Fig. 9A–H)

Material examined: $1 \Leftrightarrow$, NMNS 8772-35, 3.8×2.5 , Shihmen Township, New Taipei City, 12 October 2008.

Description: Carapace (Fig. 9A-C) transversely ovate, width to length ratio about 1.53, dorsal area slightly convex transversely, longitudinally; dorsal surface well covered by microscopic granules; regions moderately defined, divided by shallow grooves; subhepatic, pterygostomial regions covered with short setae. Front weakly advanced, about 0.41 times as long as carapace width, strongly deflexed ventrally, margin granulate, outer angles well marked and separated by V-shaped notch from orbital rim; divided into two lobes by wide, shallow V-shaped notch, continuing posteriorly as shallow median groove on dorsal carapace. Anterolateral margin convex, divided into 4 low lobes, separated from each other by small, shallow V-shaped notches; first lobe feebly demarcated from second lobe; second lobe widest; third lobe narrower at base but more projecting than preceding, anterior margin much shorter than posterior; fourth lobe smallest, posterior margin continuous with carapace posterolateral margin; short transverse groove between second, third teeth, slightly continuing onto branchial region. Posterolateral margin about as long as anterolateral margin, straight to slightly concave in central region.

Orbits (Fig. 9A–C) suboval, margins granulate, continuous; inner pre-frontal supraorbital and exorbital tooth weakly developed. Eyes well developed, eyestalks short, stout, corneas large. Antennular fossae transversely oval; antennules folding transversely. Basal article of antenna short, subrectangular; flagellum freely entering orbital hiatus, short, tip not exceeding exorbital tooth.

Third maxillipeds (Fig. 9D) subrectangular, length to greatest width ratio about 1.89; palp tapering distally, articles subcylindrical; merus subquadrate, length to greatest width ratio about 0.64, anterolateral angle rounded, not projecting, anterior margin cristate and granulate, sinuous, external surface with patched granules; ischium subrectangular, about 2.06 times longer than merus, sulcate submedially, mesial margin cristate, serrated, lined with submarginal setae; exopod stout, margins slightly convex, inner margin cristate, tapering slightly toward distal end, distal end concave.

Thoracic sternum (Fig. 9H) margins cristate; sternites 1, 2 fused, external surfaces granulate, anterior area of sternite 1 with setal tuft; sternites 2, 3 and 3, 4 separated entirely by deep and shallow sutures, respectively; sternite 4 lateral margins slightly convex; sutures 4/5, 5/6 joining toward median longitudinal axis of thoracic sternum; vulvae oval, without operculum, located mesial third of sternite 5.

Chelipeds (Fig. 9A, E, F) subequal, moderately robust, external surface almost fully granulate, except partial surfaces of fingers. Meri moderate long, distal end extending slightly beyond carapace anterolateral margin in dorsal view. Carpi internal angle with blunt,



Fig. 8. *Liocarpilodes harmsi* (Balss, 1934) (female, CW 7.2 mm; NMNS 8772-30): A, habitus, dorsal view; B, G1, right, external view; C, G1, right, distal area, external view. Scale bars: A = 2.0 mm; B = 0.5 mm; C = 0.05 mm.



Fig. 9. *Liocarpilodes* sp. (female, CW 3.8; NMNS 8772-35): A, habitus, dorsal view; B, carapace, dorsal view; C, habitus, anterior view; D, third maxilliped; E, right chela, external view; F, left chela, external view; G, P5, right, dorsal view; H, thoracic sternum and pleon. Scale bars: A = 1.0 mm; B–C, H = 0.5 mm; D–G = 0.2 mm.

triangular projection. Palm external surface granules compacted, forming perpendicular lines or stripes. Fingers thick, tips hemi-cupuliform, beige in alcohol; dactylus subdorsal margin with 2 granular crests, forming longitudinal shallow groove extending to subdistal area, distal area moderately deflexed, lower submargin with longitudinal shallow groove, extending two-thirds of dactylus from proximal end, 3 large teeth on cutting edge; pollex external surface upper submargin with longitudinal shallow groove, extending two-thirds of dactylus from proximal end, bottom margin of shallow groove granulate, lower submargin with a row of longitudinal scattered granules.

Ambulatory legs (Fig. 9A, E) flattened, broad, moderate in length, P3, P4 longest, coxa-to-dactylus length about 0.93 times carapace width, P5 shortest, coxa-to-dactylus length about 0.87 times carapace width; surfaces entirely granulate; anterior margin of meri, carpi, propodi, dactyli granulate with scattered long setae; posterior margin of meri, propodi, dactyli granulate with scattered short and long setae, dactyli with single large spine posterior to chitinous claw, single-tipped. P5 merus subrectangular, median length about 2.03 times greatest width; carpus curved, distal end distinctly wider than proximal end, median length about 1.53 times greatest width; propodus subrectangular, median length about as long as greatest width; dactylus about as long as propodus, stout proximally, tapering distally, terminating in sharp, short chitinous claw with length about 1.83 times greatest width.

Pleon (Fig. 9H) moderate long relative to thoracic sternum, tip of telson almost reaching anterior margin of sternite 4; somites 1, 2 trapezoidal, much wider than long; all somite free, base of somite 3 widest, distal somites progressively narrower, anterior combined lateral margin gently convex; somite 6 subquadrate, slightly wider than long, center of anterior margin slightly concave; telson subtriangular, angles rounded, basal width about 1.36 times median length.

Distribution: Known only from Shihmen Township, North Taiwan.

Remarks: Among known congeners, the morphology of *Liocarpilodes* sp. shows some resemblance to *L. biunguis* (Rathbun, 1906) and *L. kauaiensis* (Edmondson, 1962), sharing features such as a transversely ovate carapace with granules throughout and low anterolateral lobes with granulate margins (Fig. 9A, B; Rathbun 1906: 849, fig. 12; Edmondson 1962: 272, fig. 18c-e). However, *L.* sp. differs from *L. biunguis* in the following ways: 1) greater width/length ratio of the carapace (1.52 versus 1.44); 2) absence of coarse tubular setae on the carapace surface (versus presence); 3) first anterolateral lobe not fused with the orbital tooth (versus fused); 4) chelipeds almost entirely granulate, except for parts of the fingers (versus mostly granulate, except for the inner arm face of arm and lower palm); 5) smaller width/length ratio of the cheliped palm (0.66 versus 0.79); 6) more teeth on cutting edges of the dactylus and pollex (3-5 versus 2); and 7) dactylus of ambulatory legs with a single tip (versus two tips) (Fig. 9A, B, E-G; Rathbun 1906: 849, fig. 12a-b). *Liocarpilodes* sp. can be distinguished from L. kauaiensis by: 1) front outer angles being well-marked and separated from the orbital rim by a V-shaped notch (versus weakly marked and separated by a V-shaped indentation); 2) first anterolateral lobe not fused with the orbital tooth (versus fused); 3) anterolateral lobes defined by a small notch (versus enlarged granules); 4) last anterolateral lobe as a small triangle lobe (versus sharp granule); 5) chelipeds almost fully granulate, except parts of the fingers (versus granulate except on the arm and lower palm); 6) more teeth on the pollex cutting edges (3-5 versus 2); and 7) surface and margins of ambulatory legs covered with granules and spines (versus smooth) (Fig. 9A, B, E-G; Edmondson 1962: 272, fig. 18c-e). The morphology description is based on a single juvenile female specimen. It remains uncertain whether variations between sexes or ontogenetic changes occur in this species.

Genus Luniella Lasley, Klaus and Ng, 2015

Luniella scabricula (Dana, 1852) (Fig. 10A–C)

Pilodius scabricula Dana 1852a: 80; 1852b: 220; 1855: 6, pl. 12, fig. 9; Nobili 1907: 394; Forest and Guinot 1961: 91, fig. 83a, b, 84, 86 bis; Guinot 1967b: 268; Serène 1968: 80; 1984: 244, figs. 143i, 149, pl. XXXIV D (for complete synonymy); Peyrot-Clausade 1977a, index espèces: 27; 1977b: 213; Thomassin 1978, annexe 3: 64; Ng et al. 2008: 197 [List]; Hsueh et al. 2009: 1026.

Luniella scabricula Lasley et al. 2015: 174, fig. S4C; Ng et al. 2017: 88.

Material examined: $1 \Leftrightarrow$, NMNS 8772-36, 4.1 × 2.8, Wanlitong, Pingtung County, 13 May 2009; 1 \diamond , NMNS 8772-37, 4.4 × 3.0, Shadao, Hengchun Township, Pingtung County, coll. H.-T. Hung, 16 October, 2020.

Distribution: Indo-West Pacific; French Polynesia (Serène 1984; Poupin, 1996).

Remarks: The morphology of the present specimens (Fig. 10A–C) aligns with the diagnosis of *L. scabricula* (Dana, 1852) (Dana 1852b: 221; Lasley et al. 2015: 174). Hsueh et al. (2009) documented the first record of this species in Taiwan from a specimen collected in Shihmen, northern Taiwan. The current findings indicate that this species is also present along the coasts of southern Taiwan.

Genus Pilodius Dana, 1851

Pilodius nigrocrinitus Stimpson, 1859 (Fig. 11A–E)

Pilodius nigrocrinitus Stimpson 1859: 34; 1907: 58, pl. 7, fig. la, b; Balss 1938: 57 [List]; Forest and Guinot 1961: 89 [List]; Sakai 1965: 148, pl. 73, fig. 5; 1976: pl. 164, fig. 2, text-figs. 248a-b; Serène 1968: 80 [List]; Serène 1984: 235 [Key]; Dai et al. 1986: 307, pl. 43(5), text-fig. 166(2); McNeill 1968: 73 (part); Takeda and Nunomura 1976: 73; Dai and Yang 1991: 330, pl. 43(5), text-fig. 166(2); Clark and Galil 1993: 1139, figs. 9A–G, 24, 35A, 42B, C (for complete synonymy); Ng et al. 2008: 197 [List]; Lasley et al. 2015: 172, fig. S4B. *Material examined*: 1 \diamond , NMNS 8772-38, 8.4 \times 5.6, Shihmen, New Taipei City, 3 October 2008; 1 \Leftrightarrow , NMNS 8772-39, 5.2 \times 3.4, Jihuei, Taitung County, 13 December 2012.

Distribution: Indo-West Pacific; Pacific Ocean (Clark and Galil 1993: 1140–1142).

Remarks: The morphology of the present specimens (Fig. 11A–E) largely aligns with the description of *P. nigrocrinitus* Stimpson, 1859 provided by Clark and Galil (1993: 1139–1140, figs. 9A–G, 35A, 42B–C). Notably, it features an enlarged distolateral flange on the basal antennal article that completely blocks the orbital hiatus and moderately stout G1 with numerous stout subdistal setae and a hooked apical



Fig. 10. Luniella scabricula (Dana, 1852) (male, CW 4.4 mm; NMNS 8772-37): A, habitus, dorsal view; B, G1 of male, right, external view; C, close-up of G1 distal area, right, external view; E, G1 of male, right, internal view; F, close-up of G1 distal area, right, internal view. Scale bars: A = 2.0 mm; B = 0.5 mm; C = 0.05 mm.



Fig. 11. *Pilodius nigrocrinitus* Stimpson, 1859 (male, CW 8.5 mm; NMNS 8772-38): A, habitus, dorsal view; B, habitus, anterior view; C, right chela, external view; D, left chela, external view; E, G1, right, internal view; F, G1, right, distal area, internal view; G, G1, right, apex area, internal view. Scale bars: A = 2.0 mm; B = 1.0 mm; C, D = 0.5 mm; E = 0.2 mm; F, G = 0.05 mm.

lobe. This is the first recorded occurrence of this species in Taiwan.

Subfamily Etisinae Ortmann, 1893 Genus *Etisus* H. Milne Edwards, 1834

Etisus frontalis (Dana, 1852) (Fig. 12A, B)

Etisus frontalis Guinot 1964b: 50–56, figs. 23, 25–27, 31a–c, 35, pl. V, fig. 2; Serène 1968: 80; 1984: 229, fig. 139, pl. XXXI E (for complete synonymy); Ng et al. 2008: 198 [List].

Material examined: $1 \Leftrightarrow$, NMNS 8772-40, 8.7 × 6.3, Shanfu, Liuqiu Township, Pingtung County, 18 November 2017.

Distribution: Aldbra (Seychelles); Hikueru (French Polynesia); Jolo Sea (Philippines) (Guinot 1964); Xiao Liuqiu Island, southwestern Taiwan.

Remarks: The morphology of the present specimen (Fig. 12A, B) matches description of *E. frontalis* (Dana, 1852), characterized by similarly sized submedian and lateral lobules of the front and the black coloration of the fixed finger of the chelipeds extending slightly onto the palm (Guinot 1964b: 51, 53, figs. 23, 26–27; Serène 1984: 224, pl. XXXI E). This species is reported for the first time from Taiwan.

Etisus sp. A (Fig. 13A–H)

Material examined: $1 \Leftrightarrow$, NMNS 8772-41, 5.2 × 3.6, Jialulan, Taitung County, coll. Y.-W. Tzeng, 23 July 2013.

Description: Carapace (Fig. 13A–C) transversely ovate, width to length ratio about 1.45, dorsal area

slightly convex transversely, longitudinally; dorsal surface well covered by microscopic granules, except 3M, 4M, L, P, R regions, stout long setae scattered at anterior regions and lined with grooves of posterior regions; regions well defined, divided by wide, deep grooves; subhepatic, pterygostomial regions granulate, long setae scattered. Front strongly advanced, about 0.33 times as long as carapace width, slightly deflexed ventrally, margin granulate, outer angles well marked and separated by V-shaped notch from orbital rim; divided into 2 lobes by shallow V-shaped notch, continuing posteriorly as deep median groove on dorsal carapace, each lobe with 2 subequal lobules. Anterolateral margin convex, granulate, divided into 4 lobes, separated from each other by wide V-shaped notches; first lobe highest, gradually reducing in height thereafter; third lobe base widest, anterior margin slightly shorter than posterior; fourth lobe smallest, posterior margin continuous with carapace posterolateral margin. Posterolateral margin slightly longer than anterolateral margin, central region slightly concave.

Orbits (Fig. 13A–C) suboval, margins granulate, continuous; inner pre-supraorbital tooth prominent, supraorbital margin with low tooth adjacent to exorbital tooth, separated from pre-supraorbital tooth and from exorbital tooth by V-shaped notch; exorbital tooth sharply triangular. Eyes well developed, eyestalks short, stout, corneas large. Antennular fossae transversely oval; antennules folding transversely. Basal article of antenna short, triangular; flagellum freely entering orbital hiatus, long, tip far exceeding exorbital tooth.

Third maxillipeds (Fig. 13D) subrectangular, length to greatest width ratio about 2.22; palp tapering distally, articles subcylindrical; merus subquadrate,



Fig. 12. *Etisus frontalis* (Dana, 1852) (female, CW 8.7 mm; NMNS 8772-40): A, habitus, dorsal view; B, right chela, external view. Scale bars: A = 2.0 mm; B = 0.5 mm.



Fig. 13. *Etisus* sp. A (female, CW 5.2 mm; NMNS 8772-41): A, habitus, dorsal view; B, carapace, dorsal view; C, habitus, anterior view; D, 3rd maxillipeds; E, left chela, internal view; F, left chela, external view, arrow pointing acetabulum-like structure; G, P5, left, dorsal view; H, pleon. Scale bars: A = 1.0 mm; B-H = 0.5 mm.

length to greatest width ratio about 0.67, anterolateral angle rounded, slightly projecting, anterior margin straight, cristate, granulate, stout setae scattered, external surface with patched granules, long, thin setae scattered; ischium subrectangular, about 1.83 times longer than merus, sulcate submedially, mesial margin cristate, serrated, lined with submarginal setae, external surface scattered with long setae; exopod stout, margins slightly convex, tapering slightly toward distal end, distal end slightly convex.

Thoracic sternum margins cristate; sternites 1, 2 fused, external surface smooth; sternites 2, 3 and 3, 4 separated by deep and shallow sutures, respectively; sternite 4 with row of long setae at anterior margin, lateral margins clearly convex; sutures 4/5, 5/6 joining toward median longitudinal axis of thoracic sternum; vulvae oval, without operculum, located mesial third of sternite 5.

Left cheliped (Fig. 13E, F) moderately robust. Meri moderate long, distal end clearly extending beyond carapace anterolateral margin in dorsal view. Carpi dorsal margin granulate, subdistal end with large tubercle, internal distal angle with one row of 3 small spines. Palm dorsal margin granulate, with small tubercle proximally, external surface granules compacted, forming perpendicular lines or stripes, proximal end of lower margin with large acetabulumlike structure, distal end of lower margin with shallow groove extending anteriorly to middle of pollex. Finger thick, tips rounded; dactylus brownish in alcohol except distal end, dorsal margin with granulate submargin crests, forming longitudinal groove toward medial region of dorsal margin, distal area moderately recurved, external surface lower submargin with longitudinal shallow groove, extending two-thirds of dactylus from proximal end, three large teeth on proximal end of cutting edge, 2 thin, blade-like low teeth on distal end of cutting edge; pollex beige in alcohol, proximal end of cutting edge with 2 small, low teeth and 3 larger blunt teeth, distal end with 2 medium-sized low teeth.

Ambulatory legs (Fig. 13G) flattened, broad, moderate in length, P2, P3 longest, coxa-to-dactylus length about 0.94 times carapace width, P5 shortest, coxa-to-dactylus length about 0.81 times carapace width; surfaces entirely smooth, anterior margin of meri spinose, anterior margin of carpi, propodi, dactyli granulate, anterior submargin of meri, carpi, propodi, dactyli lined with many short and long setae, posterior margin of meri, carpi smooth, submargin lined with short and long setae, posterior margins of propodi denticulate, submargin lined with short and long setae, posterior margins of dactyli spinose, with single large tubercle posterior to chitinous claw, single-tipped. P5 merus subrectangular, median length about 1.54 times greatest width; carpus curved, distal end distinctly wider than proximal end, median length about 1.60 times greatest width; propodus subrectangular, median length about as long as greatest width; dactylus longer than propodus, stout proximally, tapering distally, terminating in sharp, short chitinous claw with length about 1.86 times greatest width.

Pleon (Fig. 13H) moderate long relative to thoracic sternum, tip of telson reaching anterior margin of sternite 4; somites 1, 2 trapezoidal, much wider than long; somites 3–5 subrectangular, not fused, subequal in width, combined lateral margin gently convex; somite 6 subrectangular, much wider than long, angles rounded, lateral margins convex; telson subtriangular, angles rounded, basal width about 1.5 times median length.

Distribution: Known only from the coast of East Taiwan.

Remarks: Interestingly, Etisus sp. A possesses an acetabulum-like structure on external, lower proximal margin of the propodus of the left chela (Fig. 13F). This feature might be a scar from a previous injury. The morphology of *Etisus* sp. A is somewhat resembles that of *E. anaglyptus* (H. Milne Edwards, 1834), which has subquadrate frontal lobes extending beyond the supraorbital angles and separated by a deep V-shaped notch (Fig. 13A, B; A. Milne-Edwards 1873: 80 (4), pl. 12 (1), fig. 3; Serène 1984: 227-228, pl. XXXII A, E). However, Etisus sp. A differs from E. anaglyptus in the following ways: 1) frontal lobes extending well beyond the supraorbital angles (versus slightly beyond); 2) a greater fronto-orbital to carapace width ratio (0.33 versus 0.19); 3) anterolateral tooth N, T and S $(2^{nd} to 4^{th})$ with blunt-tipped (versus acute tips); and 4) outer edge of ambulatory legs covered in granules (versus strong spines) (Fig. 13A, B, G; Serène 1984: 228, pl. XXXII A). More adult male and female specimens are needed to determine the true identity of this distinct *Etisus* species. The current description is based on a single juvenile female specimen, and it remains uncertain whether there are variations between sexes or ontogenetic morphological changes.

Etisus sp. B (Figs. 14A–H, 15A–H, 16A–F)

Material Examined: 1 \Leftrightarrow , NMNS 8772-42, 5.3 \times 3.8, Shanfu, Liuqiu Township, Pingtung County, 4 May 2007; 1 \diamondsuit , NMNS 8772-43, 5.7 \times 4.1, Shanfu, Liuqiu Township, Pingtung County, 24 October 2008; 1 \Leftrightarrow , NMNS 8772-44, 4.1 \times 2.9, Shanfu, Liuqiu Township, Pingtung County, 5 November 2011.

Description: Carapace (Fig. 14A, C, E) transversely ovate, width to length ratio about 1.38, dorsal area slightly convex transversely, longitudinally; dorsal surface well covered by microscopic granules, short setae scattered at anterior regions and level with grooves at posterior regions; regions moderately divided by shallow grooves; subhepatic, pterygostomial regions granulate, glabrous. Front moderately advanced, about 0.41 times as long as carapace width, strongly deflexed ventrally, margin granulate, outer angles well marked, separated by V-shaped notch from orbital rim; divided into two lobes by deep V-shaped notch, continuing posteriorly as shallow median groove on dorsal carapace. Anterolateral margin convex, granulate, divided into 4 or 5 lobes, separated from each other by V-shaped or U-shaped notches with intercalated denticles; right anterolateral margin with 5 lobes, first lobe very low, feebly demarcated from second lobe; second lobe low; third lobe base widest, apex pointing anteriorly, anterior margin much shorter than posterior; fourth lobe similar to third but smaller; fifth lobe triangular, posterior margin continuous with carapace posterolateral margin; left anterolateral margin with 4 lobe, all lobes in equilateral triangle, apex of lobes 1-3 pointed anterolaterally, fourth lobe pointing laterally. Posterolateral margin slightly longer than anterolateral margin, with central region slightly concave.

Orbits (Fig. 14A, C, E) suboval, margins granulate; inner pre-frontal supraorbital and exorbital tooth weakly developed; supraorbital margin with one closed fissure. Eyes well developed, eyestalks short, stout, corneas large. Antennular fossae transversely oval; antennules folding transversely. Basal article of antenna short, subrectangular; flagellum freely entering orbital hiatus, short, tip slightly exceeding exorbital tooth.

Third maxillipeds (Fig. 16B, D) subrectangular, length to greatest width ratio about 2.05; palp tapering distally, articles subcylindrical; merus subquadrate, length to greatest width ratio about 0.83, anterolateral angle rounded, slightly projecting, anterior margin slightly sinuous, cristate and granulate, stout and thin setae scattered, external surface well covered with granules; ischium subrectangular, about 1.85 times longer than merus, sulcate submedially, mesial margin cristate, serrated, lined with submarginal setae; exopod stout, margins slightly convex, inner margin cristate, tapering slightly toward distal end, distal end slightly concave.

Thoracic sternum (Fig. 14G) margins cristate; sternites 1, 2 fused, external surface smooth; sternites 2, 3 and 3, 4 separated by deep and shallow sutures, respectively; sternite 4 with prominent median longitudinal line extending through half of exposed length, lateral margins slightly convex; median longitudinal line interrupted on sternite 4 within anterior region of sternopleonal cavity, continued at posterior limit of sternite 4, absent in sternites 5, 6, continued in sternites 7, 8 without interruption; sutures 4/5, 5/6 joining toward median longitudinal axis of thoracic sternum; vulvae oval, without operculum, located mesial third of sternite 5; small, central, triangular, non-calcified area present between sternites 6, 7 within sternopleonal cavity; press-button on anterior half of sternite 5.

Chelipeds (Figs. 14A, 15A-D) subequal, moderately robust, external surface almost fully granulate, except distal areas of fingers. Meri moderate long, distal end extending slightly beyond carapace anterolateral margin in dorsal view, dorsal margin granulates, with triangular projection distally. Carpi dorsal margin granulate, with 2 large, triangular tubercles subdistally. Palm dorsal margin granulate, granules raised forming as crest, with two triangular tubercles sub-proximally and 1 rounded tubercle distally, external surface granules compacted, forming reticulated pattern, or arranged in longitudinal rows. Fingers thick, tips hemi-cupuliform; dactylus dorsal margin with 2 parallel crests, forming groove extending toward subdistal end, proximal end with triangular tubercle, distal area strongly deflexed, meeting only at tip with pollex, leaving large gap between fingers, 3 large teeth on proximal end of cutting edge; pollex distal area slightly deflexed, 1 small, 2 large teeth on proximal end of outer cutting edge, 1 small tooth on proximal end of inner cutting edge.

Ambulatory legs (Figs. 14A, 16A) flattened, broad, moderate in length, P3, P4 longest, coxa-todactylus length about 0.91 times carapace width, P5 shortest, coxa-to-dactylus length about 0.71 times carapace width; surfaces entirely smooth; anterior margin of meri spinose, submargin lined with short and long setae, carpi, propodi, dactyli denticulate, submargin lined with short and long setae; posterior margin of meri, submargin lined with long setae, carpi, propodi smooth, without setae, dactyli spinose, with single medium-sized spine posterior to chitinous claw, singletipped. P5 merus subrectangular, median length about 1.72 times greatest width; carpus curved, distal end distinctly wider than proximal end, median length about 1.25 times greatest width; propodus subrectangular, median length about 1.19 times greatest width; dactylus longer than propodus, stout proximally, tapering distally, terminating in sharp, short, slender chitinous claw with length about 2.0 times greatest width.

Pleon (Fig. 14G) moderate long relative to thoracic sternum, tip of telson reaching level to anterior sternal condyles of P2 coxae; somites 1, 2 trapezoidal, much wider than long; somites 3–5 fused, base subequal in width, combined lateral margin straight; somite 6 subquadrate, slightly longer than wide, lateral margins



Fig. 14. *Etisus* sp. B, male (CW 5.8 mm; NMNS 8772-42), A, C, E, G; female (CW 4.1 mm; NMNS 8772-44), F, G: A, B, habitus, dorsal view; C, D, carapace, dorsal view; E, F, habitus, anterior view; G, male pleon; H, female pleon. Scale bars: A, C-D = 1.0 mm; B = 2.0 mm; E-H = 0.5 mm.



Fig. 15. *Etisus* sp. B, male (CW 5.8 mm; NMNS 8772-42), A–D; female (CW 4.1 mm; NMNS 8772-44), E–H: A, E, right chela, external view; B, F, right chela, internal view; C, G, left chela, external view; D, H, left chela, internal view. Arrows indicate the second row of tooth on the proximal end of the cutting edge's internal margin. Scale bars: A-H = 0.5 mm.

straight; telson subtriangular, angles rounded, basal width about as long as median length.

Female morphology: The female (Figs. 14B, D, F, H, 15E–H, 16C) is morphologically similar to the male in most body parts, with differences in the carapace, sexual characters, and chelipeds. The female's carapace is less concave compared to that of the male. The front of the female shows only traces of submedian lobules and is slightly retreated laterally, whereas the male has broader submedian lobules that are moderately retreated. The female's pleon is generally wider and more triangular than the male's. Additionally, the sternopleonal cavity of the female is wider but shallower. The vulvae are oval and located on the mesial third of sternite 5. The female's chelipeds are less robust and nearly equal in size, in contrast to the male's, which are robust and subequal. The dactylus of

both chelae in the female is slightly recurved distally, leaving a smaller gap when close, whereas in the male, it is strongly recurved and leaves a larger gap.

Distribution: Known only from the Liuqiu Island, offshore from southwestern Taiwan.

Remarks: Of the known congeners, *Etisus* sp. B shares morphological similarities with *E. demani* Odhner, 1925 and *E. odhneri* Takeda, 1971, notably in the following features: 1) a bi-lobed front separated by a median V-shaped notch with frontal lobes being slightly sinuous and fringes with pearly granules; 2) intercalated denticles between the anterolateral lobes of the carapace; and 3) strongly recurved distal fingers of chelipeds (Figs. 14A–D, 15A–D; Gordon 1941: 135–136, fig. 9c; Guinot 1964b: 51, 53, figs. 19, pl. VI, fig. 1; Takeda 1971: 193–195, pl. 3, figs. 1–2; Serène 1984: 219, 223). However, *Etisus* sp. B can be distinguished from *E. demani* by the



Fig. 16. *Etisus* sp. B (male, CW 5.8 mm; NMNS 8772-42), A, B, D–F; paratype (female, CW 4.1 mm; NMNS 8772-44), C: A, P5, left, dorsal view; B, C, right 3rd maxilliped; D, anterior area of the right 3rd maxilliped; E, G1, right, external view; F, G1, right, distal area, external view. Scale bars: A - D = 0.2 mm; E = 0.5 mm; F = 0.05 mm.

following: 1) a smaller carapace width/length ratio (1.38 versus 1.46-1.48) (Fig. 14A-D; Guinot 1964b: 51, fig. 19, pl. VI, fig. 1); 2) a single-rimmed front fringed with one row of pearly granules (versus double-rimmed with two rows of pearly granules) (Fig. 14A-D; Gordon 1941: 134, fig. 9d); 3) a granulate supraorbital margin with one fissure (versus smooth and with two fissures) (Fig. 14C-D; Gordon 1941: 134, fig. 9d; Guinot 1964b: 51, figs. 19, pl. VI, fig. 1); 4) a shallow, longitudinal groove dividing the middle of the 3M region in males (versus undivided) (Fig. 14A, C; Guinot 1964b: 51, figs. 19, pl. VI, fig. 1); 5) three uneven-sized teeth on the proximal half of the major chela's dactylus cutting edge (versus two) (Fig. 15A-H; Gordon 1941: 134, fig. 9c); 6) two rows of teeth on the proximal cutting edge of the major chela's pollex, with the outer and inner rows featuring three uneven conical teeth and one small teeth, respectively (versus with one row of one large and several minute teeth) (Fig. 15B, D, F, H; Gordon 1941: 134, fig. 9c); 7) a mosaic of granules on upper region and two rows of small conical granules on lower region of the minor chela's palm (versus smooth) (Fig. 15C; Gordon 1941: 134, fig. 9c); 8) conical granules on the outer margins of the fourth ambulatory leg (versus strong spines) and a smooth inner margin on the fourth leg's merus (versus spines) (Fig. 16A; Gordon 1941: 134, fig. 9a); 9) a smaller dactylus width/length ratio of the fourth ambulatory leg (0.33 versus 0.43) (Fig. 16A; Gordon 1941: 134, fig. 9a); 10) a smaller ischium width/length ratio of the third maxilliped (1.13 versus 1.48) (Fig. 16B-D; Guinot 1964b: 53, fig. 24, pl. VI, fig. 1); 11) a fully granulated outer surface of the third maxilliped's merus and palp (versus smooth) (Fig. 16B-D; Guinot 1964b: 53, fig. 24, pl. VI, fig. 1); and 12) a strongly curved posteroventrally G1 distal part and subapex with eight short, stout setae (versus moderately curved with five long and two short setae) (Fig. 16E, F; Gordon 1941: 135, fig. 10d; Takeda 1971: 192, fig. 3C, D; Serène 1984: 222, fig. 140).

Etisus sp. B differs from *E. odhneri* by: 1) broader submedian lobules on the front, single-rimmed with one row of pearly granules (versus feeble submedian lobules and double-rimmed with two rows) (Fig. 14A–D; Takeda 1971: 193, 209, pl. 3); 2) a divided middle 3M region by a shallow, longitudinal groove (versus undivided) (Fig. 14C; Takeda 1971: 193, 209, pl. 3, fig. 1); 3) a granulate supraorbital margin with one fissure (versus with two notches) (Fig. 15A–H; Takeda 1971: 193, 209, pl. 3, fig. 1); 4) three uneven teeth on the proximal cutting edge of the major chela's dactylus (versus two) (Fig. 15A–H; Takeda 1971: 194, 209, pl. 3, fig. 2); 5) two rows of teeth on the major chela's pollex, with the outer and inner rows having three uneven sized conical teeth and one small teeth (versus one row and four uneven teeth) (Fig. 15B, D, F, H; Takeda 1971: 194, 209, pl. 3, fig. 2); and 6) a strongly curved posteroventrally G1 distal area and a spatulate apex (versus moderately curved) (Fig. 16E, F; Takeda 1971: 192, fig. 3E–F; Serène 1984: 222, fig. 141). The described characteristics of *Etisus* sp. B are based on juvenile specimens, leaving the possibility of ontogenetic morphological changes as the species matures.

Subfamily Euxanthinae Alcock, 1898 Genus *Psaumis* Kossmann, 1877

Psaumis cavipes (Dana, 1852) (Fig. 2B)

Psaumis cavipes Serène 1984: 129–130, fig. 76, pl. XVIII F (for complete synonymy); Ng et al. 2008: 196 [List]; Ng et al. 2017: 87 (for complete collection records from Taiwan).

Material examined: 1 & 1 & 1 &, NMNS 8772-45-46, 3.8-5.1 × 2.3-3.3, Shanfu, Liuqiu Township, Pingtung County, 3-4 May 2007; 1 &, NMNS 8772-47, 5.8 × 3.5, Shanfu, Liuqiu Township, Pingtung County, 24 October 2008; 1 &, NMNS 8772-48, 8.5 × 5.4, Wanlitong, Pingtung County, 13 November 2009.

Distribution: Indo-West Pacific; Fiji and Samoa (Dana 1852b; Serène 1984).

Remarks: *Psaumis* Kossmann, 1877 was previously classified within the subfamily Actaeinae (Serène 1984: 92–94). However, Lai et al. (2011) proposed that this genus belongs to the subfamily Euxanthinae Alcock, 1898 based on both morphological and molecular evidence. Serène (1984: 129) reinstated the genus, following discussions on the identification of *A. cavipes* (Dana, 1852) by Guinot (1976: 203).

The genus is a small taxonomic group represented by only two species: *P. cavipes* (Dana, 1852) (type locality: Fiji and Samoa) and *P. fossulata* (Girard, 1859) (type locality: Red Sea) (Serène 1984). While Serène (1984: 130) synonymized *P. fossulata* as junior name of *P. cavipes*, Ng et al. (2008) considered *P. fossulata* as a valid species. Alcock (1898: 148) distinguished *Actaea fossulata* (Girard, 1859) (= *P. fossulata*) (collection location: Great Coco Island and East Island, Andamans) from *P. cavipes* based on differences in the morphology of the front projections, carapace lobes, chelipeds, and ambulatory legs.

The morphology of the current species (Fig. 2B) matches with diagnosis features of *Psaumis cavipes*, which include numerous small cavities on the dorsal carapace and ambulatory legs, and three distinct cavities on the suborbital and subhepatic regions (Serène 1984: 129).

Subfamily Liomerinae T. Sakai, 1976 Genus *Liomera* Dana, 1851

Liomera bella (Dana, 1852) (Fig. 17A)

Liomera bella Ng et al. 2008: 200; Ng et al. 2017: 91 (for complete collection records from Taiwan).

Liomera (*Liomera*) *bella* Serène 1984: 60, fig. 21, pl. V E (for complete synonymy).

Material examined: 1 &, NMNS 8772-49, 5.7 \times 3.4, Shihmen, New Taipei City, 12 October 2008.

Distribution: Indo-West Pacific (Serène 1984).

Remarks: The morphology of the current specimen (Fig. 17A) aligns with the description of *L. bella* (Dana, 1852) (Dana 1852b: 196, pl. 11, fig. 2). Previous records of this species in Taiwanese waters were from offshore islands in the southeast and southwest regions of the island (Suzuki 1985; Chen and Lo 2014). This study reports the presence of this species along the northern coast of Taiwan, where the annual surface seawater temperature in January is more than 5°C lower than that of southeastern and southwestern Taiwan (Central Weather Bureau 2023).

Liomera rugata (H. Milne-Edwards, 1834) (Fig. 17B)

Liomera rugata Ng et al. 2008: 200; Ng et al. 2017: 91 (for complete record from Taiwan).

Liomera (Liomera) rugata Serène 1984: 62, fig. 22, pl. VI B (for complete synonymy).

Material examined: 1 \diamond , NMNS 8772-50, 8.7 × 5.3, Wanlitong, Pingtung County, 13 May 2009.

Distribution: Indo-West Pacific (Serène 1984).

Remarks: Previous records of *Liomera rugata* (H. Milne-Edwards, 1834) (Fig. 17B) in Taiwanese waters were limited to the Penghu Islands, located off western Taiwan (Ho et al. 2000; Shy et al. 2010). This report documents the species' presence in southern Taiwan.

Subfamily Xanthinae MacLeay, 1838 Genus *Leptodius* A. Milne-Edwards, 1863

Leptodius sanguineus (H. Milne-Edwards, 1834) (Fig. 17C)

Leptodius sanguineus Richters 1880: 147; Alcock and Anderson 1894: 200; De Man 1902: 602; Borradaile 1902: 252; Lenz 1905: 352; 1910: 548; Grant and McCulloch 1906: 10; Rathbun 1906: 847; 1907: 39; Nobili 1907: 389; Calman 1909: 704; Klunzinger 1913: 213 (117); Bouvier 1915: 284 (107); Parisi 1916: 181; Gravier 1920: 466; Balss 1922: 127; 1938: 42; Boone 1934: 116, pls. 60, 61; Ward 1934: 14; 1942: 89; Forest and Guinot 1961: 63, fig. 50; Sankarankutty 1961: 129; 1962: 128, fig. 10–11;

Edmondson 1962: 240, fig. 6e; Guinot 1962a: 235; 1967b: 265; Sakai 1965: 141, pl. 70, fig. 4; 1976: 422, fig. 222; Serène 1968: 75; 1984: 183–184, fig. 106, pl. XXVI A (for complete synonymy); Ooishi 1970: 92, fig. 12, pl. 13; Takeda 1976: 77; Takeda and Miyake 1976: 109; Takeda and Nunomura 1976: 71; Chen and Lan 1978: 263; Ng et al. 2008: 203 [List]; Ng et al. 2017: 93 (for complete collection records from Taiwan).

Material examined: 1 &, NMNS 8772-51, 14.9 \times 9.5, Youzaihu, Ludao Township, Taitung County, 6 September 1996; 3 \updownarrow , NMNS 8772-52, 10.5–11.6 \times 6.5–7.9, Longtou, Lanyu Township, Taitung County, 5 September 1998; 3 & 1 \updownarrow , NMNS 8772-53, 5.8–9.5 \times 3.9–6.8, Jihuei, Taitung County, 7 October 2010; 1 &, NMNS 8772-54, 14.1 \times 8.8, Shitiping, Hualien County, coll. Y.-W. Tzeng, 20 August 2012.

Distribution: Indo-West Pacific; Red Sea; Hawaii (Serène 1984).

Remarks: Leptodius sanguineus (H. Milne Edwards, 1834) (Fig. 17C) is commonly found on the rocky coasts of Taiwan (Ng et al. 2017). This study reports new collection sites for this species along the coasts of eastern Taiwan and offshore islands in the southwestern and southeastern regions.

Genus Lioxanthodes Calman, 1909

Lioxanthodes alcocki Calman, 1909 (Fig. 17D, E)

Lioxanthodes alcocki Calman 1909: 707–708, pl. 72, figs. 1–3; Odhner 1925: 27; Buttendijk 1950: 76; Guinot 1962b: 8, fig. 6a, b; 1971: 1069; Miyake and Takeda 1967: 293; Serène 1968: 77; 1984: 205–206, fig. 124, pl. XXX A; Ng et al. 2008: 203 [List]. *Paraxanthias alcocki* Balss 1938: 50.

Material examined: 2 \diamond 2 \Leftrightarrow (including 1 ovigerous individual), NMNS 8772-55-56, 2.9-4.8 \times 1.7-2.6, Shadao, Hengchun Township, Pingtung County, coll. H.-T. Hung, 17 October, 2020.

Distribution: Christmas Island (Australia), Amami-Oshima Island (Japan); Gilbert Island; southern Taiwan.

Remarks: The genus *Lioxanthodes* is a small group of xanthid crabs represented by only three species: *Lioxanthodes alcocki* Calman, 1909 (Christmas Island, Australia), *L. madagascariensis* Serène, 1984 (Madagascar), and *L. pacificus* Edmondson, 1935 (Washington Island, Kiribati). This study documents the first record of this genus from Taiwan. The morphology of the specimens examined (Fig. 17D, E) closely matches the description of *L. alcocki* Calman, 1909 (Calman 1909: 706–708, pl. LXXII, figs. 1–3; Serène 1984: 202, fig. 124, pl. XXX A). One female specimen from this study carried 28 eggs with an average diameter $0.49 \pm 0.14 \text{ mm} (n = 5)$ preserved in alcohol.



Fig. 17. *Liomera bella* (Dana, 1852) (male, CW 5.7 mm; NMNS 8772-49), A; *Liomera rugata* (H. Milne-Edwards, 1834) (male, CW 8.7 mm; NMNS 8772-50), B; *Leptodius sanguineus* (H. Milne-Edwards, 1834) (female, CW 11.2 mm; NMNS 8772-52), C; *Lioxanthodes alcocki* Calman, 1909, female (CW 4.8 mm; NMNS 8772-56(1)); male (CW 3.2 mm; NMNS 8772-55(1)), D, E; *Macromedaeus crassimanus* (A. Milne-Edwards, 1867) (female, CW 6.2 mm; NMNS 8772-57), F; *Macromedaeus quinquedentatus* (Krauss, 1843) (female, CW 5.8 mm; NMNS 8772-58), G; *Paraxanthias notatus* (Dana, 1852) (male, CW 9.8 mm; NMNS 8772-61), H: A–D, F–H, habitus, dorsal view; E, G1, right, external view. Scale bars: A, D = 1.0 mm; B, C, F–H = 2.0 mm; E = 0.2 mm.

This species marks the first report of this species in Taiwan.

Genus Macromedaeus Ward, 1942

Macromedaeus crassimanus (A. Milne-Edwards, 1867)

(Fig. 17F)

Macromedaeus crassimanus Guinot 1968: 708; 1971: 1068, Serène 1968: 75; 1984: 179, fig. 103, pl. XXV B (for complete synonymy); Ng et al. 2008: 203 [List]; Ng et al. 2017: 93 (for complete collection records from Taiwan).

Material examined: $1 \Leftrightarrow$, NMNS 8772-57, 6.1 × 4.2, Shanfu, Liuqiu Township, Pingtung County, 4 May 2007.

Distribution: Indo-Pacific (Guinot 1968).

Remarks: Guinot (1968) identified six species within the genus Macromedaeus: M. crassimanus (A. Milne-Edwards, 1867), M. demani (Odhner, 1925), M. distinguendus (De Haan, 1835), M. nudipes (A. Milne-Edwards, 1867), M. quinquedentatus (Krauss, 1843) and M. voeltzkowii (Lenz, 1905). Recently, two additional species, M. adelus Mendoza, 2021 and M. hainanensis Yuan, Jiang and Sha, 2022, have been described, increasing the total to eight. However, M. hainanensis appears morphological similar to M. adelus, and J.C.E. Mendoza suggested that these two species are synonymous, with M. adelus being the senior synonym according to the principle of priority (ICZN Article 23). Mendoza based this conclusion on a careful comparison of the descriptions and illustrations provided by Yuan et al. (2022) and the type material of M. adelus. Key diagnostic features included the four broadly triangular teeth on the carapace anterolateral margin, the absence of lateral projections on the external margin of the ambulatory carpi, and the morphology of the G1 (e.g., overall shape, distal tapering, and arrangement of subdistal spiniform setae). Additionally, the female paratype of *M. hainanensis* resembled the female type specimens of *M. adelus*. Most of the type series of *M*. hainanensis comprised immature or subadult individuals with carapace widths of less than 10 mm, showing no significant morphological differences from similarly sized specimens of *M. adelus* (Hsueh, pers. comm.).

The current specimen (Fig. 17F) matches the key characteristics of *M. crassimanus* (A. Milne-Edwards, 1867): five teeth on the anterolateral margins, a frontoorbital width distinctly less than half the greatest carapace width, and carapace regions separated by broad, shallow furrows (Serène 1984: 177, pl. XXV B). *Macromedaeus crassimanus* was first reported in Taiwan by Ho et al. (2000). This study provides the second record of this species, now from an offshore island in southwestern Taiwan.

Macromedaeus quinquedentatus (Krauss, 1843) (Fig. 17G)

Macromedaeus quinquedentatus Guinot 1968: 708; 1971: 1068; Serène 1968: 75; 1984: 179, fig. 104, pl. XXV D-E (for complete synonymy); Ng et al. 2008: 203 [List].

Material examined: $1 \Leftrightarrow$, NMNS 8772-58, 5.8 × 3.9, Shanfu, Liuqiu Township, Pingtung County, 4 May 2007.

Distribution: Indo-West Pacific; Hawaii (Serène 1984).

Remarks: The morphology of the present specimen (Fig. 17G) aligns with the defining characteristics of *M. quinquedentatus* (Krauss, 1843). These features include five teeth on the anterolateral margins, a fronto-orbital width slightly less than half the greatest width of the carapace, and distinct carapace regions separated by large, deep furrows (Serène 1984: 177, pl. XXV D–E). This report marks the first record of this species from Taiwan.

Macromedaeus sp. A (Figs. 18A–H, 19A–C)

Material Examined: $2 \Leftrightarrow$, NMNS 8772-59–60, 3.0–4.3 × 2.3–3.1, Shitiping, Taitung County, coll. Y.-W. Tzeng, 25 March 2011.

Description: Carapace (Fig. 18A-C) transversely ovate, width to length ratio about 1.30-1.39, dorsal area slightly convex transversely, longitudinally; dorsal surface well covered by microscopic granules, glabrous; regions weakly defined, divided by shallow grooves. Front moderately advanced, about 0.41-0.43 times as long as carapace width, slightly deflexed ventrally, margin granulate, outer angles well marked and separated by V-shaped notch from orbital rim; divided into 2 lobes by narrow V-shaped notch, continuing posteriorly as shallow median groove on dorsal carapace. Anterolateral margin convex, granulate, divided into 4 low lobes, separated from each other by wide V-shaped or U-shaped notches with intercalated denticles; first lobe low; second and third lobe subequal in size, equilaterally triangular, tip blunt, pointing anterolaterally; fourth lobe small, pointing laterally, posterior margin continuous with carapace posterolateral margin. Posterolateral margin slightly longer than anterolateral margin, straight.

Orbits (Fig. 18A–C) suboval, margins granulate; inner pre-frontal supraorbital and exorbital tooth weakly developed; supraorbital margin with 2 fissures; infraorbital margin continuous. Eyes well developed, eyestalks short, stout, corneas large. Antennular fossae transversely oval; antennules folding transversely. Basal article of antenna short, subrectangular; flagellum freely entering orbital hiatus, short, tip slightly exceeding exorbital angle.

Third maxillipeds (Fig. 19A–B) subrectangular, length to greatest width ratio about 2.16; palp tapering distally, articles subcylindrical; merus subquadrate, length to greatest width ratio about 0.79, anterolateral angle rounded, slightly projecting, anterior margin sinuous, granulate, external surface well covered with granules; ischium subrectangular, about 1.80 times longer than merus, sulcate submedially, mesial margin cristate, serrated, lined with submarginal setae, external surface well covered with granules; exopod stout, margins slightly convex, tapering slightly toward distal end, distal end straight, external surface well covered with granules.

Thoracic sternum (Fig. 18D) margins cristate; sternites 1, 2 fused, external surface granulate; sternites 2, 3 and 3, 4 separated by deep and shallow sutures, respectively; sternite 4 with prominent median longitudinal line extending through half of its exposed length, lateral margins slightly convex; median longitudinal line interrupted on sternite 4 within anterior region of sternopleonal cavity, continued at posterior limit of sternite 4; sutures 4/5, 5/6 joining toward median longitudinal axis of thoracic sternum; vulvae oval, without operculum, located mesial third of sternite 5.

Chelipeds (Fig. 18A, E–H) subequal, moderately robust, external surface almost fully granulate, except partial surfaces of fingers. Meri moderate long, distal end extending slightly beyond carapace anterolateral margin in dorsal view, margins granulate. Carpi dorsal margin granulate proximally, longitudinal granule row bifurcated at middle area with 2 raised tubercles on each side of granule rows subdistally, forming groove appearance of dorsal margin in distal half, groove appearance continuing perpendicularly toward lower margin subdistally. Palm dorsal margin granulate with longitudinal row of tubercles, external upper surface with longitudinal row of tubercles. Fingers slightly thick, tips pointed, beige in alcohol; dactylus with 2 granulate submarginal crests, forming longitudinal groove toward subdistal end, distal area moderately deflexed, leaving small gap between fingers, 4 teeth on cutting edge with larger teeth at proximal end; pollex external surface of lower submargin with longitudinal groove, 5 teeth on cutting edge with 3 larger ones at distal end.

Ambulatory legs (Figs. 18A, 19C) flattened, broad, moderate in length, P3, P4 longest, coxa-to-

dactylus length about 0.95 carapace width, P5 shortest, coxa-to-dactylus length about 0.73 times carapace width; surfaces entirely smooth, covered with shot setae, anterior margin of meri, carpi, propodi, dactyli denticulate, submargin of meri lined with long setae; posterior margin of meri, propodi, dactyli denticulate, dactyli with single large spine posterior to chitinous claw, single-tipped. P5 merus subrectangular, median length about 2.34 times greatest width; carpus curved, distal end distinctly wider than proximal end, median length about 1.29 times greatest width; propodus subrectangular, median length about 1.28 times greatest width; dactylus about as long as propodus, stout proximally, tapering distally, terminating in sharp, short, chitinous claw with length about 1.71 times greatest width.

Pleon (Fig. 18D) moderate long relative to thoracic sternum, tip of telson reaching level median to sternal condyles of Pl coxae; somites 1, 2 trapezoidal, much wider than long; all somites free, base of somite 3 widest, distal somites progressively narrower, combined lateral margin straight; somite 6 subrectangular, much wider than long, lateral margins slightly convex; telson subtriangular, angles rounded, basal width about as long as median length.

Distribution: Known only from the coast of East Taiwan.

Remarks: The morphology of *Macromedaeus* sp. A resembles that of M. adelus Mendoza, 2021, M. distinguendus (De Haan, 1835), and M. voeltzkowi (Lenz, 1905), particularly in having four teeth on the anterolateral margins of the carapace (Fig. 18A, B; Serène 1984: 178, pl. XXV F; Mendoza 2021: 470, 474, figs. 5A, 7A; Yuan et al. 2022: 8, 10, 16, figs. 3A, B, 4A, B, 8A, B). However, Macromedaeus sp. A can be distinguished from M. adelus by the following features: 1) smaller carapace width/length ratio (1.30–1.39 versus mean 1.59; Mendoza 2021: 469); 2) carapace regions are weakly defined and separated by shallow grooves (versus well-defined, separated by deep, acute furrows) (Fig. 18A, B; Mendoza 2021: 471-472, fig. 5A); 3) the dorsal carapace region 6L is divided by an oblique furrow (versus undivided) (Fig. 18A, B; Mendoza 2021: 471-472, fig. 5A); 4) anterior margin of lobes is not separated from preorbital tooth by a deep notch (versus separated by a deep notch, appearing as a small fossa from an anterior view) (Fig. 18C; Mendoza 2021: 471-472, figs. 5A, 6A); 5) outer surface of the third maxilliped is densely covered with large granules (versus micro granules) (Fig. 19A, B; Mendoza 2021: 472, fig. 6B); 6) pigmentation of the pollex does not extend onto palm (versus extending onto palm) (Fig. 18E-H; Mendoza 2021: 470, fig. 5G, H); 7) greater length/width ratio of P5 merus (3.43



Fig. 18. *Macromedaeus* sp. A (female, CW 4.2 mm; NMNS 8772-59): A, habitus, dorsal view; B, carapace, dorsal view; C, habitus, anterior view; D, thoracic sternum and pleon; E, right chela, external view; F, right chela, internal view; G, left chela, external view; F, left chela, internal view. Scale bars: A = 1.0 mm; B-H = 0.5 mm.

versus 2.11) (cf. Mendoza 2021: 470, fig. 5F); and 8) presence of a row of denticle teeth on the lower margin of P5 dactylus and a large tooth behind the claw (versus few scattered submarginal denticle teeth and a large tooth behind the claw) (Fig. 19C; Mendoza 2021: 472, fig. 6G). Macromedaeus sp. A differs from M. distinguendus by: 1) front submedian lobules divided by a notch (versus undivided) (Fig. 18A, B; Yuan et al. 2022: 11, 16, figs. 5B, 8B); 2) dorsal carapace region 6L divided by an oblique furrow (versus entire) (Fig. 18C; Serène 1984: 177; Yuan et al. 2022: 16, fig. 8A, B); 3) pollex pigmentation not extending onto the palm (versus extending) (Fig. 18E-H; Yuan et al. 2022: 16, fig. 8E, F); 4) row of denticle teeth present on the upper margin of P5 merus (versus absent) (Fig. 19C; Yuan et al. 2022: 12, fig. 6B); 5) greater length/width ratio of P5 dactylus (3.43 versus 2.50) (Fig. 19C; c.f. Yuan et al. 2022: 12, fig. 6B); and 6) row of denticle teeth on the lower margin of P5 dactylus and a large tooth behind the claw (versus absent) (Fig. 18E-H; Yuan et al. 2022: 12, fig. 6B). Compared to M. voeltzkowi, Macromedaeus sp. A has: 1) carapace regions weakly defined and separated by shallow grooves (versus welldefined, divided by deep, acute furrows) (Fig. 18A, B; Barnard 1950: 226, fig. 41d; Serène 1984: 177, pl. XXV F); 2) dorsal carapace region 6L divided by an oblique furrow (versus transverse furrow) (Fig. 18C; Barnard 1950: 226, fig. 41d; Serène 1984: 177, pl. XXV F); 3) dorsal surface covered by microscopic granules (versus irregularly granular) (Fig. 18A, B; Barnard 1950: 226, fig. 41d; Serène 1984: 177, pl. XXV F); and 4) pollex pigmentation not extending onto the palm (versus extending) (Fig. 18E-H; Lenz 1905: 353, pl. XLVII 6a). The present morphological characters observations are based on juvenile female specimens. Potential sexbased variations or ontogenetic changes in this species remain unclear.



Fig. 19. *Macromedaeus* sp. A (female, CW 4.3 mm; NMNS 8772-59): A, right 3rd maxilliped, external view; B, right 3rd maxilliped, anterior area, external view; C, P5, right, dorsal view. Scale bars: A-C = 0.2 mm.

Genus Paraxanthias Odhner, 1925

Paraxanthias notatus (Dana, 1852) (Fig. 17H)

Paraxanthias notatus Odhner 1925: 84; Balss 1938: 51; Sakai 1939: 470, 1965: 142, pl. 71, fig. 3, 1976: 430–43, pl. 155, fig. 3; Edmondson 1946: 291, fig. 177e; Guinot 1964b: 30, 1968: 718, fig. 47; Dai et al. 1986: 277, fig. 156B(2), pl. 38(4); Dai and Yang 1991: 299, fig. 156B(2), pl. 38(4) (for complete synonymy); Ng et al. 2008: 204 [List]; Ng et al. 2017: 94 (for complete collection records from Taiwan).

Material examined: 2 , NMNS 8772-61, 8.8–9.8 \times 5.9–6.5, Shadao, Hengchun Township, Pingtung County, coll. H.-T. Hung, 17 October, 2020.

Distribution: Indo-Pacific (Dai and Yang 1991). Remarks: The morphology of the present specimen (Fig. 17H) aligns with the description of *Paraxanthias* notatus (Dana, 1852) provided by Dai and Yang (1991: 299, pl. 38 (4)). Collection records from Taiwan suggest that the distribution of this species is predominantly confined to the southern tip of Taiwan and nearby offshore islands (Ng et al. 2017).

Genus Xanthias Rathbun, 1897

Xanthias lamarckii (H. Milne Edwards, 1834) (Fig. 20A)

Xanthias lamarckii Serène 1984: 195–196, fig. 112, pl. XXVII B (for complete synonymy); Ng et al. 2008: 204 [List]; Ng et al. 2017: 94 (for complete collection records from Taiwan).

Material examined: $1 \Leftrightarrow$, NMNS 8772-62, 9.2 × 5.2, Shanfu, Liuqiu Township, Pingtung County, 3 May 2007; $1 \Leftrightarrow$, NMNS 8772-63, 9.2 × 5.2, Shanfu, Liuqiu Township, Pingtung County, 24 October 2008; $1 \Leftrightarrow$, NMNS 8772-64, 5.8 × 3.8, Wanlitong, Pingtung County, 13 May 2009; $1 \Leftrightarrow$, NMNS 8772-65, 6.3 × 4.2, Jihuei, Taitung County, 13 December, 2012.



Fig. 20. *Xanthias lamarckii* (H. Milne-Edwards, 1834) (female, CW 6.3 mm; NMNS 8772-65), A; *Atergatis floridus* (Linnaeus, 1767) (female, CW 5.8 mm; NMNS 8772-66), B; *Zozymodes pumilus* (Hombron and Jacquinot, 1846 [in Hombron and Jacquinot, 1842–1854]), female (CW 9.1 mm; NMNS 8772-70); male (CW 5.6 mm; NMNS 8772-67), C, D: A–C, habitus, dorsal view; D, G1, right, distal area, external view. Scale bars: A = 2.0 mm; B = 1.0 mm; C = 3.0 mm; D = 0.1 mm.

Distribution: Indo-Pacific (Serène 1984).

Remarks: Xanthias lamarckii (H. Milne Edwards, 1834) (Fig. 20A) has been frequently documented in Taiwanese waters (Ng et al. 2017). This study reports a new collection location for this species along the eastern coast of Taiwan.

Subfamily Zosiminae Alcock, 1898 Genus Atergatis De Haan, 1833

Atergatis floridus (Linnaeus, 1767) (Fig. 20B)

Cancer floridus Linnaeus 1767: 1041.

Atergatis floridus Dai et al. 1986: 261, text-fig. 150A(1), pl. 35(8); Dai and Young 1991: 282, text-fig. 150A(1), pl. 26(8); Ng and Davie 2007: 169–172, figs. 2A–C, 3A, 4A, C (for the discussion of synonymy); Ng et al. 2008: 205, 209; Ng et al. 2017: 94 (for complete collection records from Taiwan).

Material examined: $1 \Leftrightarrow$, NMNS 8772-66, 5.8 × 4.0, Jihuei, Taitung County, 13 December 2012.

Distribution: Widely distributed in the Indo-West Pacific (Dai and Young 1991).

Remarks: The morphology of the present specimen (Fig. 20B) aligns with the neotype of this species as designated by Ng and Davie (2007). Reports of this species in Taiwan have been documented over the past century (Ng et al. 2017).

Genus Zozymodes Heller, 1860

Zozymodes pumilus (Hombron and Jacquinot, 1846)

(Fig. 20C, D)

Zozymodes pumilus Serène 1984: 153, fig. 90, pl. XIX E (for complete synonymy); Hsueh et al. 2009: 1026; Ng et al. 2008: 206 [List]; Ng et al. 2017: 95.

Material examined: $1 \Leftrightarrow 1 \Leftrightarrow \text{NMNS } 8772-67$, 5.5–5.6 × 3.7–3.8, Shanfu, Liuqiu Township, Pingtung County, 4 May 2007; $1 \Leftrightarrow 3 \Leftrightarrow \text{NMNS } 8772-68, 6.5-9.2$ × 4.1–5.6, Jihuei, Taitung County, 7–9 October, 2010; $1 \Leftrightarrow 7 \Leftrightarrow$ (including 2 ovigerous individuals) NMNS 8772-69–72, 5.4–10.0 × 3.1–5.3, Jihuei, Taitung County, 28–29 April, 2017.

Distribution: Indo-Pacific (Serène 1984).

Remarks: The morphology of the present specimens (Fig. 20C, D) matches the key characteristics of *Zozymodes pumilus* (Hombron and Jacquinot, 1846) (Serène 1984: 152, fig. 90, pl. XIX E; Lasley and Ng 2013: 8–9, fig. 4B). Hsueh et al. (2009) first recorded this species based on specimens collected from Wanlitong, Pingtung County, southern Taiwan. Li et al. (2010) reported it from Liuqiu Island, off southwestern Taiwan. This study documents a new collection location for the species along the coasts of eastern Taiwan.

DISCUSSION

The size of xanthid crabs varies greatly among species. The adult carapace width of some species (i.e., Lioxanthodes alcocki Calman, 1909) can be as small as a few millimeters, whereas in others (i.e., Atergatis latissimus (H. Milne-Edwards, 1834), it can exceed 100 millimeters (Serène 1984). Specimens from the present study were excavated from small rock crevices in intertidal habitats, and their sizes tended to be small, with carapace widths not exceeding 15 millimeters. This suggests that most of them are likely in their juvenile or adolescent of life stage. Evidence supporting this observation includes the triangular or oval shapes of the female pleon in most specimens (Figs. 5D, 7G, 9H, 13H, 14H, 18D). Exceptions include two egg-bearing females (Liocarpilodes harmsi, CW 6.7 and 4.8 mm; NMNS 8772-29, 36), one egg-bearing female (Lioxanthodes alcocki, CW 6.2 mm; NMNS 8772-56), and two egg-bearing females (Zozymodes pumilus, CW 9.4 and 10.4 mm; NMNS 8772-71, 72). Proper identification of juvenile xanthid crabs can be challenging due to potential ontogenetic morphological changes.

CONCLUSION

The present study reviews xanthid crabs collected from rocky intertidal habitats in Taiwan and nearby offshore islands during ecological surveys conducted over the past 25+ years. A total of 24 species are recognized, represented by seven subfamilies and 16 genera in the family Xanthidae MacLeay, 1838. The subfamilies are Actaeinae Alcock, 1898, Chlorodiellinae Ng and Holthuis, 2007, Etisinae Ortmann, 1893, Euxanthinae Alcock, 1898, Liomerinae T. Sakai, 1976, Xanthinae MacLeay, 1838, and Zosiminae Alcock, 1898. The 16 genera include Actaeodes Dana, 1851, Atergatis De Haan, 1833, Chlorodiella Rathbun, 1897, Cyclodius Dana, 1851, Etisus H. Milne Edwards, 1834, Leptodius A. Milne-Edwards, 1863, Liocarpilodes Klunzinger, 1913, Liomera Dana, 1851, Lioxanthodes Calman, 1909, Luniella Lasley, Klaus and Ng, 2015, Macromedaeus Ward, 1942, Paraxanthias Odhner, 1925, Pilodius Dana, 1851, Psaumis Kossmann, 1877, Xanthias Rathbun, 1897, and Zozymodes Heller, 1860. Lioxanthodes is recorded from Taiwan for the first time. Of the 24 recognized species, 14 have been previously

reported from Taiwan, five are new record to Taiwan, one is new to science, and four unnamed species. The new records include *Chlorodiella barbata* (Borradaile, 1900), *Etisus frontalis* (Dana, 1952), *Lioxanthodes alcocki* Calman, 1909, *Macromedaeus quinquedentatus* (Krauss, 1843), and *Pilodius nigrocrinitus* Stimpson, 1859. The new species, *Cyclodius taiwanensis* sp. nov., is described herein.

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