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GENERIC AFFINITIES OF *ERIOCHEIR LEPTOGNATHUS* AND *E. FORMOSA* WITH DESCRIPTION OF A NEW GENUS (BRACHYURA: GRAPSIDAE: VARUNINAE)

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ABSTRACT

The varunine crab genus *Neoeriocheir,* previously synonymized under *Eriocheir,* is here regarded as a valid taxon. The type species, *N. leptognathus,* differs from members of *Eriocheir* sensu stricto in the form of its epistome, chelipeds, and male first pleopod as well as first zoeal structures. *Eriocheir formosa* is here assigned to a new genus, *Platyeriocheir.* The type species, *Eriocheir formosa,* is distinctly different from species of *Eriocheir* sensu stricto based on the structure of the carapace, the chelipeds, the thoracic sternum, and the male first pleopod, and on the form of the zoeal and megalopal stages.

The varunine crab genus *Eriocheir* de Haan, 1835, as currently defined, contains five taxa, namely, *E. japonica* (de Haan, 1835) (type species by designation by H. Milne Edwards, 1854), *E. sinensis* H. Milne Edwards, 1854, *E. leptognathus* Rathbun, 1913, *E. hepuensis* Dai, 1991, and *E. formosa* Chan, Hung, and Yu, 1995. Sakai (1983) noted that *E. leptognathus* differed from its congeners in several important characters and referred it to a new monotypic genus, *Neoeriocheir.* Subsequent workers, however, have not used this classification (e.g., Chan *et al.,* 1995; Kim and Hwang, 1995), preferring to retain *E. leptognathus* in *Eriocheir* instead. Chan *et al.* (1995) commented that they could discern no good reasons for recognizing *Neoeriocheir* as a valid genus and regarded it as a junior synonym of *Eriocheir.* Guo *et al.* (1997) recently revised the taxonomy of *E. japonica, E. sinensis,* and *E. hepuensis,* commenting briefly that *E. leptognathus* and *E. formosa* should be referred to other genera.

As part of a study of the taxonomy and biology of *Eriocheir,* we have examined a large series of specimens of all the species currently placed in the genus. Our studies show that *Eriocheir* is a heterogeneous taxon, and can be split into three discrete genera. *Neoeriocheir* Sakai, 1983, is considered here to be a valid genus, with its type species, *E. leptognathus,* differing markedly from all other species of *Eriocheir* sensu stricto in numerous adult and larval characters. *Eriocheir formosa* also possesses its own suite of characters which strongly argue against its continued inclusion in *Eriocheir* sensu stricto or *Neoeriocheir* as presently defined. *Eriocheir formosa* is here referred to a new genus, *Platyeriocheir.* As such, *Eriocheir* sensu stricto contains only three species, *E. japonica* (type species), *E. sinensis,* and *E. hepuensis* (see Guo *et al.,* 1997). The present paper serves to revalidate and rediagnose *Neoeriocheir,* as well as to describe *Platyeriocheir,* new genus.

Specimens examined are deposited in the Institute of Zoology, Academia Sinica (AS), Beijing, China; Institute of Zoology, Academia Sinica (ASIZ), Taipei, Taiwan; Beijing Natural History Museum (BNHM), Beijing, China; Tsing Hua University (CHCD), Hsinchu, Taiwan; Muséum National d'Histoire Naturelle (MNHN), Paris, France; Natural History Museum (NHM), London, England; National Museum of Natural Science (NMNS), Taichung, Taiwan; National Taiwan Ocean University (NTOU), Keelung, Taiwan; Rijksmuseum van Natuurlijke Historie (RMNH), Leiden, The Netherlands; Taiwan Museum (TMCD), Taipei, Taiwan; National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C., U.S.A.; Zoological Institute and Museum (ZIM), Hamburg, Germany; and Zoological Reference Collection (ZRC), and Department of Biological Sciences, National University of Singapore. All measurements provided are of the carapace width and carapace length, respectively. The abbreviations G1 and G2 are used for the male first and second pleopods, respectively.

SYSTEMATICS

Grapsidae Dana, 1851
Varuninae Alcock, 1900

Neoeriocheir Sakai, 1983.
Neoeriocheir Sakai, 1983: 19, pls. III, VIII.

Diagnosis.—Carapace quadrate; epigastric, protogastric cristae very low to almost indiscernible; frontal margin very low, lobes faint, appearing almost straight; anterolateral margin with 3 teeth; posterior margin of epistome entire, lateral parts without lobes or clefts. Merus of third maxilliped slender; dactylus twice as long as propodus; exopod not reaching middle of merus. Outer surface of chelae smooth, glabrous; inner surface covered with dense, soft, long setae. Suture between sternites 2 and 3 distinctly convex toward abdomen; lateral margins of sternites 3 and 4 almost entire, no clear notch demarcating edge of suture; longitudinal median groove between sternites 5 and 6 narrow; space on sternite 8 very narrow throughout length. G1 short, stout. Operculum of vulvae crenulated, margins setose.

Type species.—Eriocheir leptognathus Rathbun, 1913, by original designation.

Remarks.—Sakai (1983) briefly stated that the main difference between *N. leptognathus* and all other species of *Eriocheir* was in the form of the third maxilliped. In *N. leptognathus,* the ischium and merus of the third maxilliped are long and narrow (Fig. 2Bi). In all other species of *Eriocheir,* however, these segments are short and wide (Figs. 2Bii, 3D). A detailed comparison of all known taxa of *Eriocheir* (present study) showed a number of key differences between *N. leptognathus* and the other species. These include differences in characters of the carapace, third maxilliped, anterior thoracic sternites, chelipeds, ambulatory legs, G1, and vulvae (Table 1). These substantial differences are sufficient to warrant the recognition of *Neoeriocheir* as a valid genus. It is important to note that all the characters listed in Table 1 for *Eriocheir sinensis* are also valid for *E. japonica* and *E. hepuensis* (i.e., *Eriocheir* sensu stricto).

Comments on characters regarded here as having generic significance seem pertinent. For the purposes of the discussion, *E. formosa* is regarded as a member of the genus *Platyeriocheir* (see details below). The carapace in *N. leptognathus* is smooth (Fig. 1A), with very low epigastric and protogastric cristae (in smaller specimens, these cristae are almost indiscernible). The frontal margins of *E. sinensis, E. japonica,* and *E. hepuensis* are very distinctly quadrilobed or quadridentate. In *P. formosa,* the lobes are shallow and this margin appears gently sinuous to almost straight. In *N. leptognathus,* however, the frontal margin lobes are so strongly reduced that the frontal margin appears straight (Fig. 1A). All species of *Eriocheir* sensu stricto have four teeth along the anterolateral margin (versus three in *N. leptognathus* and *P. formosa*). The presence of long soft setae only on the inner surfaces of the chelae is distinctive for *N. leptognathus.* In species of *Eriocheir* sensu stricto, these setae are present both on the inner and outer surfaces of the chelae, and in *P. formosa,* the setae are present only on the outer surfaces of the chelae (Fig. 3E, F). The very differently structured posterior margin of the epistome is a key character. In *N. leptognathus,* the lateral parts are continuous and entire, with only the median lobe present (Fig. 2Fi). In species of *Eriocheir* sensu stricto (Fig. 2Fii), the lateral part of the posterior margin of the epistome has two distinct clefts, and the margin is trilobed. The longitudinal median groove between the fifth and sixth thoracic sternites in *N. leptognathus* is narrow (Fig. 2Ci), while in species of *Eriocheir* sensu stricto, this groove is broad (Fig. 2Cii). The G1 of *N. leptognathus* (Fig. 5A) is short and thick, with the distal end notably different from those of species of *Eriocheir* and *Platyeriocheir* (Fig. 5B–E). The vulvae of *N. leptognathus* (Fig. 5F) are also distinct from those of *Eriocheir* (Fig. 5G–I).

In addition, there are some general characters which can also differentiate *Neoeriocheir* from known species of *Eriocheir* sensu stricto. The cornea of *N. leptognathus* is smaller than that of *Eriocheir,* and the basal part of the eye stalk is narrower. The ambulatory legs of *N. leptognathus* (Fig. 2Di) are also proportionately longer and more slender than those of *Eriocheir* sensu stricto (Fig. 2Dii) and *P. formosa* (Fig. 3H).

Sakai (1983) used the color as well as the small size of *N. leptognathus* to justify its placement in its own genus. Color characters, however, while occasionally useful at the species level, are unlikely to be significant when genera are considered. Neither is size, but marked size differences sometimes give an indication that generic assignments may be incorrect. All known species of *Eriocheir* sensu stricto are relatively large crabs, reaching maturity at carapace lengths of at least

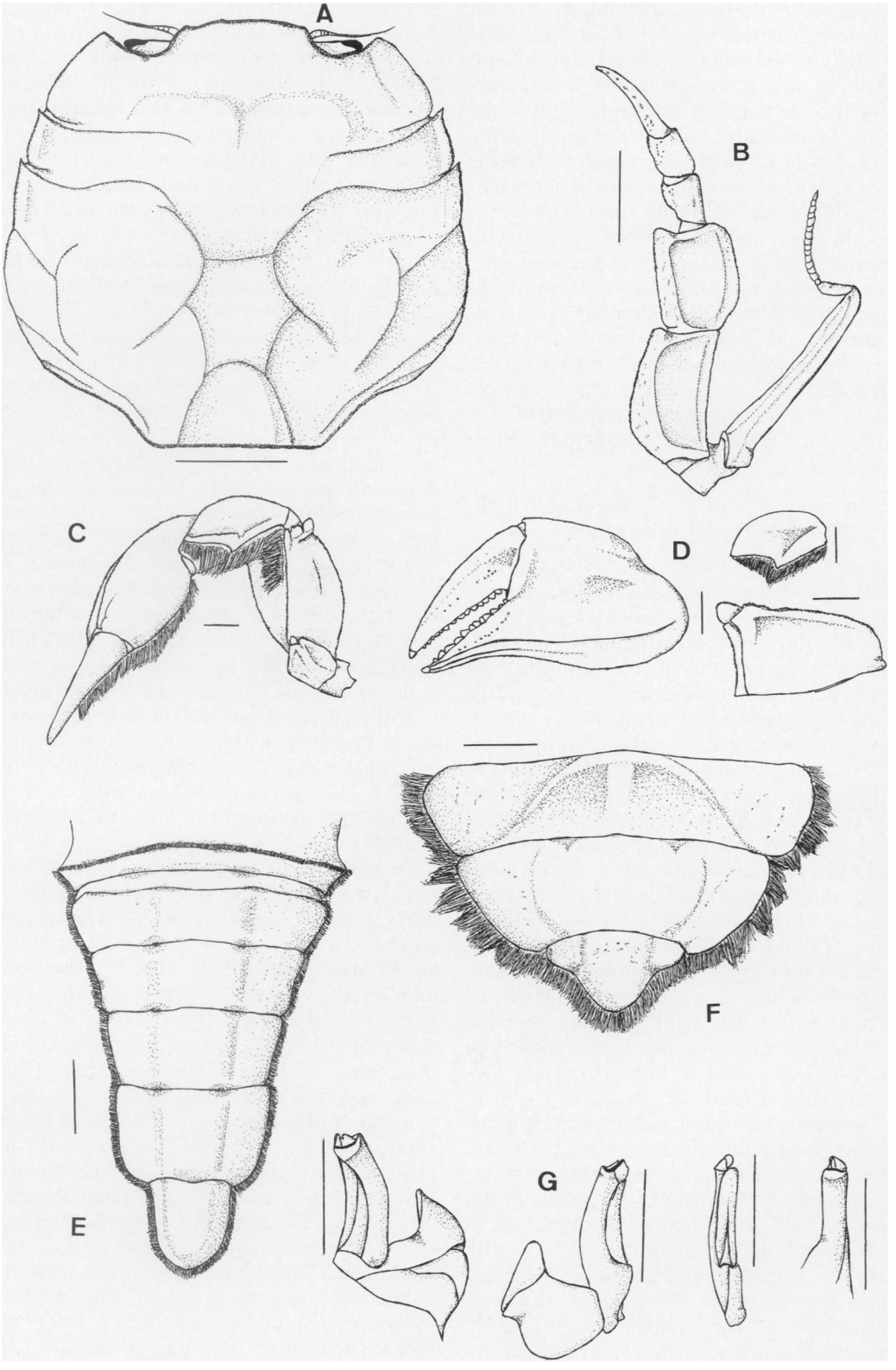
A
B
C
D
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Table 1. Summary of the morphological differences between *Neoeriocheir leptognathus, Eriocheir sinensis,* and *Platyeriocheir formosa.* * = characters of generic significance.

Characters	*Neoeriocheir leptognathus*	*Eriocheir sinensis*	*Platyeriocheir formosa*
Frontal margin*	lobes low; indistinct, appears straight (Fig. 6A)	4 distinct sharp lobes (Fig. 6B)	lobes indiscernible; margin straight (Fig. 6C)
Lateral margin*	3 teeth (Fig. 6A)	4 teeth (Fig. 6B)	3 teeth (Fig. 6C)
Bases of eye stalks	narrow	broad	broad
Epi- and protogastric cristae*	very low; discernible (Fig. 6A)	high and sharp (Fig. 6B)	low and blunt (Fig. 6C)
Epistome*	not separated into lobes (Fig. 2Fi)	separated into 3 lobes (Fig. 2Fii)	separated into 3 lobes (Fig. 3C)
Ischium and merus of third maxilliped*	long and narrow (Fig. 2Bi)	short and wide (Fig. 2Bii)	short and wide (Fig. 3D)
Dactylus and propodus of third maxilliped*	dactylus 2 times length of propodus (Fig. 2Bi)	dactylus 1.5 times length of propodus (Fig. 2Bii)	dactylus 1.7 times length of propodus (Fig. 3D)
Exopod of third maxilliped*	reaches to midlength of merus (Fig. 2Bi)	reaches to just before distal edge of merus (Fig. 2Bii)	reaches to just before distal edge of merus (Fig. 3D)
Thoracic sternites*	Suture between sternites 2 and 3 distinctly convex toward abdomen; lateral margins of sternites 3 and 4 almost entire, clear notch demarcating edge of suture; longitudinal median groove between sternites 5 and 6 narrow; space on sternite 8 very narrow throughout length (Fig. 2Ci)	Suture between sternites 2 and 3 distinctly almost straight or only slightly convex toward abdomen; lateral margins of sternites 3 and 4 gently sinuous, with small but distinct notch demarcating edge of suture; longitudinal median groove between sternites 5 and 6 broad; space on sternite 8 narrow; sternite 8 narrow throughout length (Fig. 2Cii)	Suture between sternites 2 and 3 distinctly convex toward abdomen; lateral margin of sternites 3 and 4 strongly sinuous, with deep broad notch demarcating edge of suture; longitudinal median groove between sternites 5 and 6 very broad; space on sternite 8 narrow proximally and distinctly broad distally (Fig. 4A)
Setae on chelae*	inner surface only (Fig. 1A)	both outer and inner surface (Fig. 3E)	outer surface only (Fig. 6B)
Distal tooth on cheliped merus*	absent (Fig. 2Ei)	present (Fig. 2Eii)	absent (Fig. 3F)
Tip of dactylus of cheliped	sharp and corneous (Fig. 1C)	sharp and corneous (Fig. 6B	blunt and spoon-shaped (Fig. 3G)
Propodus of last ambulatory leg*	very long and slender with very long thick setae (Fig. 2Di)	long and slender with long sparse setae (Fig. 2Dii)	very short and wide with short bristlelike setae (Fig. 3H)
Dactylus of last ambulatory leg	slightly compressed dorsoventrally (Fig. 2Di)	rounded with angular margins (Fig. 2Dii)	dorsoventrally compressed (Fig. 3H)
G1*	short and stout, distal portion chitinous, slightly curved dorsally outward (Fig. 5A)	short and stout, distal portion broadly rounded, ball-like in lateral view (Fig. 5B)	long and narrow, distal portion rounded (Fig. 5E)
Vulvae*	operculum crenulated with setose margins (Fig. 5F)	operculum triangular, concave dorsally (Fig. 5G)	operculum rectangular, concave dorsally (Fig. 5J)
Spawning season	October–January	October–January	May–June
Spawning behavior	no migration, remains in coastal areas	migrates from fresh water to estuarine waters	migrates from fresh water to estuarine waters

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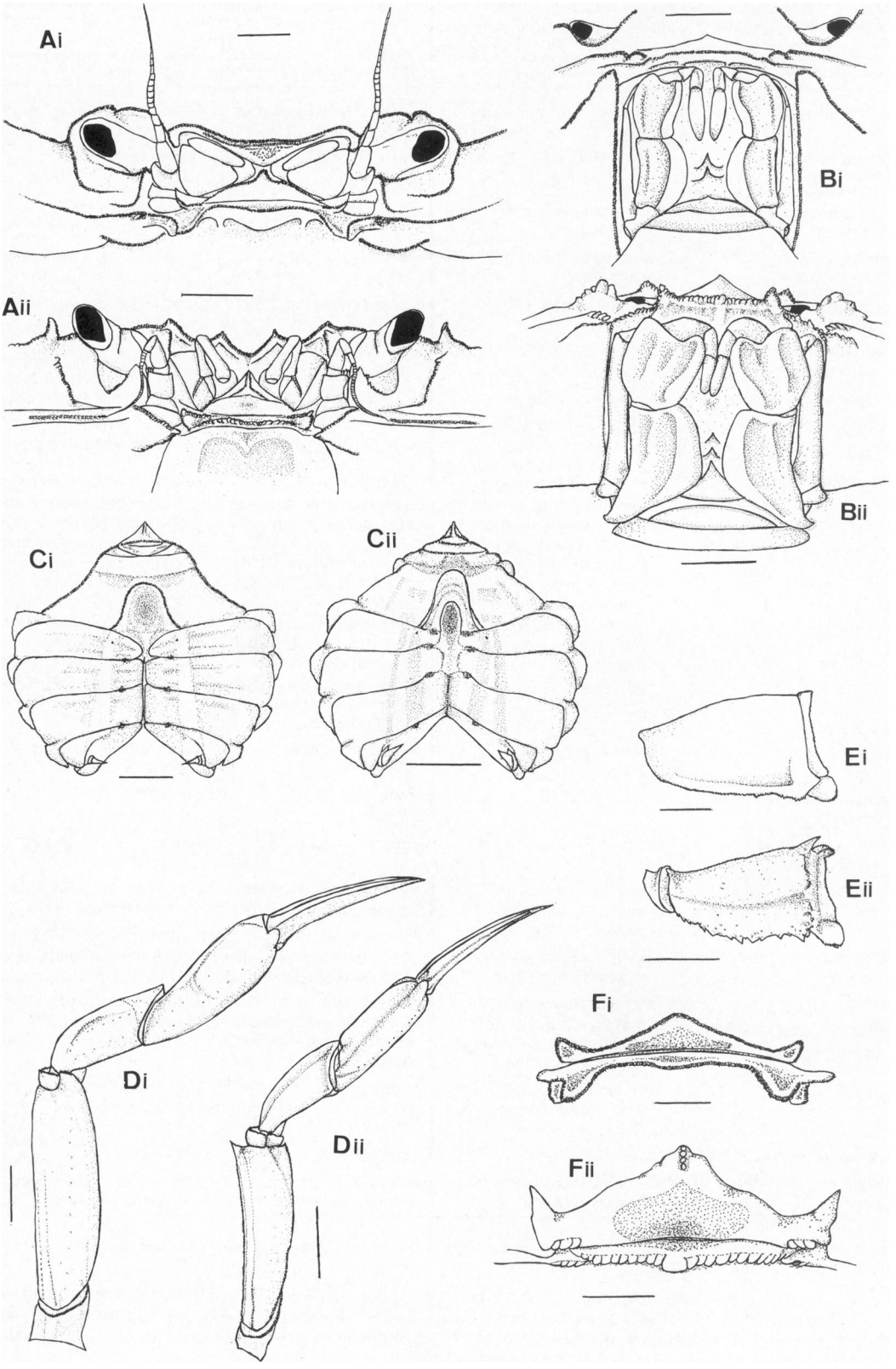
Fig. 1. *Neoeriocheir leptognathus* (male, A, B, C, D, E, G, 20.0 × 19.0 mm, ZRC 1997.588; female, F, carapace 21.0 × 20.0 mm, ZRC 1997.588). A, carapace; B, third maxilliped; C, dorsal view of right cheliped; D, ventral view of right cheliped; E, male abdomen; F, female abdomen, and G, different views of male second pleopod (G2). Scales, A = 5.0 mm; B, C, D, E, F = 2.0 mm; G = 1.0 mm.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Aii
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Table 2. Comparison of morphological characters of the first zoeal and megalopal stages of *Neoeriocheir leptognathus, Eriocheir sinensis,* and *Platyeriocheir formosa.* Types of antennal nomenclature follow Aikawa (1933). Data of *N. leptogathus* from Kim and Hwang, 1995; *P. formosa* (as *E. rectus*) from Shy and Yu (1992).

Characters	*Neoeriocheir leptognathus*	*Eriocheir sinensis*	*Platyeriocheir formosa*
	Zoea 1	Zoea 1	Zoea 1
Antennal type	B7	B3	B1
Setation of coxal endite of maxillule	6	5	4
Setation of coxal endite of maxilla	3, 3 (6)	4, 2 (6)	no data
	Megalopa	Megalopa	Megalopa
Antennular peduncle	2-segmented	3-segmented	4-segmented
Antennal flagellum	11-segmented	10-segmented	8-segmented

45 mm. In contrast, the smallest ovigerous *N. leptognathus* examined was only 10 mm in carapace length, the largest mature, non-ovigerous female only 21 mm, and the largest mature male was only 20 mm. These sizes are less than half those of mature *Eriocheir.*

Comparisons of larval (including megalopal) characters strongly support the recognition of *Neoeriocheir* as a distinct genus. Larval stages have been described for *E. hepuensis* (see Li *et al.,* 1992; Ng *et al.,* 1998), *E. sinensis* (see Liang *et al.,* 1974; Kim and Hwang, 1995; Montú *et al.,* 1996), *E. japonica* (see Morita, 1974; Lai *et al.,* 1986; Kim and Hwang, 1990), and *E. formosa* (as *E. rectus* Stimpson, 1853, cf. Shy and Yu, 1992), while Kim and Hwang (1995) listed the zoeal features of *N. leptognathus.* The main differences are in the absence or presence of first zoeal abdominal somite knobs, the antennular setation, the antennal type, and the coxal endite of the maxillule and maxilla (Table 2).

The larval ecology of *N. leptognathus* is strikingly different from that of species of *Eriocheir* and *P. formosa.* The fifth zoeal stage and the megalopal stage of species of *Eriocheir* sensu stricto and *P. formosa* migrate upstream from brackish to fresh-water habitats (Zhao *et al.,* 1988; Xu, 1994; Shy and Yu, 1992; Chan *et al.,* 1995). Such behavior is basically not known for *N. leptognathus.* Instead, both the adults and larvae of *N. leptognathus* remain in coastal areas (Kamita, 1938; A. Y. Dai, personal communication). The only exception was the record of a small male found together with young *E. sinensis* in a fresh-water habitat (Kemp, 1918; Urita, 1926; Kamita, 1938). All species of *Eriocheir* sensu stricto and *P. formosa* live in fresh water as adults and migrate downstream to brackish or sea water to breed. *Platyeriocheir formosa,* in particular, migrates into deep sea water for breeding (Chan *et al.,* 1995; T. Y. Chan, personal communication).

Neoeriocheir leptognathus (Rathbun, 1913) Figs. 1A–G; 2Ai–Fi; 5A, F; 6A

Neoeriocheir leptognathus Sakai, 1983: 20, fig. 1, pl. 3, fig. 3; pl. 8F.

Eriocheir leptognathus Rathbun, 1913: 353, pl. 33, figs. 2, 3; Kemp, 1918: 232; Tesch, 1918: 107; Urita, 1926: 433; Balss, 1922: 152; Sakai, 1935: 6; Panning, 1938: 106; Kamita, 1938: 383, 3 figs.; Chan *et al.,* 1995: 301, fig. 2D.

Eriocheir rectus Shen, 1932: 178, text figs. 111–113, pl. 11, fig. 6 (non Stimpson, 1858 = *E. japonica,* fide Chan *et al.,* 1995).

Utica sinensis Parisi, 1918: 102, text-fig. 3, pl. 8, fig. 1.

Material Examined.—Holotype, USNM 45567, ♀ (11.6 × 10.6 mm), Shanghai, China. collected by E. Deschamps.

Other specimens: USNM 58733, 5 ♂♂, 8 ♀♀, Fuchow ("Foochoa"), China, 1924, collected by G. R. Kellogg; USNM 64950, 1 ♂, 1 ♀, Amoy, China, 1928, collected by C. J. Shen; USNM 61904, 2 ♂♂, 2 ♀♀, Wenchao, Chekiang Province, China, collected by H. W. Wu; NHM 052–53, 1 ♂, 1 ♀, Tatung Kow, northern China, 19 Mar 1935, collected by J. R. Shen; ZIM K–3908, 4 ♂♂, 6 ♀♀, Foochow ("Futschau"), 14 Jun 1903, collected by G. Siemssen; AS 02643, 10 ♂♂, 6 ♀♀, Changle, Zhejiang Province, China, Jul 1931; AS 02642, 15 ♂♂, 4 ♀♀, Dagushan, Liaoling Province, 8 Aug 1931; AS 02655, 1 ♂, Tatung Kow, northern China, 4 Aug 1931; AS02651, 1 ♂, 1 ♀, Yang He Kou,

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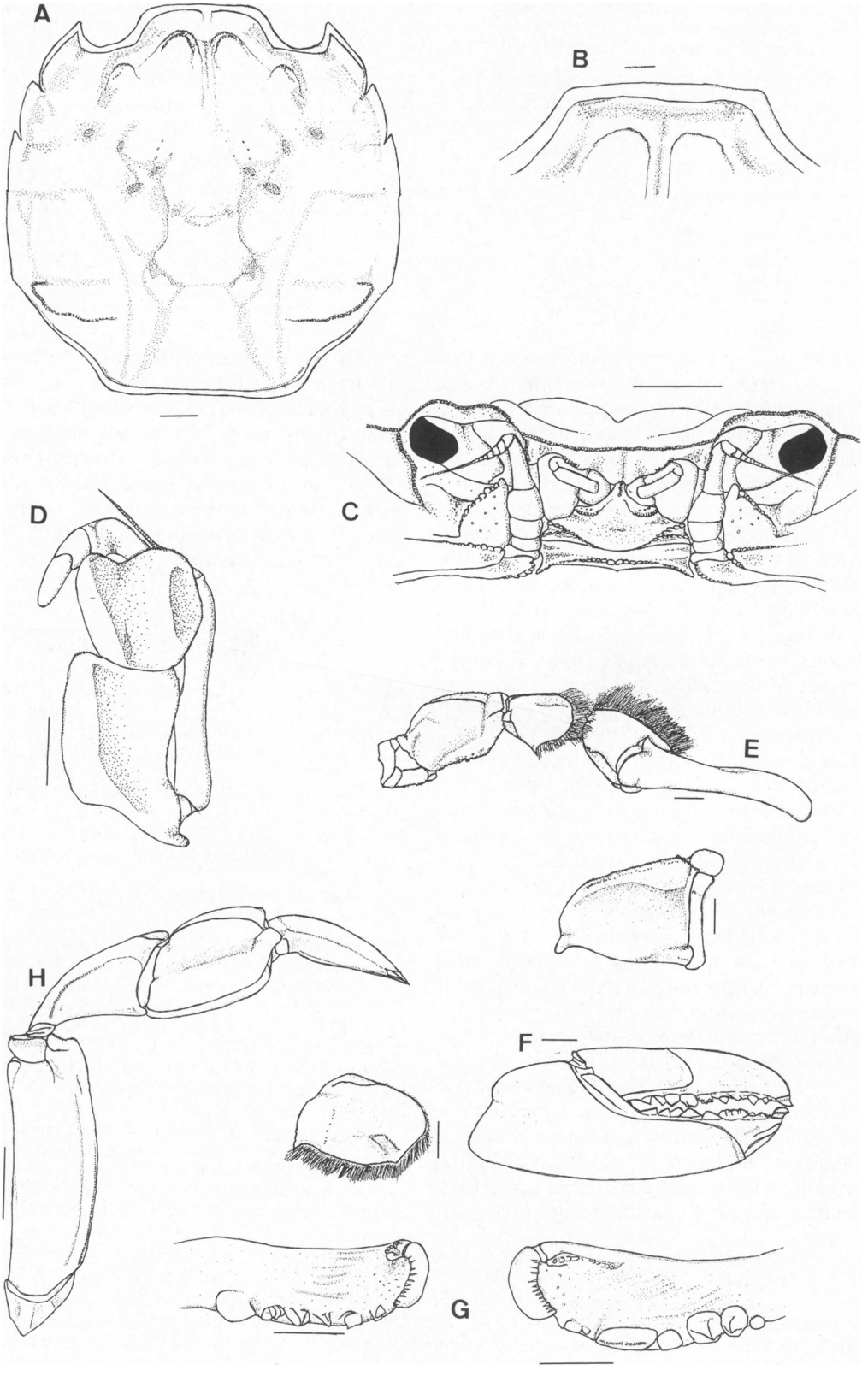
Fig. 2. *Neoeriocheir leptognathus* (male, Ai, Bi, Ci, Di, Ei, Fi, 20.0 × 19.0 mm, ZRC 1997.588); *Eriocheir sinensis* (male, Aii, Bii, Cii, Dii, Eii, Fii, 78.5 × 73.0 mm, ZRC 1997.558). A, frontal region; B, mouthparts; C, thoracic sternum; D, fourth ambulatory legs; E, merus of chelipeds; F, epistomes. Scales, Ai, Bi, Ci, Di, Ei, Fi = 2.0 mm; Aii, Bii, Cii, Dii, Eii, Fii = 10.0 mm.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Hebei Province, 17 Aug 1930; AS 12389, 1 ♀, Magong Dao, northern China; AS 02648, 5 ♂♂, 1 ♀, Changledai, northern China, Jul 1931; AS 02649, 5 ♂♂, 1 ♀, Tanggu, Heibei Province, 6 May 1929; AS 02652, 1 ♂, Wuting, Zhejiang Province; AS uncatalogued, 1 ♀, Tanggu, Hebei Province, 21 Apr 1930; AS uncatalogued, 1 ♂, 2 ♀♀, Xiamen, Fujian Province, Aug 1928; AS 02583, 17 ♂♂, 1 ♀, Tatung Kow, Shangdong Province, 3 Aug 1931; AS 02650, 12 ♂♂, 19 ♀♀, Tangu, Hebei Province, 9 Jul 1930; AS 02654, 35 ♂♂, 38 ♀♀, Yingkou, Liaoling Province, 20 Aug 1931; AS 02647, 45 ♂♂, 3 ♀♀, Tanggu, Heibei Province; AS 02644, 19 ♂♂, Tanggu, Heibei Province, May 1934; AS 02646, 171 ♂♂, Tanggu, Hebei Province, 1 Jul 1931; AS 02645, 365 ♂♂, Tanggu, Hebei Province, 21 Apr 1930; AS uncatalogued, 1 ♂, northern region of South Korea, summer 1958; BNHM J96–244, 1 ♂, Hainan, southern China, 2 Apr 1957; BNHM J84–0144 001873, 1 ♀, Zhou Shan, northern China, 20 Nov 1983; BNHM J84–0143 001872, 5 ♂♂, 4 ♀♀, Zhou Shan Fisheries Research Institute; BNHM J84–061 001790, 2 ♂♂, Zhou Shan, northern China, 1983; BNHM J88–103, 1 ♂, 4 ♀♀, Changle louhua, northern China, 16 Aug 1984; ZRC 1997.588, 5 ♂♂, 3 ♀♀ (ovigerous), Tanggu, Hebei Province, China, 1928, collected by J. R. Shen.

Description.—Carapace quadrate, slightly longer than broad (length to width ratio ~1.01–1.23) (Fig. 1A). Epigastric, protogastric cristae very low, almost indiscernible; hepatic region depressed, gastrocardiac, cardiobranchia, cardio-intestinal grooves distinct. Epibranchial ridge low, mesobranchial ridge granular, extending obliquely backward. Frontal margin straight, supra-orbital margin concave, infra-orbital margin crest granulated, extending to ventral surface of outer orbital tooth, lateral edge slightly concave. Anterolateral margin finely serrated with 3 teeth, first tooth (external orbital tooth) longest, rectangular, separated from second tooth by wide U-shaped notch; second tooth sharp, acute; third tooth smallest, usually blunt, sometimes denticulate; posterolateral margin lined by finely granulated ridge. Posterior carapace margin slightly convex; ridge between pterygostomian, suborbital regions granulated. Pterygostomian region tuberculated, continuing as fine groove to posterior end of lateral margin. Eyes well developed, base narrow, cornea small, pigmented; antennule folding obliquely in broad fossa, antennal basal segments occupying entire orbital hiatus, flagellum short, reaching to tip of first anterolateral tooth; endostomial ridge (Fig. 2A, F) prominent, granulated; posterior margin of epistome entire, margin granulated, denticulated at lateral edges (above afferent branchial opening), without clefts or lobulation. Third maxilliped (Fig. 1B) slender; ischium, merus narrow, elongate longitudinally, inner margin raised, covered by bristlelike setae, inner angle of merus produced, auriculiform, ischium longer than broad, longer than merus; merus longer than broad (length to width ratio ~1.14–1.80), narrow at base; outer margin obliquely straight, covering anterior part of exopod, outer margin setose; dactylus twice length of propodus; exopod narrow, reaching to midlength of merus, with well-developed flagellum.

Chelipeds of males larger than those of females, outer surfaces of merus, carpus, and chela smooth (Fig. 1C); inner surfaces covered with soft, long setae, especially at distal half of merus; ventral distal margin of coxa granulated, basal margin articulating with sternum by toothlike hinge at lateral distal end, with large toothlike hinge connecting to smooth basis. Anterior, posterior margins of ischium denticulated; merus prismatic in cross section, all margins denticulated, basal region of dorsal margin with long setae, no subdistal tooth on dorsal margin, transverse groove parallel to distal margin of merus. Outer surface of merus with short, fine, irregular granulated grooves; ventral, inner surfaces granulated; outer ventral margin with distal lobe. Carpus quadrate, coarse granules on surface; prominent curved granulated ridge on inner dorsal margin, inner ventral margin with long, sharp spine, inner base margin spinulose. Outer surfaces of manus finely granulated, prominent fine ridge in female extending to distal end of pollex; inner surface, basal half of fingers thickly setose in male but less densely so in female. Dactylus (Fig. 1D) regularly toothed, small bunch of bristles near inner base, fingers closing without gap, inner margins regularly denticulated; inner surface of dactylus tip corneous, excavated, subspatuliform.

Ambulatory legs long slender, long setae on anterior, posterior surfaces of carpus, prop-

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Fig. 3. *Platyeriocheir formosa* (male, A, B, C, D, E, F, G, H, 58.4 × 54.8 mm, ZRC 1997.941). A, carapace; B, frontal margin; C, frontal region; D, third maxilliped; E, dorsal view of right cheliped; F, ventral view of right cheliped; G, inner surface of cheliped tip; H, fourth ambulatory leg. Scales, A, C, G = 5.0 mm; B, D, E, F, H = 2.0 mm.

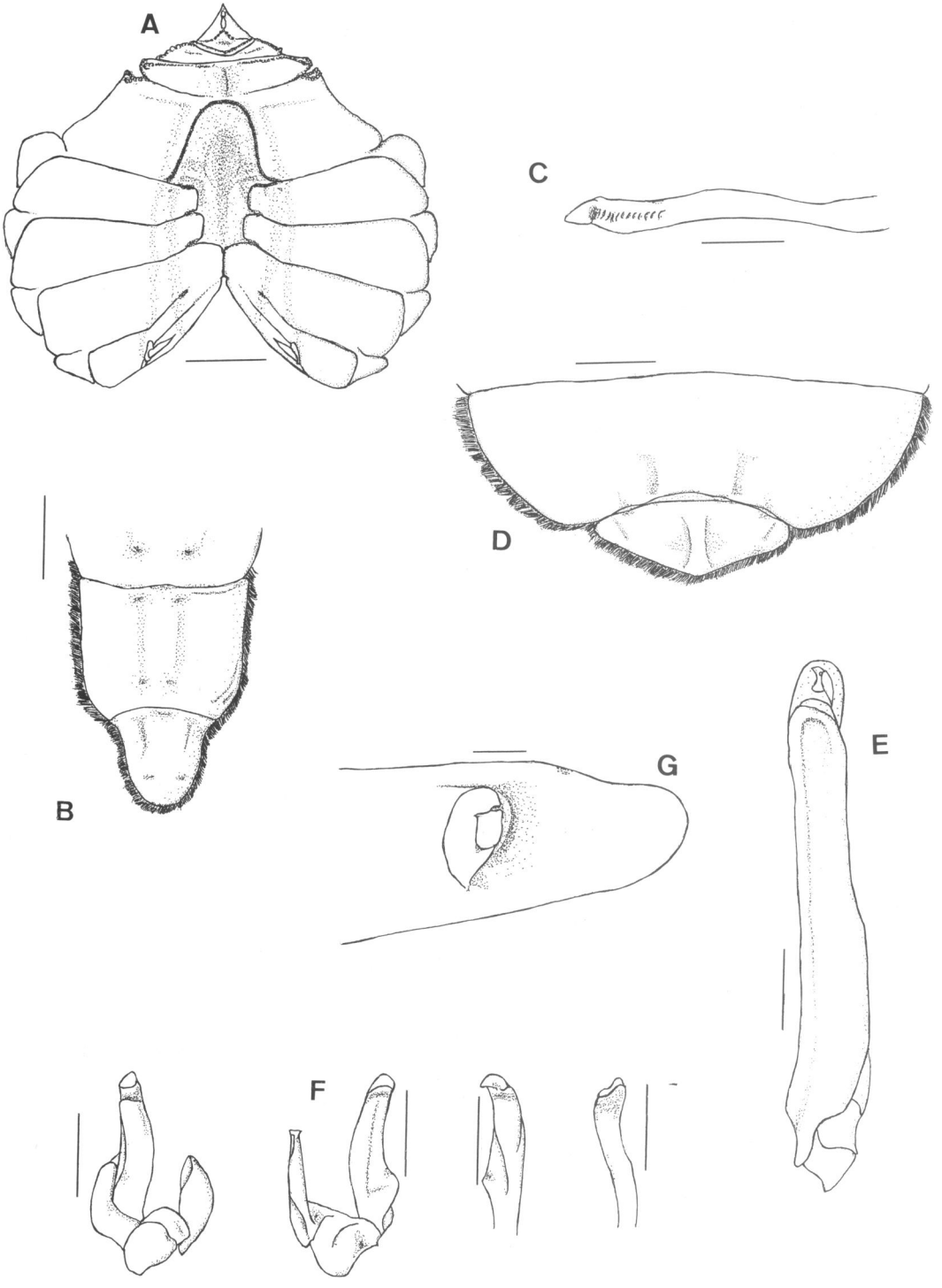


Fig. 4. *Platyeriocheir formosa* (male, A, B, C, D, E, F, 58.4 × 54.8 mm, ZRC 1997.941; female, G, carapace 49.6 × 46.4 mm, ZRC 1997.594). A, thoracic sternum; B, sixth abdominal somite and telson; C, third abdominal somite; D, sixth abdominal somite and telson; E, G1, F, different views of G2; G, vulvae. Scales, A, B, C, D = 5.0 mm; E, F, G = 2.0 mm.

odus, and dactylus (Fig. 2Ei). Second and third legs longer than first, fourth; dactylus long, slightly curved; coxa quadrate; basis-ischium granulated on anterior, posterior distal margins. Anterior margin of merus serrated with subdistal tooth on first 3 legs, finely serrated ridge on dorsal surface, almost parallel to basal portion anterior margin, extending from base to submedian point; ridge on fourth leg inconspicuous. Carpus with anterior margin ridged, first leg with ridge on dorsal, ventral surfaces, second, third, fourth only on dorsal surface, last leg inconspicuous; distal part of all ridges setose except fourth leg. Propodus setose on anterior, posterior margins, more compressed in fourth leg; dactylus very long, sharply pointed, curved inward with 6 setose grooves, longer setae in anterior and posterior grooves in fourth leg. Dactylus of first leg shortest, second, third styliform, fourth more compressed than preceding legs. Tip of each dactylus sharp, corneous.

Lateral margins of first 2 thoracic sternites gently serrated; suture between sternites 2 and 3 distinctly convex toward abdomen; lateral margins of sternites 3 and 4 almost entire, no clear notch demarcating edge of suture; longitudinal median groove between sternites 5 and 6 narrow; space on sternite 8 very narrow throughout length.

Male abdomen triangular; first abdominal segment arched, with transverse ridge; second segment narrow, short; third segment broad, slightly swollen laterally but medially depressed with proximal margin broader than distal, lateral margin rounded; fourth segment broader but shorter than fifth; fifth with basal margin convex, distal margin concave medially, lateral margins slightly concave; sixth segment quadrate, lateral margins subparallel, proximal part slightly concave, convex medially, lateral distal angle smoothly rounded. Telson triangular (Fig. 1E).

Female abdomen rounded, large, covering most of sternum when mature. First 3 segments ridged, second segment shorter than third; fourth and fifth segments similar in shape; sixth segment narrower than fifth, proximal margin slightly convex medially, distal margins concave. Lateral margins of 4 preceding segments slightly convex. Telson transversely triangular. Anterior border of female abdominal cavity densely covered with soft setae (Fig. 1F).

Penis at base of eighth sternite. G1 with short, chitinous distal prominence, slightly curved dorsally outward with subdistal lobe and genital opening (Fig. 3Ai). G2 short, small (Fig. 1G). Vulvae on third sternite, chitinous with crenulated anterior margins lined with short fine setae (Fig. 3Bi).

Eggs small (diameter ~0.27 mm) (preserved eggs yellowish orange in color), natural color unknown.

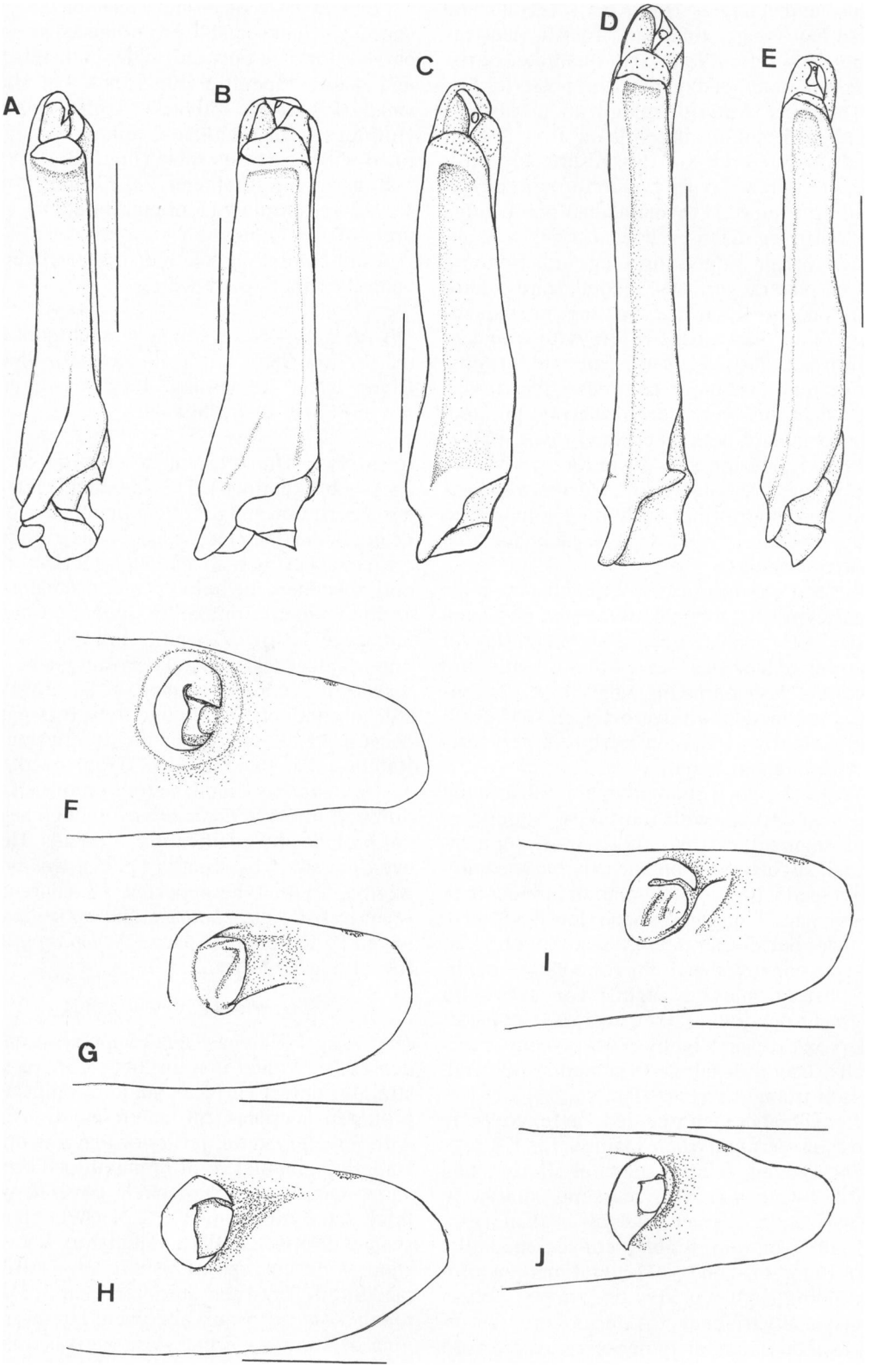
Adult coloration pale bluish green overall, ventral surfaces dirty white.

Distribution.—North China; west coast of Korea (Yellow Sea); and Saga, mouth of Shioda River, Japan. Remaining along coastal area, not migrating to fresh water.

Remarks.—The original description of the species by Rathbun (1913) is rather brief, but her description and excellent figures leave little doubt that the present specimens examined are conspecific with *N. leptognathus.* The only specimen, the holotype, unfortunately, is a dried, small, immature juvenile female (carapace 11.6 × 10.6 mm) and most of the important generic characters cannot be observed on such a specimen. It is, however, still in relatively good condition. It is partly because of the brevity of the description by Rathbun that Panning (1933) supposed that *N. leptognathus* might merely be one of the different forms of *E. sinensis,* although he did not provide any justification or details. However, the study by Kamita (1938), was noteworthy, in that he reported 10 characters (mainly from the carapace and appendages) which he felt could separate *N. leptognathus* from typical species of *Eriocheir.*

Platyeriocheir, new genus

Diagnosis.—Carapace quadrangular, strongly depressed; frontal margin lobes transversely straight; dorsal surfaces smooth; epigastric, protogastric cristae low; anterolateral margin with 3 teeth, lateral, posterior margins thick, smoothly granulated; third maxilliped broad, short. Outer surface of chela covered with thick setae, tip of dactylus of chela spoon-shaped. Propodus of last ambulatory leg very short, wide, covered with short dense stiff setae. Suture between sternites 2 and 3 distinctly convex toward abdomen; lateral margins of sternites 3 and 4 strongly sinuous, with deep notch demarcating edge of suture;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longitudinal median groove on sternites 5 and 6 broad; space on sternite 8 narrow distally but distinctly broad proximally.

Etymology.—The name is derived from the Greek *platus* meaning flat, in arbitrary combination with the genus name *Eriocheir,* alluding to the straight frontal margin and the flat physiognomy of the carapace. Gender feminine.

Type Species.—Eriocheir formosa Chan, Hung and Yu, 1995, by present designation.

Remarks.—Until 1995, only two species of mitten crabs were recognized from Taiwan, *Eriocheir japonica* and *E. recta.* Both species have a very distinct distribution on the island with minimal overlap. *Eriocheir japonica* is found mainly in western Taiwan, while *E. recta* is distributed in eastern Taiwan (Hung, 1993; Chan *et al.,* 1995).

Chan *et al.* (1995) argued, however, that the Taiwanese specimens were not *E. recta,* and synonymized this species with *E. japonica.* The neotype of *E. recta* (see Stimpson, 1858), designated by Chan *et al.,* 1995, was examined. They subsequently established a new name, *E. formosa,* for the specimens previously known as *E. rectus.* Chan *et al.* (1995) gave a concise diagnosis and commented on the differences between *E. formosa* and the other species of *Eriocheir,* including *N. leptognathus.* Detailed comparison of all known species of *Eriocheir* showed a number of differences between *E. formosa* and the other species (present study). These differences are mainly in the carapace, thoracic sternites, chelipeds, ambulatory legs, G1, and vulvae (see Table 1).

It is interesting to note that Chan *et al.* (1995) had allied *P. formosa* with *Neoeriocheir leptognathus* (as *E. leptognathus*), based on the straight frontal margin and presence of three anterolateral teeth, while citing differences between the two taxa in their maxillipeds and sizes. There are also differences in the eye stalk, epistome, third maxilliped, thoracic sternites, chelipeds, last ambulatory legs, G1, and vulvae (see Table 1).

The larval ecology of *Platyeriocheir formosa* is similar to that of *Eriocheir.* The fifth zoeal stage and megalopal stage of these two taxa migrate upstream from brackish water to fresh water (Hung, 1993). Comparison of larval (including megalopal) characters also supports the recognition of *Platyeriocheir.* The main differences lie in the type of antenna, coxal endite of the maxillule, antennule peduncle, and antennal flagellum (see Table 2).

Platyeriocheir formosa (Chan, Hung and Yu, 1995)
Figs. 3A–G; 4A–E; 5E, J; 6C

Eriocheir formosa Chan, Hung, and Yu, 1995: 301, figs. 1B, 2A, 2B, 3A.

Eriocheir rectus—Sakai, 1939: 669, text fig. 118, pl. 109(3); 1976: 647, text-fig. 355; Lin, 1949: 29; Chiu, 1964: 64; Hwang and Mizue, 1985: 1–22, figs. 1–10, pls. 1, 2; Yu and Ho, 1986: 111, pl.1; Dai and Yang, 1991: 522, fig. 267 (2), pl. 67(1); Shy and Yu, 1992: 277, figs. 1–7; Hung, 1993: 9, pls. 1C, 1E, 2A–E; Dai, 1993: 63; Kim and Hwang, 1995: 793.

Material Examined.—Holotype, NTOU H–1991, ♂ (60.2 × 57.2 mm), Nan–Ao River, I–Lan County, Taiwan, 1991.

Paratypes: NTOU 1986–3–8, 2 ♂♂, 1 ♀, Nan–Ao River, I–Lan County, 8 Mar 1986; NTOU 1991–7, 2 ♂♂, Nan–Ao River, I–Lan County, Jul 1991; NTOU 1991–9, 2 ♂♂, 7 ♀♀, Nan–Ao River, I–Lan County, Sep 1991; NTOU 1991–10, 10 ♂♂, 7 ♀♀, Nan–Ao River, I–Lan County, Oct 1991; NTOU 1991–11–8, 6 ♂♂, 3 ♀♀, Nan–Ao River, I–Lan County, 8 Nov 1991; NTOU 1992–4–9A, 2 ♀♀, Nan–Ao River, I–Lan County, 9 Apr 1992; NTOU 1992–5–27, 1 ♂, Nan–Ao River, I–Lan County, 27 May 1992; NTOU nd–12, 4 ♂♂, 8 ♀♀, Nan–Ao River, I–Lan County; NTOU, uncatalogued, 2 ♂♂, 1 ♀, SCSIO, NTOU in exchange; NTOU 1991–7–10, 3 ♀♀ (ovigerous), Pe–Qun Market, Taipei County (collected by bottom gill nets near Ka–Fung estuary), 10 Jul 1991, collected by S. Y Shy and M. S. Hung, NTOU 1991–7–16, 3 ♀♀ (ovigerous) Pe–Qun market (collected by bottom gill nets near Ka–Fung estuary), collected by S. Y. Shy and M. S. Hung; NTOU 1992–4–9B, 8 ♂♂, 13 ♀♀, Nan–Ao River, I–Lan County, 9 Apr 1992; 2 ZRC 1997.943, 2 ♂♂, Ho–Ping River, Hue–Lien County, collected by S. Y. Shy. All localities in Taiwan.

Others: NTOU n–11, 2 ♂♂, Ho–Ping River, Hua–Lein County, no date; NTOU 1992–5–6, 1 ♀, Pai–Chu River,

←

Fig. 5. A, G1, *Neoeriocheir leptognathus,* male, 20.0 × 19.0 mm (ZRC 1997.588); B, G1, *Eriocheir sinensis,* male, 78.5 × 73.0 mm (ZRC 1997.558); C, G1, *E. hepuensis,* male, 54.9 × 49.8 mm (ZRC 1997.560); D, G1, *E. japonica,* male, 71.8 × 65.6 mm (ZRC 1997.565); E, G1, *Platyeriocheir formosa,* male, 58.4 × 54.8 mm (ZRC 1997.941); F, vulvae, *N. leptognathus,* female, 21.0 × 20.0 mm (ZRC 1997.588); G, vulvae, *E. sinensis,* female, 61.2 × 57.6 mm (ZRC 1997.558); H, vulvae, *E. hepuensis,* female, 52.0 × 46.0 mm (ZRC 1997.560); I, vulvae, *E. japonica,* female, 58.8 × 49.0 mm (ZRC 1997.565); J, vulvae, *P. formosa,* female, 49.6 × 46.4 mm (ZRC 1997.594). Scales, A, F = 2.0 mm; B, C, D, E, G, H, I, J = 5.0 mm.

Ping–Tung County, 6 May 1992; NTOU n–5, 7 ♀♀; NTOU n–6, 1 ♂; NTOU n–7, 4 ♂♂; NTOU uncatalogued, 1 ♂, Chi–Shi River, Tai–Tung County, 26 Aug 1992, collected by H. P. Yu; NTOU uncatalogued, 1 ♀, Siu–Gu River, Tai–Tung County, collected by H. P. Yu; NTOU uncatalogued, 9 ♂♂, 1 ♀, Sheng Mi Ku, Taroko Gorge, 10 Jan 1997, NTOU uncatalogued, 2 ♂♂, Nan–Tou County, Jul 1991, M. S. Hung; NTOU uncatalogued, 10 ♀♀; NTOU uncatalogued, 4 ♂♂, 4 ♀♀, 1993, collected by M. S. Hung; NTOU uncatalogued, 4 ♀♀, Nan–Ao River, I–Lan County, 1993, collected by M. S. Hung; TOU uncatalogued, 79 ♀♀, Sheng Mi Ku, Taroko Gorge, Hua–Lien County; TMCD 2795, 1 ♂, 3 ♀♀, Nan–Ao river, I–Lan County, collected by C. S. Tseng; 2 ♂♂, TMCD 3264, 2 ♀♀, Tai–Tung County, 4 Oct 1996, collected by T. J. Lin; TMCD 3273, 1 ♀, Hua Lien County, 10 May 1993, collected by T. J. Lin; NMNS 001876–00007, 1 ♂, Wan–Da Shui Ku, 20 Aug 1993, collected by C. F. Seow; CHCD 1438, 1 ♀, Cheng–Gong Town, Tai–Tung County, collected by H. C. Liu, Y. L. Xu, and I. C. Lin; CHCD uncatalogued, 3 ♂♂, 8 ♀♀, Tai–Ban, Ta–Ren Village, Tai–Tung County, 22 Apr 1995, collected by H. C. Liu; ASIZ–70500, 1 ♂, Da–Cheng, Tai–Tung County, 15 Feb 1996, collected by M. S. Jeng; ZRC 1997.593, 2 ♂♂, He–Ping River, Hua–Lien County, eastern Taiwan, collected by S. Y. Shy; AS exchange from USNM 123465, 1 ♂, 1 ♀, Chu–Pen River tributaries, Taiwan, 20 Mar 1961; AS uncatalogued, 2 ♂♂, eastern Taiwan; ZRC 1997.594, 2 ♀♀, Nan–Ao River, I–Lan County, collected by M. S. Hung; ZRC 1997.941, 3 ♂♂, Nan–Ao River, I–Lan County, 9 Apr 1992, collected by M. S. Hung; 2 ♂♂, 4 ♀♀, ZRC 1997.942. All localities in Taiwan.

Description.—Carapace quadrangular, slightly longer than broad (~1.06 times as long as broad) (Fig. 3A); epigastric, protogastric cristae low, blunt; hepatic region slightly depressed, gastrocardiac, cardiobranchial, cardio-intestinal grooves distinct; epibranchial ridge low, mesobranchial ridge granular, extending backward obliquely; frontal margin transversely straight (Fig. 3B), supra-orbital margin concave, infra-orbital margin crest granulated, extending to ventral surface of outer orbital tooth, lateral edge slightly concave; anterolateral margin smooth, thick, bluntly granulated with 3 teeth, first (external orbital angle) longest, rectangular, separated from second tooth by narrow V-shaped notch, second tooth sharp, acute, third tooth smallest, usually blunt, rest of posterolateral margin lined by smooth granulated ridge; posterior margin slightly convex; ridge between pterygostomian, suborbital regions granulated; pterygostomian region tuberculated, continuing as fine groove to posterior end of lateral margin. Eyes well developed, base of eye stalk broad, cornea pigmented, small; antennule obliquely folded in broad fossa, antennal basal segments occupying entire orbital hiatus, flagellum short, reaching tip of first anterolateral tooth. Endostomial ridge (Fig. 3C) prominent, granulated; posterior margin of epistome entire, margin granulated, denticulated at lateral edges (above branchial openings), with lobulations. Third maxilliped (Fig. 3D) broad, ischium and merus short, wide, inner margin raised, covered by bristle-like setae, inner angle produced, auriculiform; ischium broader than long, broader than merus (length to width ratio: 1.67), merus longer than broad (~1.33 times as long as broad), narrow at base, outer margin obliquely straight, covering anterior part of exopod, outer margin setose; dactylus 2.0 times length of propodus; exopod narrow, reaching distal edge of merus, well-developed flagellum.

Chelipeds of male much larger than those of female. Outer surface of carpus, merus, manus, dactylus with long soft setae (Fig. 3E); inner surfaces of these segments smooth, glossy. Ventral distal margin of coxa of cheliped granulated, basal margin articulating with sternum by toothlike hinge at lateral distal end, large toothlike hinge connecting to smooth basis. Anterior, posterior margins of ischium denticulated. Merus (Fig. 3F) prismatic in cross section, all margins denticulated, basal region of dorsal margin bearing long setae, no subdistal tooth on dorsal margin, transverse groove parallel to distal margin of merus. Outer surface of merus with short, fine irregular granulated grooves; ventral, inner surface granulated. Outer ventral margin with distal lobe. Carpus (Fig. 3F) quadrate with coarse granules on surface. Inner dorsal margin with prominent curved granulated ridge, inner ventral margin terminating in very sharp spine, base with inner margin spinulose. Outer surface of manus (Fig. 3F) very finely granulated, prominent fine ridge extending to distal end of pollex in female. Inner surface, basal half of fingers with thick setae in males but thin setae in females. Dactylus (Fig. 3G) regularly toothed with small bundle of bristles near inner base,

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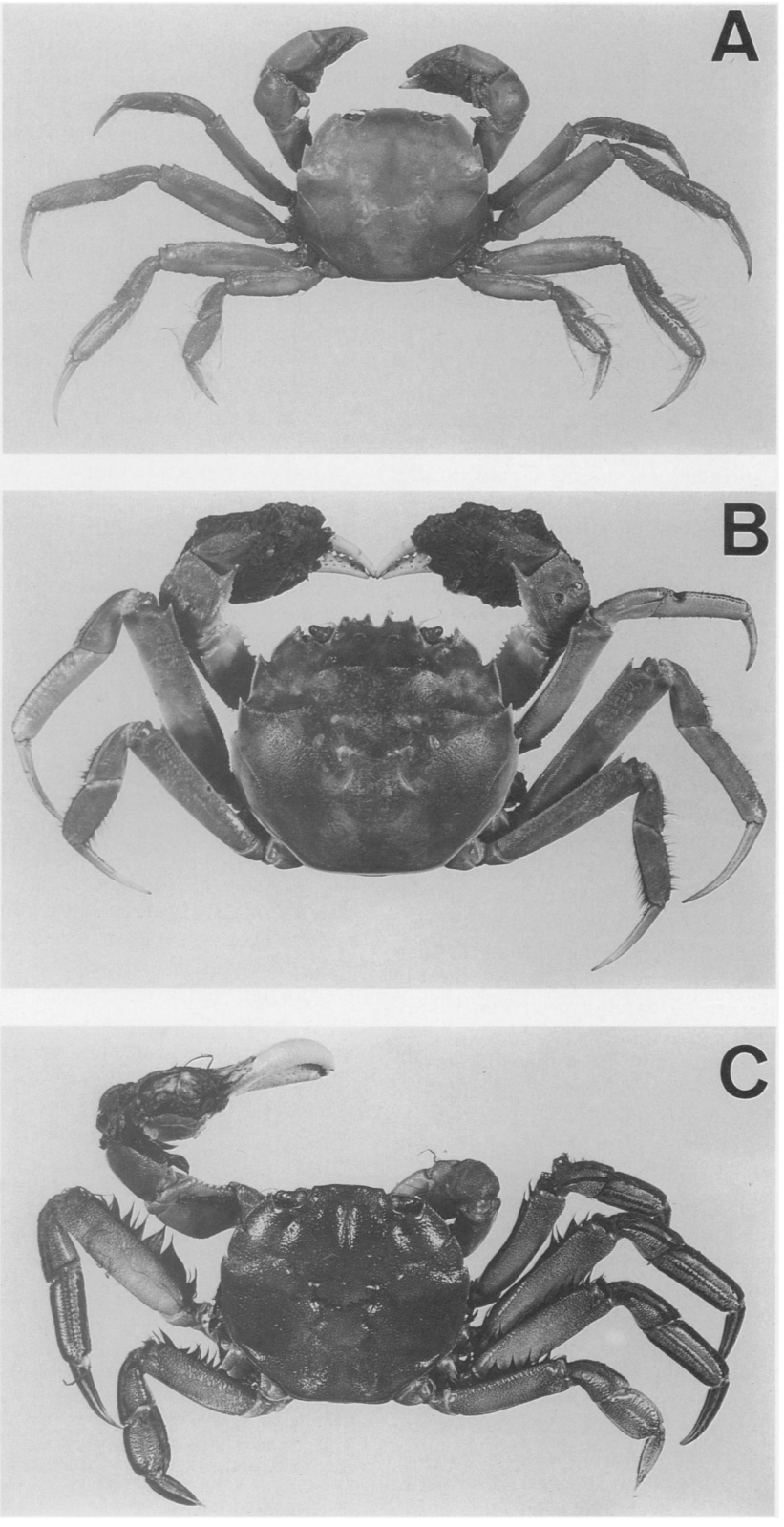
Fig 6. A, *Neoeriocheir leptognathus* (male, 20.0 × 19.0 mm, ZRC 1997.588); B, *Eriocheir sinensis* (male, 78.5 × 73.0 mm, ZRC 1997.558); C, *Platyeriocheir formosa* (male 58.4 × 54.8 mm, ZRC 1997.941).


A
B
C

fingers closing without gap, inner margins regularly denticulated. Inner surface of dactylus tip corneous, excavated, and spoon-shaped.

Ambulatory legs long, slender, long setae on meri, anterior margin of carpus, propodus, dactylus with dense, short bristles (Fig. 3H). Second, third ambulatory legs longer than first, fourth. Dactylus slightly curved and long. Coxa quadrate. Basi-ischium granulated on anterior surface, posterior distal margin. Anterior margin of merus serrated with subdistal tooth on first 3 legs, finely serrated ridge on dorsal surface, almost parallel to basal portion anterior margin, extending from base almost to middle. Ridge of fourth leg inconspicuous, carpus with anterior margin ridged, carpus of first leg with ridge on dorsal, ventral surfaces, carpus of second, third, fourth legs each with ridge on dorsal surface, fourth leg inconspicuous, distal parts of all ridges setose except fourth leg. Propodus setose on anterior, posterior margins, more compressed in fourth leg. Dactylus very long, sharply pointed, curved inward with 6 setose grooves with longer setae in anterior, posterior grooves in fourth leg. Dactylus of first leg shortest, second, third styliform, fourth leg much more compressed than preceding legs. Tip of each dactylus sharp, corneous.

Lateral margins of first to third thoracic sternites gently serrated; suture between sternites 2 and 3 distinctly convex toward abdomen; lateral margins of sternites 3 and 4 strongly sinuous, with deep, broad notch demarcating edge of suture; longitudinal median groove between sternites 5 and 6 very broad, space on sternite 8 narrow proximally and distinctly broad proximally (Fig. 4A).

Male abdomen triangular. First abdominal segment arched, transverse ridge. Second segment narrow, short. Third segment broad, slightly swollen laterally but medially depressed with proximal margin broader than distal, lateral margin rounded. Fourth segment broader but shorter than fifth. Fifth segment with basal margin convex, distal margin concave medially, lateral margins slightly concave. Sixth segment quadrate, lateral margins subparallel, proximal part slightly concave, convex medially, lateral distal angle smoothly rounded. Telson triangular (Fig. 4B).

Female abdomen rounded, completely covering sternum when mature. First 3 segments ridged, second segment shorter than third, small transverse groove at lateral ends (Fig. 4C). Fourth, fifth segments similar in shape. Sixth segment narrower than fifth, proximal margin slightly convex medially, distal margin concave. Lateral margins of four preceding segments slightly convex. Telson transversely triangular (Fig. 4D). Anterior border of female abdominal cavity densely covered with soft setae.

Penis of male at base of eighth sternite (Fig. 4A). G1 with short, chitinous distal prominence, slightly curved dorsally outward with subdistal lobe and genital opening (Fig. 4E). G2 short, small (Fig. 4F). Vulvae on third sternite, chitinous with operculum (Fig. 4G).

Eggs small (~0.30 mm), numerous, natural color unknown, all preserved eggs yellowish orange in color.

Adult color green to blue-green overall with reticular markings on dorsal surface, eyes dark green. Ventral surface dirty white. Setae on chelipeds brown to dark brown, those on ambulatory legs blackish brown. All preserved specimens brownish yellow in color.

Distribution.—In river systems of eastern Taiwan, from I–Lan County to Ping–Tong County. Known only from Taiwan.

Remarks.—The general biology and larval development of *Platyeriocheir formosa* (as *Eriocheir rectus*) has been studied by Hung (1993) and Shy and Yu (1992). Unlike *Eriocheir sinensis, P. formosa* migrates from fresh water to relatively deep sea water for breeding. The breeding season is midsummer (May to June) which is different from all species of *Eriocheir* sensu stricto and *Neoeriocheir. Platyeriocheir formosa* is a commercially valuable crab in Taiwan (see Hung, 1993; Chan *et al.,* 1995).

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ANNOUNCEMENT

The Second International Symposium on Krill will be held 23–27 August 1999 at the University of California Santa Cruz, Santa Cruz, California, U.S.A. This symposium is the first open, international conference in the field since 1982. Its purpose is to review current knowledge of krill biology, to highlight gaps and future areas for research, and to show how the study of a range species of krill can illuminate more general problems (for example, krill flux, recruitment, swarming behavior, age and growth, and life histories).

Each day will consist of one plenary review talk, followed by invited and contributed talks. There will also be a poster session. Proceedings of the meeting will be published; contributors will be expected to arrive with disk and hard copies of their papers in a form suitable for review.

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Krill development, growth, reproduction and aging
Krill physiology, metabolism, nutrition and energetics
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