

ROBUN

**THE TAXONOMY OF THREE COMMERCIALY
IMPORTANT SPECIES OF MITTEN CRABS OF
THE GENUS *ERIOCHEIR* DE HAAN, 1835
(CRUSTACEA: DECAPODA: BRACHYURA: GRAPSIDAE)**

J. Y. Guo, N. K. Ng, A. Dai and Peter K. L. Ng

ABSTRACT. - The southern Chinese mitten crab *Eriocheir hepuensis* Dai, 1991, whose taxonomic status has been subjected to some debate, is here regarded as a valid species. This taxon differs from *Eriocheir sinensis* and *E. japonica* in the form of its carapace, cheliped, ambulatory leg, abdomen, male first pleopod, female gonopore as well as its distribution. Our study shows that the genus *Eriocheir* s. str. contains only three species, *E. japonica* (de Haan, 1835) (type species), *E. sinensis* H. Milne Edwards, 1854, and *E. hepuensis* Dai, 1991, with *Eriocheir leptognathus* Rathbun, 1913, and *Eriocheir formosa* Chan, Hung & Yu, 1995, transferred to other genera. The different *E. sinensis* forms reported by Panning (1933, 1938) were re-examined and their taxonomy discussed.

KEY WORDS. - Grapsidae, *Eriocheir*, mitten crabs, taxonomy.

INTRODUCTION

The east Asian varunine genus *Eriocheir* de Haan, 1835, as currently defined, contains five taxa, viz. *E. japonica* (de Haan, 1835) (type species, selection by H. Milne Edwards, 1854), *E. sinensis* H. Milne Edwards, 1854, *E. japonicus hepuensis* Dai, 1991, *E. leptognathus* Rathbun, 1913, and *E. formosa* Chan, Hung & Yu, 1995. Four of these taxa (especially *E. sinensis*) are commercially important as food crabs and are the subject of numerous biological studies.

Eriocheir sinensis is the largest and most important species, naturally occurring in the north-eastern China but has been introduced into Europe (Panning, 1933; Christiansen, 1969; Ng, 1988) and North America (Nepszy & Leach, 1973; Ng, 1988; Cohen & Carlton, 1997). There have been reports of this crab found in Britain (Ingle, 1980; Clark, 1984) and it is now creating problems in the Thames River (R. W. Ingle & P. F. Clark, pers. comm.) and its

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numbers are rising along the coast of San Francisco (R. B. Doran & G. Miller, pers. comm. to second author). *Eriocheir japonica*, the type species of the genus, has the widest distribution, ranging from Japan, Korea, Taiwan to south-eastern China. Taxonomically, the most problematic taxon is the one described as *E. japonicus hepuensis* by Dai (1991) from southern China. Most authors, however, do not to recognise this taxon. *Eriocheir formosa* is found only along the east coast of Taiwan (Chan et al., 1995). *Eriocheir leptognathus*, the smallest member of the genus, is found only in the northern coast of China, west coast of Korea, Yellow Sea, and Japan (Sakai, 1976). This species was referred to a new monotypic genus, *Neoeriocheir*, by Sakai (1983), but all subsequent authors (e.g. Chan et al., 1995; Kim & Hwang, 1995) have not recognised it. Chan et al. (1995) specifically commented that they could discern no good reasons for recognising *Neoeriocheir* as a valid genus and noted that it should be regarded as a junior synonym of *Eriocheir*.

In recent years, there has been some confusion over the identities of *E. sinensis*, *E. japonicus hepuensis* and *E. japonica*. Several workers have argued that *E. japonicus hepuensis* is not valid (e.g. Chan et al., 1995) or that all three taxa are synonyms (Li et al., 1993). There is a pressing need to resolve the taxonomy of these taxa as they are the most commercially important of the *Eriocheir* species. To this effect, we have examined the types of all nominal taxa of *Eriocheir* as well as a very large series of specimens of these taxa from China and Europe to ascertain their identities.

Our study shows that contrary to what has been published, *E. japonicus hepuensis* Dai, 1991, is a good species, and the genus *Eriocheir* is in fact, heterogeneous, with *Eriocheir* s. str. containing only three species, viz. *E. japonica* (de Haan, 1835) (type species), *E. sinensis* H. Milne Edwards, 1854, and *E. hepuensis* Dai, 1991. *Neoeriocheir* Sakai, 1983, is a good genus and *E. leptognathus* Rathbun, 1913, is transferred back to it (Ng et al., in prep.). *Eriocheir formosa* Chan, Hung & Yu, 1995, possesses so many apomorphic features that it cannot be retained in *Eriocheir* s. str. as presently defined. It is instead referred to its own genus (Ng et al., in prep.).

Specimens examined are deposited in the Institute of Zoology, Academia Sinica (AS), Beijing; Beijing Natural History Museum (BNHM), Beijing; South China Sea Institute of Oceanology, Academia Sinica (SCSIO), Qingdao; National Taiwan Ocean University (NTOU), Keelung; Zoological Reference Collection (ZRC), National University of Singapore; Natural History Museum (NHM), London; Rijksmuseum van Natuurlijke Historie (RMNH), Leiden; Institut de Zoologie (ZI), Liege; Muséum National d'Histoire Naturelle (MNHN), Paris; Zoological Institute and Museum (ZIM), Hamburg; Senckenberg Museum (SM), Frankfurt; and Zoologisk Museum Oslo (ZMO), Norway.

All measurements provided are of the carapace widths and lengths respectively. Statistical analysis using the SAS/STAT[®] Version 6.0 programme (SAS Institute Inc.) was performed on some of the characters. T-test was applied to analyse the length to width ratio of the propodus of the fourth ambulatory leg, first male gonopod, female genital pore, telson and sixth abdominal somite of both male and female specimens (Fig. 1). Probability test was used for the analysis of the physiognomy of the carapace and the sharpness of the frontal teeth (Fig. 7a-c). In addition, characters like the physiognomy of the carapace, strength of the epigastric crests, proportions and degree of setation of the various segments of the ambulatory legs and chelipeds, proportions of the overall male gonopod (not just the distal part), male and female abdomens, female vulvae were also grouped, compressed and subjected to Principal Component Analysis (PCA) using the SAS/STAT[®] programme. The abbreviations

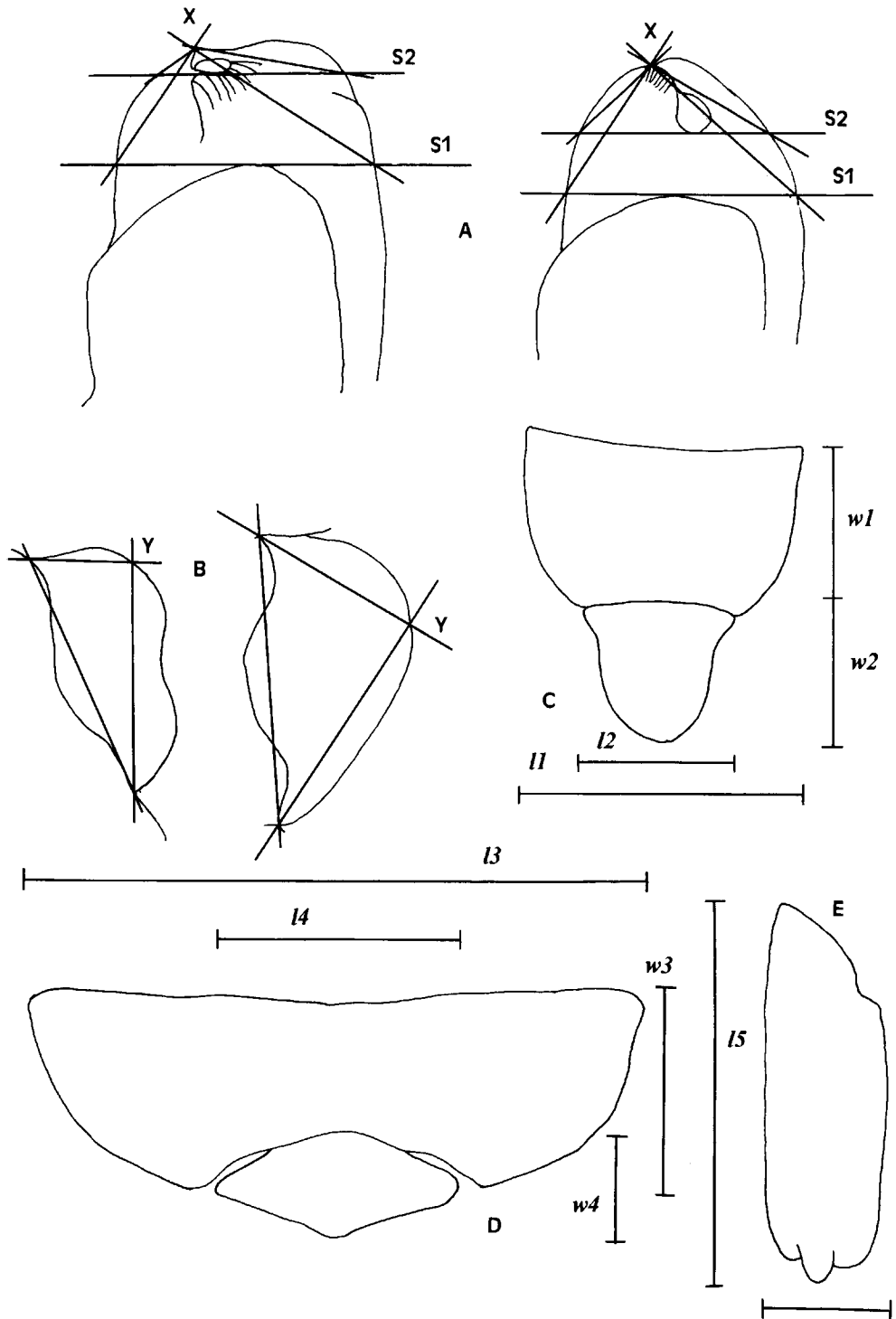


Fig. 1. Meristic measurements of a) first male gonopod; b) female genital pore; length to width ratio of c) male abdominal sixth somite ($l1$ - length, $w1$ - width) and telson ($l2$ - length, $w2$ - width); d) female abdominal sixth somite ($l3$ - length, $w3$ - width) and telson ($l4$ - length, $w4$ - width); e) propodus of the fourth ambulatory leg ($l5$ - length, $w5$ - width). S1 - transverse horizontal line across hump of first male gonopod; S2 - transverse horizontal line across base of genital opening, parallel to S1; x - highest point of G1; Y - perpendicular point of two lines from two ends of female genital opening.

G1 and G2 are used for the male first and second pleopods respectively. A complete description for the first species is presented and only structures with distinct morphological differences for subsequent species are provided.

TAXONOMY

FAMILY GRAPSIDAE MACLEAY, 1838

SUBFAMILY VARUNINAE ALCOCK, 1900

Genus *Eriocheir* de Haan, 1835

Grapsus (*Eriocheir*) de Haan 1835: 32.

Eriocheirus - H. Milne Edwards 1853: 176 (incorrect spelling).

Eriocheir - Kingsley, 1880: 210; Doflein, 1902: 665; Parisi, 1918: 102; Balss, 1912: 152; Kemp, 1918: 231; Tesch, 1918: 107; Schellenberg, 1928: 140, text-fig. 110; Shen, 1932: 172, text-fig. 108, 110, pl. 8, fig. 5; Peters & Panning, 1933: 1-180; Sakai, 1939: 667, pl. 109, fig. 1; Shen & Dai, 1964: 127; Christiansen, 1969: 1; Kim, 1973: 465, fig. 202; Nepszy & Leach, 1973: 1909; Ingle, 1980: 123, fig. 76, pl. 24b; Manning & Holthuis, 1981; Clark, 1984: 111, pl. 1; Hwang & Mizue, 1985: 12; Gu, 1986: 268; Dai et al., 1986: 523; Yu & Ho, 1986: 116; Dai, 1988: 22; Adema, 1991: 201, fig. 79; Dai & Yang, 1991: 523; Dai, 1991: 61; Lai & Lu, 1992: 23; Hong et al., 1993: 10, pls. A, F; Chan et al., 1995: 301, fig. 3B; Cohen & Carlton, 1997: 1.

Type species. - *Eriocheir japonica* (de Haan, 1835), was selected by H. Milne Edwards (1854) (see Manning & Holthuis, 1980). When describing *Eriocheir*, de Haan (1835) described two species, *Grapsus* (*Eriocheir*) *japonica* and *Grapsus* (*Eriocheir*) *penicillatus*, but did not choose a type species. Ortmann (1894) transferred *Grapsus* (*Eriocheir*) *penicillatus* to *Heterograpus* Ortmann, 1894, and was later placed in a new genus *Hemigrapsus* by Stimpson (1907).

Diagnosis. - Carapace rectangular, dorsal surface convex. Epigastric, protogastric cristae present. Frontal margin granulated with four teeth, antero-lateral margins with four teeth. Posterior margin of epistome entire with lobulations at lateral ends. Third maxilliped broad, ischium, merus broad. Merus of chelipeds with distal tooth, fingers, manus of cheliped thickly setose on outer, inner surfaces. Ambulatory legs slender, long. G1 long, slender.

Remarks. - It is worthwhile to give a short diagnosis of the genus *Eriocheir* s. str. since the description given by de Haan (1835) had included *Hemigrapsus penicillatus*. Characters like the presence of inner granules and outer smaller prominences on the infra-orbital ridge and a small patch of seta on the inner and outer surfaces of the fingers of the chelipeds in *Hemigrapsus* species are not applicable in *Eriocheir* s. str. species.

Two species previously referred to *Eriocheir* are also removed from the genus. *Neoeriocheir* Sakai, 1983, erected for *Eriocheir leptognathus* Rathbun, 1913, can also be differentiated from *Eriocheir* de Haan, 1835, by possessing the following characters, viz. almost straight frontal margin, lateral margin with only three teeth, low or discernible epigastric and proto-gastric cristae, unlobed posterior epistomal margin, third maxilliped long and narrow, fingers and manus of chelipeds thickly setose only on the inner surface, ambulatory legs very long and slender, and G1 very long and slender. Our studies have also indicated that *Eriocheir formosa* Chan, Hung & Yu, 1995, possesses so many apomorphic features that it cannot be retained in *Eriocheir* s. str. as presently defined. It is instead referred to its

own genus (Ng et al., in prep.).

Gender is feminine as stated in Chan, Hung & Yu (1995: 307).

***Eriocheir sinensis* H. Milne Edwards, 1854**

(Figs. 2, 6a, 6d, 7d)

Eriocheir sinensis H. Milne Edwards, 1854: 146, pl. 9, figs 1a-c.

Eriocheirus sinensis - H. Milne Edwards, 1854: 146, pl. 9, figs 1a-c.

Eriocheir sinensis - Kingsley, 1880: 210; Doflein, 1902: 665; Parisi, 1918: 102; Balss, 1912: 152; Kemp, 1918: 231; Tesch, 1918: 107; Schellenberg, 1928: 140, text-fig. 110; Shen, 1932: 172, text-fig. 108, 110, pl. 8, fig. 5; Peters & Panning, 1933: 1-180; Sakai, 1939: 667, pl. 109, fig. 1; Shen & Dai, 1964: 127; Christiansen, 1969: 1; Kim, 1973: 465, fig. 202; Nepszy & Leach, 1973: 1909; Ingle & Andrews, 1976: 638; Ingle, 1980: 123, fig. 76, pl. 24b; Manning & Holthuis, 1980: 225; Clark, 1984: 111; Hwang & Mizue, 1985: 12; Gu, 1986: 268; Dai et al., 1986: 523; Yu & Ho, 1986: 116; Türkay, 1987: 38; Dai, 1988: 22; Adema, 1991: 201, fig. 79; Dai & Yang, 1991: 523; Dai, 1991: 61; Lai & Lu, 1992: 23; Hong et al., 1993: 10, pls. A & F; Chan et al., 1995: 301, fig. 3B; Cohen & Carlton, 1997: 1.

E. sinensis form *rostrata* Panning, 1933: 53, fig 22B; Panning, 1938: 110, fig. 8.

E. sinensis form *rotundifrons* Panning, 1938: 109, fig 5.

E. sinensis form *acutifrons* Panning, 1938: 109, fig 6.

E. sinensis form *trilobata* Panning, 1938: 110, fig 7.

Material examined. - Lectotype -1 female (66.0 x 57.0mm) (MNHN: B3383S), Macao, China, coll. M. Callery, no date.

Others: **CHINA** - 1 male, 9 females (AS 02616), Yingkou, Liaoling Province, 20 Aug.1931. — 1 male (AS 02629), Yingkou, Liaoling Province, 6 Jun.1950. — 2 males, 2 females (AS 02628), Fengcheng, Liaoling Province, 15 Sep.1975. — 2 males, 1 female (AS 02590), Shanhaiguan, Hebei Province, 14 Jun.1929. — 14 males, 7 females (AS 02617), Shanhaiguan, Hebei Province, 8 Aug.1930. — 2 females (AS 02611), Qinghuangdao, Hebei Province, 27 Jun.1930. — 8 males, 8 females (AS 02626), Beidaihe, Hebei Province, 4 Jun.1929. — 1 female (AS 02572), Beidaihe, Hebei Province, 24 Jun.1930. — 3 females (AS 02625), Beidaihe, Hebei Province, 6 May 1950. — 2 males (AS uncatalogued), Baiyangdian, Hebei Province, 1957. — 3 males, 1 female (AS 02618), Baiyangdian, Hebei Province, 13 May 1957. — 1 female (AS 02598), Beitang, Hebei Province, 2 Apr.1930. — 2 males (AS 02581), Xinzheng, Hebei Province, 20 Jun.1930. — 1 male (AS 02576), Liangminzhuang, Hebei Province, 8 May 1932. — 1 male, 1 female (AS 02605), Beitang, Hebei Province, 12 Jun.1930. — 1 male, 2 females (AS 02597), Xinzheng, Hebei Province, 12 May 1957. — 5 females (AS 02599), Yanghekou, Hebei Province, 18 Jun.1931. — 14 females (AS 02619), Xigu, Hebei Province, 21 Apr.1930. — 1 male, 6 females (AS 02622), Xigu, Hebei Province, 25 Apr.1930. — 2 males, 4 females (AS 02600), Xigu, Hebei Province, 21 Apr.1930. — 1 male, 1 female (AS 02604), Changzhou, Hebei Province, 19 Aug.1929. — 3 males (AS 02607), Sahe, Hebei Province, 1 Jun.1926. — 1 male, 2 females (AS 02578), Qinghuangdao, Hebei Province, 26 Jul.1930. — 7 males, 7 females (AS 02614), Tongzhou, Hebei Province, 7 Apr.1930. — 2 males (AS 02573), Dingxin county, Hebei Province, 17 May 1930. — 3 males, 1 female (AS 14106), Baiyangdian, Ba County, Hebei Province, 14 May 1957. — 1 female (AS 02639), Beijing, 16 Oct.1930. — 1 female (AS 02637), Beijing, 21 Sep.1928. — 15 males, 6 females (AS uncatalogued), Beijing market, 1957. — 2 males, 1 female (BNHM J58-0065), Tianjing. — 2 females (AS 02577), Longmen, Shangdong Province, 20 May.1930. — 1 female (AS 02588), Yantai, Shangdong Province. — 1 male (AS 02589), Yantai, Shangdong Province, 30 May 1930. — 2 males, 1 female (AS uncatalogued), Yantai, Shangdong Province, 1969. — 2 males, 1 female (AS 02627), Shangdong Province, 12 Apr.1975. — 1 female (AS 02579), Magongdao, Shangdong Province, 19 May 1931. — 1 male (AS uncatalogued), Yantai, Zhihuan, Shangdong Province, 22 Oct.1934. — 2 females (AS 02624), Nanjing, Jiangsu Province, Nov.1928. — 2 males, 1 female (AS uncatalogued), Nanjing, Jiangsu Province. — 123 males, 124 females (ZRC.1997.558), Haimen, Jiangsu Province, Nov.1995. — 5 males, 5 females (ZRC.1997.559), Haimen, Jiangsu Province, Oct.1996. — 2 males, 3 females (AS 02575), Wuxi, Jiangsu Province, 29 Apr.1973. — 1 male (AS 02634), Shanghai. — 1 male, 1 female (ZIM K-24729), Shanghai, 1928. — 10 males, 8

females (ZIM K-24843), Shanghai. — 1 male, 1 female (AS 02595), Qingtiansien, Zhejiang Province, Aug. 1978. — 3 males (AS 02608), Lisuisien, Zhejiang Province, May 1972. — 1 male (AS 02585), Santou, Zhejiang Province, Jul. 1955. — 1 male, 1 female (AS 02602), Wenzhou, Zhejiang Province, 20 Sep. 1929. — 1 male, 1 female (ZIM K-3910), Futschau, 13 Jun. 1903. — 3 males, 3 females (ZIM K-3904), Futschau, 31 May 1904. — 2 females (AS 02633), Jimei, Fujian Province, 1975. — 1 male, 1 female (AS 02631), Longhai, Fujian Province, 5 Mar. 1974. — 1 male (ZIM K-3911), Fo-Kien, 9 Sep. 1904. — 1 female (AS 02586), Sapayan, 11 May 1930. — 2 males, 1 female (AS 02636), Xinhousheng, 13 Jun. 1930. — 1 male (AS 02593), 21 May 1958. — 17 males, 3 females (AS 06382), Tongzhou, 8 Apr. 1929. — 2 males (AS 02580), Hekai, May 1937. — 1 male, 1 female (AS uncatalogued). — 3 males (AS uncatalogued). — 1 male (BNHM J58-0068). — 1 female (BNHM J58-0067). — 1 male (BNHM J58-0064). — 1 male, 1 female (BNHM J58-0066). — 1 female (BNHM J58-0174), 1958. — 2 males, 1 female (ZIM K-3900), Kiautschau, 23 Mar. 1910. — 1 female (ZIM K-24728), Woosung, 1846. — 1 male (ZIM K-3825). KOREA - 2 males, 3 females (AS 02615), Jizhou, Korea, 18 Jun. 1930. BELGIUM - 1 ex. mounted on board (ZI 12423). — 1 ex. mounted on board (ZI 12452). — 1 ex. mounted on board (ZI 12453). — 1 female (ovigerous) (RMNH D2919), Jantvliet, May 1935. FRANCE - 1 ex., dry mounted on board (MNHN 3384S). — 1 ex., dry mounted on board (MNHN 3388S). — 1 male, 1 female (MNHN MP B12573), Escaut. — 1 male (MNHN B12575), aquarium in Paris, Oct. 1939. — 1 female (MNHN B12576), 1939. — 1 female (MNHN MPB12577), Provenaut des courses d'eau d'Allenmague, 1938. — 1 male, 1 female (MNHN MPB12578), Escaut. — 2 males (MNHN MPB12580). — 1 male, 2 females (MNHN MPB12581), Escaut. — 1 male, 1 female (MNHN B12583), Rathenov seer Havel, Allemague, Nov. 1938. — 2 ex., mounted on board dry (MNHN B10982S). — 1 ex., dry mounted (MNHN 3387S). GERMANY - 1 male (ZIM K-24477) (paratype of *E. sinensis* form *rotundifrons*), Hamburg, 14 Mar. 1933. — 1 male (ZIM K-25230) (holotype of *E. sinensis* form *rotundifrons*), Calbe, 3 Mar. 1935. — 1 female (ZIM K-24470) (paratype of *E. sinensis* form *acutifrons*), Hafen, Hamburg, 27 May 1933. — 1 male (ZIM K-25236) (holotype of *E. sinensis* form *acutifrons*), Elbe, 21 Jul. 1935. — 1 female (ZIM K-24475) (paratype of *E. sinensis* form *acutifrons*), Hafen, Hamburg, 9 Mar. 1933. — 1 male (ZIM K-25262) (paratype of *E. sinensis* form *acutifrons*), Elbe, 29 Oct. 1936. — 1 male (ZIM K-24241) (paratype of *E. sinensis* form *trilobata*), Elbe 22 May 1936. — 1 male (ZIM K-24471) (paratype of *E. sinensis* form *trilobata*, Koln, 7 Jan. 1933. — 1 male (ZIM K-25232) (paratype of *E. sinensis* form *trilobata*) Hamburg, 17 Jul. 1935. — 1 male (ZIM K-24473) (paratype of *E. sinensis* form *trilobata*), Hamburg, 20 Jul. 1933. — 1 female (ZIM K-24847) (paratype of *E. sinensis* form *trilobata*), Brunsbittel, 27 Jan. 1934. — 1 male (ZIM K-25235) (paratype of *E. sinensis* form *trilobata*), Elbe. — 2 females (ZIM K-25231) (paratypes of *E. sinensis* form *trilobata*), Havel. — 1 female (ZIM K-25238) (holotype of *E. sinensis* form *trilobata*), Unterelbe, 1935. — 1 male, 1 female (ZIM K-24476) (paratype of *E. sinensis* form *rostrata*), Kohlbrand, 7 Jan. 1933. — 1 male (ZIM K-25229) (paratype of *E. sinensis* form *rostrata*), Elbe, 3 Jul. 1935. — 1 male (ZIM K-25242) (paratype of *E. sinensis* form *rostrata*), Finkenwarder. — 1 male (ZIM K-25501) (paratype of *E. sinensis* form *rostrata*), Michealisschlesse, 23 May 1938. — 1 male (ZIM K-25240) (paratype of *E. sinensis* form *rostrata*), Hafen, Hamburg, 10 Jul. 1936. — 1 female (ZIM K-24510) (*E. sinensis*, Panning's (1938) unnamed variety A), Elbe. — 1 female (ZIM K-25234) (*E. sinensis*, Panning's (1938) unnamed variety B), Zollenspieker, 19 Sep. 1933. — 1 female (ZIM K-25237) (*E. sinensis*, Panning's (1938) unnamed variety B), Elbe, Germany, 19 Jul. 1935. — 1 male (ZIM K-25243) (*E. sinensis*, Panning's (1938) unnamed variety B), Finkenwarder, Hamburg, 18 Jun. 1936. — 1 ex. (MNHN B12574), Elbe, pris de Wittenberg, 1930. — 1 male (ZIM K-20719), Weser. — 1 female (ovigerous) (ZIM K-22689), Norderelbe, 13 Oct. 1924. — 1 female (ZIM K-25336), Elbe, 1 Sep. 1937. — 1 female (ZIM K-22574), Elbe, 15 Sep. 1931. — 1 female (ZIM K-24490), Norderelbe. — 1 male (ZIM K-7869), Unterelbe, 19 Oct. 1924. — 1 female (newly moulted) (ZIM K-12865), Wittensee, 11 Oct. 1927. — 1 female (ZIM K-7971), Unterelbe, 7 Oct. 1924. — 3 females, 2 males (ZIM K-24480), Elbe. — 1 female (ZIM K-7824), Brunsbittel, 3 Dec. 1924. — 1 male (ZIM K-24845), Mit Rennerat, 26 Oct. 1932. — 1 male (ZIM uncatalogued), Bille Kanal, Hamburg, 17 Aug. 1957. — 3 females (ZIM K-24241), Elbwatt. — 2 males (ZIM K-37553), Elbe. — 1 male (ZIM K-33364), Oberelbe, 1932. — 2 males, 2 females (ZIM K-24480), Elbe. — 2 females (ZIM K-24846), Elbe, 27 Jan. 1934. — 1 male (ZIM K-22689), Elbe, 28 Sep. 1931. — 1 male (ZIM uncatalogued). — 2 specimens, mounted on board, covered with barnacles (ZIM uncatalogued). — 8 females, all covered with barnacles (ZIM K-24501), Cuxhaven. — 4 males, 2 females (ZIM K-24484). — 2 males (ZIM K-37478), Unterelbe, 1977. — 38 males, 23 females (ZIM K-24504), Hove. — 1 male, 1 female (ZIM K-37479), Unterelbe, 1978. — 16 males, 22 females (ZIM K-24490), Elbe. — 1 male, 1 female (ovigerous) (SM10955), Nordsee, Medemmnne 10.17m dept, coll. F. V. Sendenborg, 14 Dec. 1982. THE NETHERLANDS - 1 female (ovigerous) (RMNH D4721), Nord Breveland, 29 Mar. 1963. — 1 female (ovigerous) (RMNH D24720), Oasterzscelde, 8 Jul. 1961. — 1

male (RMNH D37185), Tussen Katwijken Noordwijk, 13 Dec.1958. — 2 males (RMNH D1819), Leiden, 1935. — 1 male (RMNH D3307), Leiden, 8 Oct.1940. — 1 male (RMNH D29622), Stomuruk, 4 Oct.1973. — 1 female (ovigerous) (RMNH D3293), 12 Apr.1940. — 1 male (RMNH D4478), 13 Aug.1944. — 1 female (ovigerous) (RMNH D24722), Schouwen, Zeeland, 26 Feb.1962. — 1 male (RMNH D3405), Rypweding, 1941. — 1 male, 1 female (RMNH D34689), Roclo Faazensiren, 3 Oct.1981. — 1 male (RMNH D10311), Ringvaart Haarlemmermeerpolder, 15 Nov.1940. — 1 male (RMNH D3918), Leiden, 29 Sep.1938. — 1 male (RMNH D4132), Zwette Scharnegoutum, 15 Oct.1943. — 1 male (RMNH D4133), Scharnegoutum, 15 Oct.1943. — 2 females (RMNH D3205), Leiden, 22 Nov.1938. — 1 male (RMNH D3140), Leiden, 1936. — 1 male, covered with barnacles (RMNH D29626), Den Helder, 26 May 1987. — 1 male (RMNH D10312), Reins Henderik Kanaal, 27 Sep.1955. — 1 male, 1 female (RMNH D2825), Oijde Bifdtzijt, Friesland, 27 Sep.1932. — 1 female (ovigerous) (RMNH D21348), Scheueningen-naozd, 30 Apr.1941. — 1 male (RMNH D3126), Leiden, 1936. — 1 male (RMNH D2824), Stezyensas, 13 Aug.1932. — 4 males (RMNH D36306), Nauecha Noord, 5 Jul.1985. — 1 female (RMNH D3715), Leiden, 28 Aug.1943. — 1 female (RMNH D3206), Leiden, 15 Nov.1938. — 1 male (RMNH D10310), Zoutkamp, Gzoningen Province, 4 Feb.1932. — 1 female (RMNH D31716), Brezum, Gzoningen, Dec.1959. — 1 male (RMNH D3714), Scharisshoot, Voozhart, 10 Aug.1943. — 1 female (ovigerous) (RMNH D32940), Gzenelingen, 26 May 1966. — 1 male (RMNH D3165), Niewkoop, 1936. — 1 male (RMNH D3766), Leiden, 17 Oct.1943. — 1 female (RMNH D8490), Leiden, 19 Jul.1952. — 1 male (RMNH D8491), Fegefen Limburg, 4 Aug.1952. — 1 male (RMNH D3716), Leiden, 28 Sep.1943. — 1 female, ovigerous (RMNH D32941), Strand-Westduin, 28 Apr.1962. — 1 male (RMNH D8492), Geneente Wassenawe, 17 Jul.1962. — 1 female, ovigerous (RMNH D23265), Rockanje, Voorne, Luid-Holland, 6 Jan.1967. — 1 female (RMNH D3307), Warmord Tb Sveuleborn, 27 Sep.1940. — 1 male (RMNH D35191), Nymegen, Getalezland, 14 Aug.1981. — 1 female (RMNH D2500), Leiden, Nederlands, 1 Nov.1936. — 1 male (RMNH D35187), Amsterdam, 9 Sep.1981. — 1 female, ovigerous (RMNH D11345), Noordwykaan Lee, Zuid-Holland, 7 Apr.1957. — 2 males (RMNH D3717), Leiden, Nederlands, 1 Oct.1943. — 2 males (RMNH D3768), Leiden, no date. — 1 male (RMNH D3769), Leiden, 5 Nov.1942. — 2 females (RMNH D16015), Tussen Nazdwijken, 5 Mar.1961. — only carapace (RMNH D5325), De Kwak, Voozne, Putten, 10 Jul.1947. — 1 male, 2 females, (RMNH D3765), Oegstgeist, Oct.1943 — 1 male (RMNH D2443), de Waal, 1936. — 1 male (RMNH D3306), Leiden, Nederlands, 1939-1940. — 4 males (RMNH D1572), Gwingen, no date. — 1 male (RMNH D34690), Fjobbemeec, Zultewaemond, 5 Oct.1981. — 1 male (RMNH D35191), Maas-Waal Kanaal, 31 Aug.1981. — 1 male (RMNH D2929), no location, no date. — 1 male (RMNH D2527), Brentsche A by de Passt, 20 Oct.1933. — 7 males (RMNH D2885), Groningen, 17 Sep.1933. — 4 carapaces, 2 female and 1 male abdomens (RMNH D10248), no location, 10 Sep.1954. — 2 males (RMNH D36013), Nymegen Waal Centrale, 10 Sep.1954. — 2 females (RMNH D24723), Naard Brabant, 16 Sep.1965. — 2 males (RMNH D24724), Naard Brabant, 14 Jan.1960. — 1 male (RMNH D35931), Nymegen, Getdesland, 26 May.1981. — 1 female (left side broken) (RMNH D4134), 7 May 1944. — 1 female (RMNH D3705), Haven, Leeland, 14 Jun.1943. — 2 males (RMNH D2528), Paterwoldschemeer, 9 May.1934. — 1 female (RMNH D27189), Warmond, 21 Jul.1971. — 2 males, 1 female (RMNH D10676), Stzyensas Beyeslad, 29 Apr.1956. — 1 female (RMNH D24718), Noord Bieshosch, 12 Jul.1966. — 1 female (RMNH D24719), Sleauryk, 3 Jul.1959. — 1 male (RMNH D23962), Moerdyk, N. Brabant, 23 May 1960. — 1 male (RMNH D23963), St Marie aan Schelde, Leeland, 1 Apr.1960. — 1 male (RMNH D23964), St. Philipsland, 19 Feb.1962. — 16 males, 4 females (barrel 1), 38 males, 44 females (barrel 2) (RMNH uncatalogued), northern Holland, 5 Apr.1985. — 1 male (RMNH D45215), northern Holland, 5 Sep.1980. — 1 female, carapace covered with barnacles (RMNH D45191), 15 Jun.1939. — 1 ex. (only carapace) (RMNH D45193), 21 Apr.1955. — 1 ex. (only broken carapace) (RMNH D45194), 23 Mar.1941. — 1 ex. (only carapace) (RMNH D46866), 6 May 1948. — 1 ex. (only carapace) (RMNH D45199), 11 Jan.1981. — 2 legs and 1 carapace (RMNH D45196), northern Holland, May-Jul.1949. — 1 ex. (broken carapace) (RMNH D46867), 23 Mar.1941. — 1 ex. (only carapace) (RMNH D45195), 4 Apr.1941. — 1 ex. (only carapace) (RMNH D45204), northern Holland, 1 May 1936. — 1 female (RMNH D46864), Delfgauwse weg Delft, Nov.1941. — 1 male (RMNH D45206), Zuid-Holland, 10 Aug.1961; — 1 male (RMNH D5645), Zuid-Holland, Oct.1935. — 1 female (RMNH D45216), summer of 1940. — only 3 fragments (RMNH D45200), 15 Jul.1944. — only 2 chelipeds (RMNH D45205), 3 Apr.1938. — 1 ex. (only carapace) (RMNH D45202), 22 May 1937. — 1 female (RMNH D45212), 8 Sep.1951. — 1 female (RMNH D45209), 26 Mar.1961. — 1 ex. (only carapace) (RMNH D45207), 5 Mar.1944. — 1 ex. (only carapace and abdomen) (RMNH D45204), Den Helder, northern Holland, 1 May 1936. — 1 female (RMNH D45198), Mar.1942. — 1 male (RMNH D5644), Leiden, 17 Oct.1940. — 1 mounted ex. (RMNH D45208, 4 Apr.1969. — 1 mounted ex. (RMNH D45201), Noord-Brabant, 25 Jul.1953. — 2 males, 4 females (RMNH D33082), northern Holland, 29

Aug.1980. — 1 male (RMNH D45211), Nov.1944. — 1 female (RMNH D45192), 17 Apr.1947. — 1 female (RMNH D5643), Jun.1936. — 1 female (RMNH D45213), Gelerland, 1 Apr.1982. — 2 carapaces and 3 legs (RMNH D45214), 30 Apr.1951. NORWAY - 1 female (ZMO F21015), Visterflo, Rolvsøy Ostofold, coll. Day Anderson, Sep.1986. — 1 male (ZMO F17280), Arisholmen ved Krakerøy Hvaler Kommune, coll. Ole Magussen, 11 Dec.1976. — 2 males, 2 females (ZMO F4319), Elben neddenfor Freiburg, Nov.1929. ENGLAND - 5 males, 2 females (NHM), Lots Road, Chelsea, London, England, coll. B.D. Smith & C. Bryne, Nov.1996.

Description. - Carapace (Fig. 2a) rectangular (length : width ratio 1:1.1), overall dorsal surface very convex. Epigastric, protogastric cristae very high, granular, very sharp with prominent ridge. Hepatic region slightly depressed; gastro-cardiac, cardio-branchial, cardio-intestinal grooves very distinct. Branchial region very swollen. Epibranchial ridge high, granular, mesobranchial ridge granular, extends obliquely backwards. Frontal margin granulated divided into four lobes with sharp, acute, triangular teeth. Median two teeth separated by a wide, deep V-shaped sinus. Supra-orbital margin concave, infra-orbital margin crest granulated, extending to ventral surface of outer orbital tooth, lateral edge slightly concave.

Antero-lateral margins granulated, slightly convergent anteriorly, with four teeth. Each tooth separated by wide V-shaped notches, lateral margins granulated. First tooth (external orbital tooth) largest, strongest, very sharply pointed anteriorly, acute, antero-lateral margin of first tooth concave, postero-lateral end convex; second tooth acute, smaller than first. Third tooth more acute, smaller than second. Fourth tooth smallest, sharp. Postero-lateral margin after last tooth serrated, progressively more granular on postero-lateral margin, posterior margin granulated. Posterior carapace margin slightly convex.

Ridge between pterygostomial, suborbital regions granulated. Pterygostomial region granulated ending in fine groove to posterior end of lateral margin, ventral margin regularly denticulated.

Eyes well developed, base broad, cornea small, pigmented. Eye peduncle short, stout. Antennulae folded in broad fossa; antennal basal segments occupying entire orbital hiatus, flagellum short, reaching tip of first anterolateral tooth.

Endostomial ridge prominent, granulated. Posterior margin of epistome entire, margin granulated, denticulated at lateral edges with lobulations at lateral ends.

Third maxilliped (Fig. 2b) very broad; ischium, merus broad, elongate longitudinally, each with inner margin raised, covered by very short setae, ischium longer than broad (length : width ratio 1:1.3), slightly longer than merus (length : width ratio 1:1.1); merus longer than broad (length : width ratio 1:1.1), narrow at base, outer margins obliquely straight, inner, outer angle of merus more produced, auriculiform; exopod narrow, almost reaching distal edges of merus, well developed flagellum.

Cheliped (Fig. 2c) larger in male than in female. Ventral distal margin of coxa granulated, basal margin articulating with sternum by a tooth-like hinge at distal end, a large tooth-like hinge connecting to smooth basis. Anterior, posterior margins of ischium denticulated. Merus long, slender, prismatic in cross-section, all margins denticulated, basal region of dorsal margin with some long setae, a sharp subdistal tooth on dorsal margin, with transverse groove parallel to distal margin of merus. Outer surface of merus (Fig. 1d) with irregular granulated grooves; ventral, inner surfaces granulated. Outer ventral margin with distal lobe. Carpus

quadrate with coarse granules on surface (Fig. 1d). Anterior border without setae. Inner dorsal margin with prominent curved granulated ridge, inner dorsal margin with long, sharp spine, base, inner margin spinulose. Outer surfaces of manus (Fig. 2d) finely granulated, prominent fine ridge in female extending to distal end of pollex. Inner, basal half of fingers thickly setose in male but less densely so in female. Dactylus regularly toothed, closing with a small gap, inner margins regularly denticulated. Inner surface of dactylus tip corneous, excavated, sub-spatuliform.

Ambulatory legs slender, long, with long setae on anterior, posterior surfaces of carpus, propodus, dactylus. Second, 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 all four legs, finely serrated ridge on dorsal surface, almost parallel to basal portion anterior margin which extends from base to submedian point. Carpus with anterior margin ridged, first leg with a ridge on its dorsal, ventral surfaces, second, third, fourth each on dorsal surface, last leg less conspicuous. Distal parts of all ridges setose except fourth leg. Propodus setose on anterior, posterior margins, very long, slender, compressed (length : width ratio 1:3.5), very long, slender in fourth leg. Dactylus of first leg shortest, second, third styliform, in fourth (Fig. 2e) slightly more compressed (length : width ratio 1:10.4). Tip of each dactylus sharp, corneous.

Margins of first two thoracic sternites finely granulated. First to third thoracic sternites completely fused; fourth sternite with deep, wide medial groove, fifth, sixth sternite narrower than fourth. Groove absent in seventh, eighth sternites. Sternum structures of females similar to male, medial groove wider, shallower.

Male abdomen triangular. First abdominal segment arched, with transverse submedian ridge. Second segment narrow, short. Third broad, slightly swollen laterally, medially depressed, proximal margin broader than distal, lateral margin rounded, slightly concave. Fourth segment broader, shorter than fifth, fifth with basal margin convex, distal concave medially, lateral margins slightly concave. Sixth segment quadrate (Fig. 2f), lateral margins subparallel, proximal part slightly concave, convex medially, lateral distal angle broad, smoothly rounded. Telson triangular (Fig. 2f). Female, abdomen rounded, large covering most of sternum when mature. First three segments ridged, second shorter than third. Fourth, fifth segments similar in shape. Sixth narrower than fifth, proximal margin slightly convex medially, distal margins concave. Lateral margins of four preceding segments convex. Telson transversely triangular (Fig. 2g). Anterior border of female abdominal cavity densely covered with soft setae.

G1 (Fig. 2h) with distal margin truncate, squarish-round when viewed laterally, distal chitinous prominence short, genital pore near distal end, tip reaching suture of sternite III/IV. G2 short, small. Vulva (Fig. 2i) on sixth sternite, semicircular in shape, very concave dorsally.

Distribution. - Northern China and Korea.

Remarks. - Henri Milne Edwards (1854) briefly described *E. sinensis* without specifically stating how many specimens he had available. He, however, provided a somewhat schematic figure of a female specimen. In the MNHN is a dried female specimen labelled as "type" which agrees well with H. Milne Edwards' figure (including size). As it was possible that H. Milne Edwards had additional material when he described this species which may not

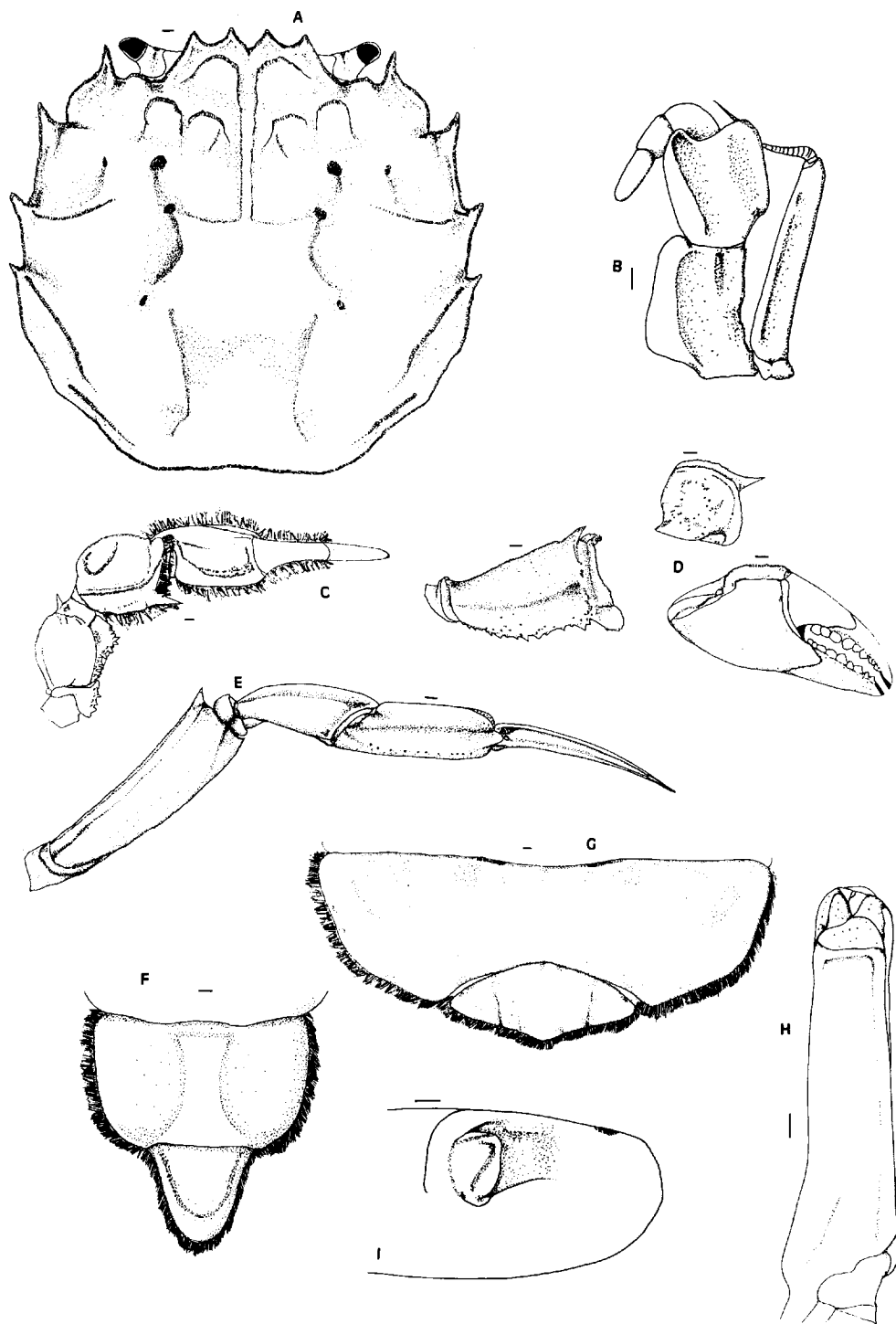


Fig. 2. *Eriocheir sinensis* H. Milne Edwards, 1854 (male, a, b, c, d, e, f, h, 78.5 mm x 73.0 mm, ZRC.1997.558; female, g, i, 61.2 mm x 57.6 mm, ZRC.1997.558); a) carapace; b) third maxilliped; c) dorsal view of left cheliped; d) ventral view of left cheliped; e) fourth ambulatory leg; f) male sixth abdomen somite and telson; g) female sixth abdomen and telson; h) G1; and i) vulvae.

now be extant or has been misplaced, we hereby designate the MNHN specimen as the lectotype of *E. sinensis*.

The exact provenance of H. Milne Edwards' specimen cannot be ascertained. It is known that the collector, M. Callery obtained specimens from around Guangzhou in southern China (see Ng & Dudgeon, 1992), but being a major trading centre then, he could also have obtained specimens from more northern localities. The high food value of *E. sinensis* would probably have seen many specimens been sent throughout China even at that time. The area around Guangzhou, from our data, has only one species, *E. hepuensis*, although it is not very common there. In any case, the lectotype of *E. sinensis* is clearly identical to specimens from northern China and not with *E. hepuensis*.

Panning (1933, 1938) had recognised six forms of *E. sinensis* in his study of the German *E. sinensis*, but provided names to only four of them, viz. *E. sinensis* form *rostrata* Panning, 1933, *E. sinensis* form *rotundifrons* Panning, 1938, *E. sinensis* form *acutifrons* Panning, 1938, and *E. sinensis* form *trilobata* Panning, 1938. For these four names, descriptions were provided and holotypes and paratypes were designated. His names are therefore nomenclaturally available and under the current ICZN (1985) rules, Panning's forms can be regarded as valid taxa. There was thus a necessity to examine Panning's (1933, 1938) "forms" and see if any of them might be *E. hepuensis*. This is because while it is generally accepted that it was *E. sinensis* which entered Europe, there is every possibility that *E. hepuensis* might also have been introduced and the various forms might be *E. hepuensis* or even the result of hybridisation between the two species.

Examination of all of Panning's (1933, 1938) specimens show that they are *E. sinensis* as presently defined. The differences which led Panning (1933, 1938) to recognise several forms are entirely in the form of the frontal margin. Our examination of all these specimens show that the observed differences are all results of damage and/or anomalous regeneration. We will now comment with each of his forms individually:

Eriocheir sinensis form *rostrata* Panning, 1933, has the most peculiar frontal features. The frontal margin is almost straight with two distinct outer orbital teeth. Beneath this margin, there is an unevenly depressed pentagonal outgrowth bearing two minute sharp teeth (Fig. 3a). Examination of the syntypes revealed that there are numerous compression lines between the frontal margin and the protogastric cristae. Obviously, the frontal margins of these specimens had been "squashed" and severely damaged, possibly shortly after postmoult, and the resultant margin after repair and hardening has assumed this rather odd structure. *Eriocheir sinensis* form *rotundifrons* Panning, 1938, is characterised by its wide elliptical frontal margin without any sharp teeth (Fig. 3b). Examination of the frontal margins of the syntypes showed that there are rudimentary bumps separated by a slight groove in the center and asymmetrical thickening along the frontal margin respectively. This again, is almost certainly the result of post-injury regrowth.

Eriocheir sinensis form *acutifrons* Panning, 1938, is characterised by the frontal margin narrowing to a single sharp tooth which is slightly bent downwards at the middle (Fig. 3c). In all the syntypes examined, the distances between the outer orbital teeth and the 'median frontal tooth' are unequal. The marginal thickening on the frontal tooth is also distinctly asymmetrical. These observations again indicate anomalous regrowth.

Eriocheir sinensis form *trilobata* Panning, 1938, is supposedly characterised by its frontal

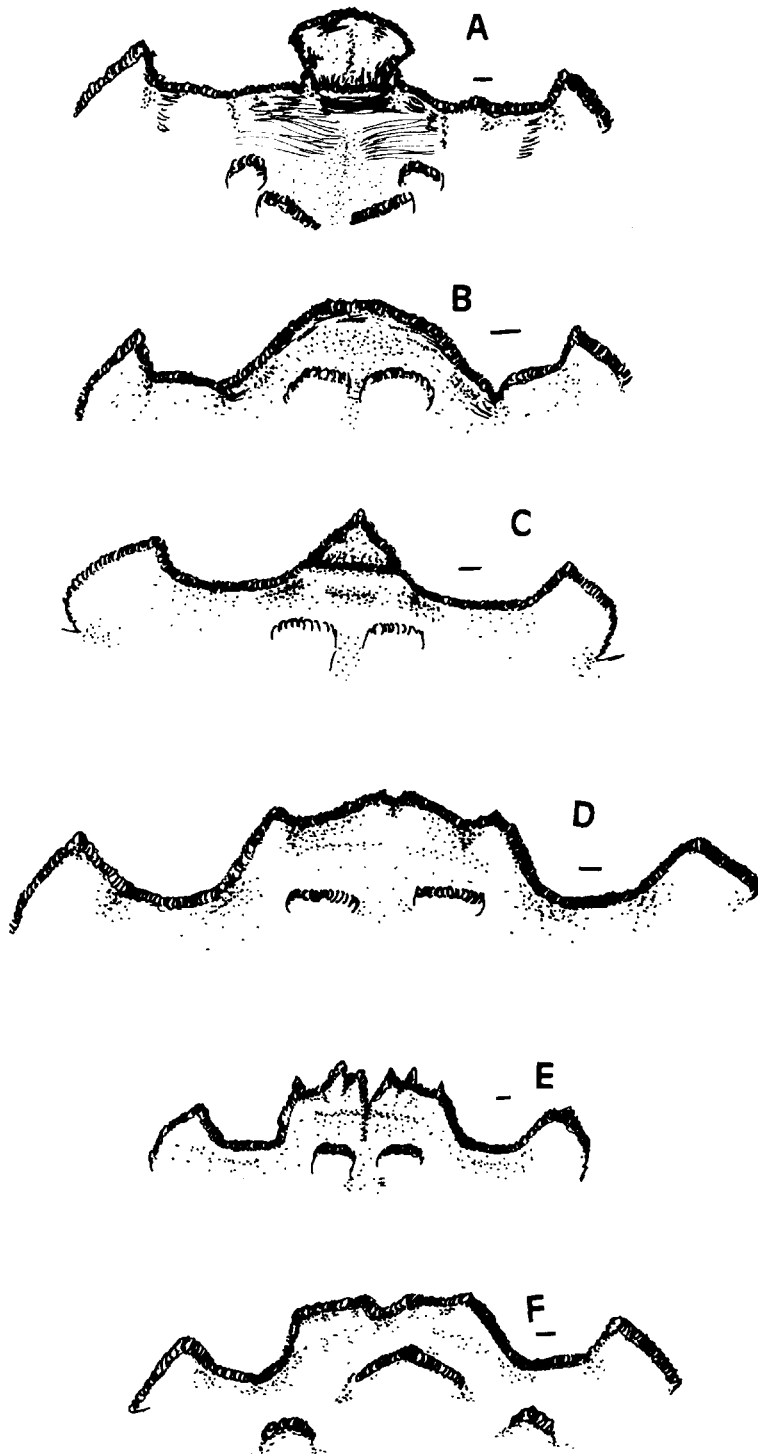


Fig. 3. Frontal margin of a) *Eriocheir sinensis* form *rostrata* Panning, 1933, male, 36.0 mm x 32.8 mm (ZIM K 24474); b) *E. sinensis* form *rotundifrons* Panning, 1938, male, 48.7 mm x 44.0 mm (ZIM K 25230); c) *E. sinensis* form *acutifrons* Panning, 1938, male, 36.0 mm x 32.0 mm (ZIM K 25236); d) *E. sinensis* form *trilobata* Panning, 1938, male, 66.9 mm x 61.3 mm (ZIM K 25238); e) *E. sinensis* "variety A", male, 60.6 mm x 56.6 mm (ZIM K 24510); f) *E. sinensis* "Variety B", male, 48.00 mm x 44.3 mm (ZIM K 25234).

margin having only three blunt teeth (Fig. 3d). The type show a distinct uneven thickening of frontal margin on the median tooth when compared to the lateral teeth. This suggests that the median part of the margin (with two teeth) had been damaged and the single median resultant tooth is the consequence of regrowth.

There are two other forms that Panning referred to as "varieties" without giving any formal names. One variety (variety A) with only one specimens (ZIM K-24510) has a higher frontal margin with six small teeth (Fig. 3e). When viewed dorsally, the three teeth on the left are higher and wider than the three on the right, with the teeth all pointing in different directions. The second variety (variety B) (three specimens, ZIM K-25234; ZIM K-25237; ZIM K-25243) have virtually no teeth on the frontal margin but numerous small bumps are irregularly spaced along the frontal margin (Fig. 3f). The asymmetry of the frontal margins in both these "varieties" and unevenness in the thickening of the margins are clear indications of anomalous growth after injuries.

Panning (1938) noted that only 26 specimens belonged to the above-mentioned six forms, out of some 45,000 crabs he examined. This occurrence, at only 0.056%, is extremely small. As we have noted, all the various different frontal characters are clearly the result of damage and subsequent repair. Most of the 26 specimens are juveniles, with only three specimens (K-24510, variety A; K24847 and K25238, *E. sinensis* form *trilobata*) being sub-adult in sizes. Examination of all these specimens show that other than in the anomalous frontal margin features, there are no other characters which can separate them from typical *E. sinensis*. All the adult specimens of mitten crabs we have examined from Europe correspond very well with what is defined as *E. sinensis* here.

Interestingly, about one year after his 1938 paper, Panning stated that "... Now the mitten crab again has its original form without any deviation from the Chinese specimens brought to me recently from Shanghai ..." (Panning, 1939: 111). The authors have yet to find any of his six forms as yet nor have there been any reports of these after Panning (1938).

Size. - Sub-adult and adult from carapace size of approximately 40.0 x 33.0 mm and 60.0 x 56.0 mm onwards respectively.

***Eriocheir hepuensis* Dai, 1991**

(Figs. 4, 6b, 6e, 7b)

Eriocheir sinensis - Chan, Hung & Yu, 1995: 301 (part), fig. 3D.

Eriocheir japonicus hepuensis - Dai, 1991: 61, figs 1-11; Dai, 1993: 17.

Material examined. - Holotype male (70.2 x 63.0mm) (AS GX899024A), Hepu, Guangxi, southern China, 18 Nov.1989.

Paratypes - Allotype female (68.1 x 62.7mm) (AS GX899024B), same data as holotype. — 1 male, 1 female, 26 Oct.1993. — 2 males, 2 female, 20 Dec.1995. — 2 males, 1 female (AS 02662), Hepu, Guangxi, China, 19 Nov.1989. — 10 males, 10 females (AS uncatalogued), Gongguan, Guangxi Province, 18 Nov.1989. — 10 males, 10 females (AS uncatalogued), Changluo, Guangxi Province, 19 Nov.1989.

Others - CHINA - 2 males, 5 females (AS 00293), Mawei, Fuzhou, Fujian Province, 14 Oct.1975. — 3 males, 2 females (AS 08514), Fuzhou, Fujian Province. — 1 male, 1 female (AS 02587), Haimen, Zhejiang Province, 15 Jul.1962. — 1 male (AS 02641), Guangdong. — 3 males, 1 female (AS 02657), Hepu, Guangxi. — 1 male, 1 female (AS 02664), Beihai, Guangxi, Oct.1978. — 3 females (AS 02623),

Shantou, Guangdong, 19 Mar.1956. — 1 male, 2 females (AS uncatalogued), Hepu, Guangxi, Apr.1989. — 1 male, 1 female (AS 02635), Tongtoudao, Zhejiang Province, 2 Jul.1962. — 1 male, 1 female (AS 02663), Beihai, Guangxi Province, Oct.1978. — 1 female (AS 02574), Fujian Province, Aug.1932. — 1 female (AS 02592), Putuo, Zhejiang Province, Jul.1955. — 9 males, 11 females (AS 02570), Xiamen, Fujian Province, Aug.1928. — 1 male, 2 females (BNHM uncatalogued), Chongwen, Fujian Province, coll. S. L. Yang, 20 Nov.1996. — 1 male, 1 female (BNHM uncatalogued), Nanao, Guangdong Province, coll. S. L. Yang, 21 Aug.1996. — 2 males, 2 females (BNHM J96-145), Fuzhou city, Fujian Province, 5 Sep.1984. — 6 males, 4 females (BNHM J96-141), Nanning, Guangxi Province, 13 Nov.1994. — 1 female (BNHM J96-002), Tongtuo, Zhejinag Province, coll. S. L. Yang & X. M. Sun, 28 Sep.1996. — 6 males, 3 females (BNHM J58-0068), Hepu, Guangxi Province. — 2 males (BNHM no number), Tongxing, Guangxi Province, coll. S. L. Yang, 24 Mar.1992. — 12 males, 9 females (AS uncatalogued), Hepu, Guangxi Province, Nov.1993. — 2 males, 2 females (AS uncatalogued), Hepu, Guangxi Province. — 12 males, 11 females (AS uncatalogued), Hepu, Guangxi Province, 17 Mar.1992. — 5 males, 5 females (AS uncatalogued), Changle, Guangxi Province, 18 Nov.1989. — 14 females (AS uncatalogued), Gongguan, Guangxi Province, 18 Nov.1989. — 4 males, 3 females (AS uncatalogued), Hepu, Guangxi Province, 26 Oct.1993. — 1 male, 4 females (AS uncatalogued), Hepu, Guangxi Province, 19 Nov.1989. — 3 females (BNHM uncatalogued), coll. Guangxi Fisheries Institute, 18 Nov.1994. — 7 males, 4 females (AS uncatalogued), — 16 males, 13 females (AS uncatalogued), Hepu, Guangxi Province, Nov.1994. — 28 males, 1 female (AS uncatalogued), Gongguan, Hepu, Guangxi Province. — 58 males, 43 females (ZRC.1997.560), Hepu, Guangxi Province, 10 Dec.1995. — 5 males, 5 females (ZRC.1997.561), Hepu, Guangxi Province, Oct.1996. — 3 males, 3 females (SCSIO, uncatalogued), Lianhuashan, Guangzhou, China, no coll. and date.

Description. - Carapace (Fig. 4a) rectangular (length : width ratio 1:1.10), overall dorsal surface less convex than *E. sinensis* but more convex than *E. japonica*. Epigastric, protogastric cristae low, granular, sharp ridge. Frontal teeth 4-lobed. Median two teeth lowly triangular, U-shaped sinus moderately deep, lateral teeth triangular.

Antero-lateral margins with four teeth. Each tooth separated by wide V-shaped notches, lateral margins granulated. First tooth (external orbital tooth) acute, distal-lateral margin of first teeth slightly concave; second, third tooth slightly turned upwards, fourth tooth smallest, angular.

Pterygostomian similar to preceding species.

Eyes well developed, similar to preceding species.

Endostome, epistome similar to preceding species.

Third maxilliped (Fig. 4b) similar to preceding species. Ischium longer than broad (length: width ratio 1:1.31), longer than merus (length : width ratio 1:1.27); merus longer than broad (length : width ratio 1:1.06).

Cheliped (Fig. 4c) similar to preceding species. Anterior border of carpus with very short setae.

Ambulatory legs slender, long, reduced or little setae on anterior, posterior surfaces of carpus, propodus. Propodus of fourth leg short, broad, rounded, compressed (Fig. 4d) (length : width ratio 1:2.5). Dactylus of fourth, slightly longer (length : width ratio 1:6).

Thoracic sternites similar to preceding species.

Male abdomen similar to preceding species. Sixth segment quadrate (Fig. 4e), lateral margins subparallel, proximal part slightly concave, convex medially, lateral distal angle

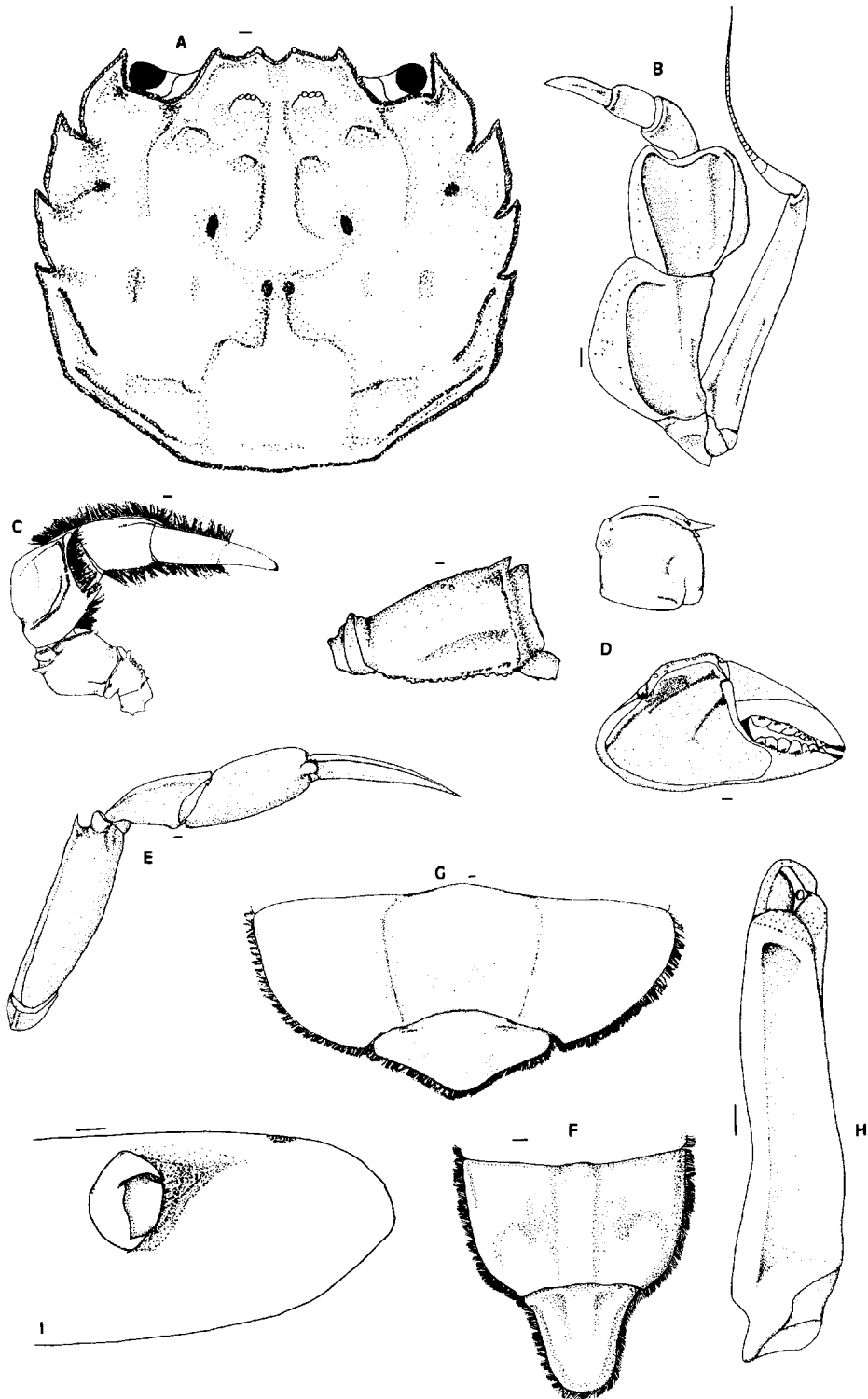


Fig. 4. *Eriocheir hepuensis* Dai, 1991 (male, a, b, c, d, e, f, h, 54.9 mm x 49.8 mm, ZRC.1997.560; female, g, i, 52.0 mm x 46.0 mm, ZRC.1997.560); a) carapace; b) third maxilliped; c) dorsal view of left cheliped; d) ventral view of left cheliped; e) fourth ambulatory leg; f) male sixth abdomen somite and telson; g) female sixth abdomen and telson; h) G1; and i) vulvae.

slightly rounded. Telson triangular (Fig. 4f). Female, abdomen rounded, large covering most of sternum when mature. First three segments ridged, second segments shorter than third. Fourth, fifth segments similar in shape. Sixth segment narrower than fifth, with proximal margin slightly convex medially, distal margins concave. Lateral margins of four preceding segments convex. Telson transversely triangular (Fig. 4g).

G1 (Fig. 4h) with distal margin broadly rounded, ball-like in lateral view, distal chitinous prominence slightly longer. Genital pore near half distal end, tip reaching suture of sternite III/IV. G2 small, short. Vulvae (Fig. 4i) slightly prominent, more triangular in shape, slightly concave dorsally.

Distribution. - Southern China.

Remarks. - The morphological differences between *E. sinensis* and *E. hepuensis* are summarised in Table 1.

There are no detailed reports or studies to show the actual distribution of the three species. Our examination of the available but still relatively limited specimens so far have indicated that *E. sinensis* is found mainly in north-eastern China while *E. hepuensis* in southern China and *E. japonica* mostly in south-eastern China and west coast of Taiwan (Fig. 9). However, no wild hybrids or intermediate have been reported or found among these specimens examined.

Eriocheir sinensis, being a popular food crab, have been transported to the southern China or even Taiwan for food before 1970s. This could probably explained how M. Callery had obtained the types of *E. sinensis* specimens, and why there was a pair of *E. sinensis* from in I-Lan county, eastern Taiwan where only *E. formosa* prevails. Since both the adult and larvae of the *Eriocheir* are distributed along the Chinese coast, it is inevitable that some individual crabs or larvae might have wandered off and "lost their way". For example, there are three specimens of *E. hepuensis* from different parts along the coast of Zhejiang Province, north-eastern China and one specimen from Haimen, at the mouth of Qiantangjiang River, where *Eriocheir sinensis* naturally occurs.

Size. - Sub-adult and adult from carapace size of approximately 35.0 x 30.0 mm and 50.0 x 42.0 mm onwards respectively.

***Eriocheir japonica* (de Haan, 1835)**

(Fig. 5, 6c, 6f, 7c)

Grapsus (Eriocheir) japonicus de Haan, 1835: 59, pl. 17.

Eriocheir japonicus - Ortmann, 1894: 716; Rathbun, 1902: 24; Brashnikov, 1907: 53; Stimpson, 1907: 124; Kemp, 1918: 231; Parisi, 1918: 101; Tesch, 1918: 107; Sakai, 1935: 227, pl. 63, fig. 1; 1939: 667, pl. 76; 1976: 646-647, pl. 221; Hoestlandt, 1948: 8-9, fig. 6; Lin, 1949: 10; Shen & Dai, 1964: 128, 1 fig.; Kim, 1973: 467, fig. 203; Kobjakova, 1976: 56, fig. 115; Dai et al., 1986: 476, fig. 268 (1); Dai & Yang, 1991: 522, fig. 268, pl. 67(2); Li et al., 1993: 111; Hong et al., 1993: 10, pls. A, F; Yamaguchi & Holthuis 1993: 460, fig. 176A-E.

Eriocheir japonica - Chan et al., 1995: 301, figs. 1A, 2C, 3C.

Material examined. - Paralectotypes - 1 male (70.0 x 65.0 mm) (RMHN D1618), Japan. — 1 female (61.0 x 57.9 mm) (RMHN D113), Japan. — 1 male (71.0 x 63.0 mm), (RMHN D114), Japan. — mouthparts only (RMHN D42175), Japan.

Paratypes - 3 males, 3 females (RMHN D421738, Japan. — 1 male, 3 females (RMHN D42174), Japan. — 1 male (RMHN D41845), Japan. — 1 male (RMHN D25142), Kyushu, Japan, 8 Sep.1986. — 1 male (NMHN 3386S), Japan.

Others - JAPAN - 2 carapaces, 1 male, 2 females (ZIM K-3781), Nagasaki. — 5 males, 3 female (ZRC 1997.562), Kagoshima Prefecture, Japan, coll. T. Kishino, 25 Jan.1996. — 2 males, 2 females (ZRC 1997.563), Kagoshima Prefecture, coll. H. Suzuki, 12 Jan.1996. — 3 males (ZRC 1997.564), Kagoshima Prefecture, coll. H. Suzuki, 20 Dec.1985. — 3 males (ZRC 1997.565), Kagoshima Prefecture, coll. H. Suzuki, 16 Dec.1995. — 1 male (ZRC 1997.566), Kagoshima Prefecture, coll. H. Suzuki, 4 Jun.1987. — 1 female (ZRC 1997.567), Kagoshima Prefecture, Japan, coll. H. Suzuki, 31 Jan.1996. **KOREA** - 1 male, 1 female (AS 02659), northern region of South Korea, summer 1958. **CHINA** - 2 males (AS 02596), Tumenjiang, Jiling Province, Jun.1958.— 2 females (AS uncatalogued), Yangsicun, Putong, coll. Y. Sakama, 22 Jul.1938. — 1 male (BNHM uncatalogued), Tongtoudao, Zhejiang Province, coll. S. L. Yang & X. M. Sun, 28 Sep.1996. — 1 male (ZRC.1997.803, ex. NTOU N-90-93, neotype of *E. recta*, designated by Chan et al., 1995), Pearl River Estuary near Macau, coll. Q. C. Chen, 1990-1993. **HONG KONG**. — 1 male (AS 02658). — 1 male, 1 female (ZRC.1997.568), Hoi Sing Wan, New Territories, Hong Kong, coll. D. Dudgeon, Mar.1983. — 2 females (ZRC.1997.569), New Territories, Hong Kong, coll. D. Dudgeon. **TAIWAN** - 1 male (ZRC.1997.589), I-Lan county, eastern Taiwan, coll. J. J. Huang, 23 Nov.1983. — 1 female (ZRC.1997.590), I-Lan county, Taiwan, coll. L. F. Chen, 26 Nov.1983. — 2 males, 2 females (ZRC.1997.591), Taipei, Taiwan, coll. X. P. Yu, 6 Jun.1982. — 2 males (ZRC.1997.592), Taipei, Taiwan, coll. J. F. Huang, 5 Jun.1988.

Description. - Carapace (Fig. 5a) rectangular (length : width ratio 1:1.1), overall dorsal surface only very slightly convex. Epigastric cristae very low, granular. Protogastric cristae very reduced. Frontal margin granulated with four lobes; lateral lobes with two angular, not prominent teeth; median pair roundly lobed, median sinus shallow.

Antero-lateral margins with 4 teeth. First tooth (external orbital tooth) largest, strongest, rectangular, pointing anteriorly, distal-lateral margin straight; second tooth smaller than first, sharp. Third tooth smaller than first two. Fourth tooth smallest, reduced, usually blunt, sometimes only a spinule present.

Pterygostomian similar to preceding species.

Eyes structure similar to preceding species.

Endostome, epistome similar to preceding species.

Third maxilliped (Fig. 5b) similar to preceding species, angle between anterior, outer border of ischium produced, ischium longer than broad (length : width ratio 1:1.58), longer than merus (length : width ratio 1:3.7); merus longer than broad (length : width ratio 1:1.3). Cheliped (Fig. 5c, d) similar to preceding species, distinctly, anterior border of carpus with long setae.

Ambulatory legs slender, long, long thick setae on anterior, posterior surfaces of carpus, propodus of first to third legs Propodus of fourth leg (Fig. 5e) much more compressed, short, wide (length : width ratio 1:2.1). Dactylus long, slightly curved in fourth more compressed than preceding legs (length : width ratio 1:5.1).

Thoracic sternites similar to preceding species.

Male abdomen similar to preceding species. Sixth segment (Fig. 5f) quadrate, lateral margins subparallel, proximal region slightly concave, convex medially, lateral distal angle

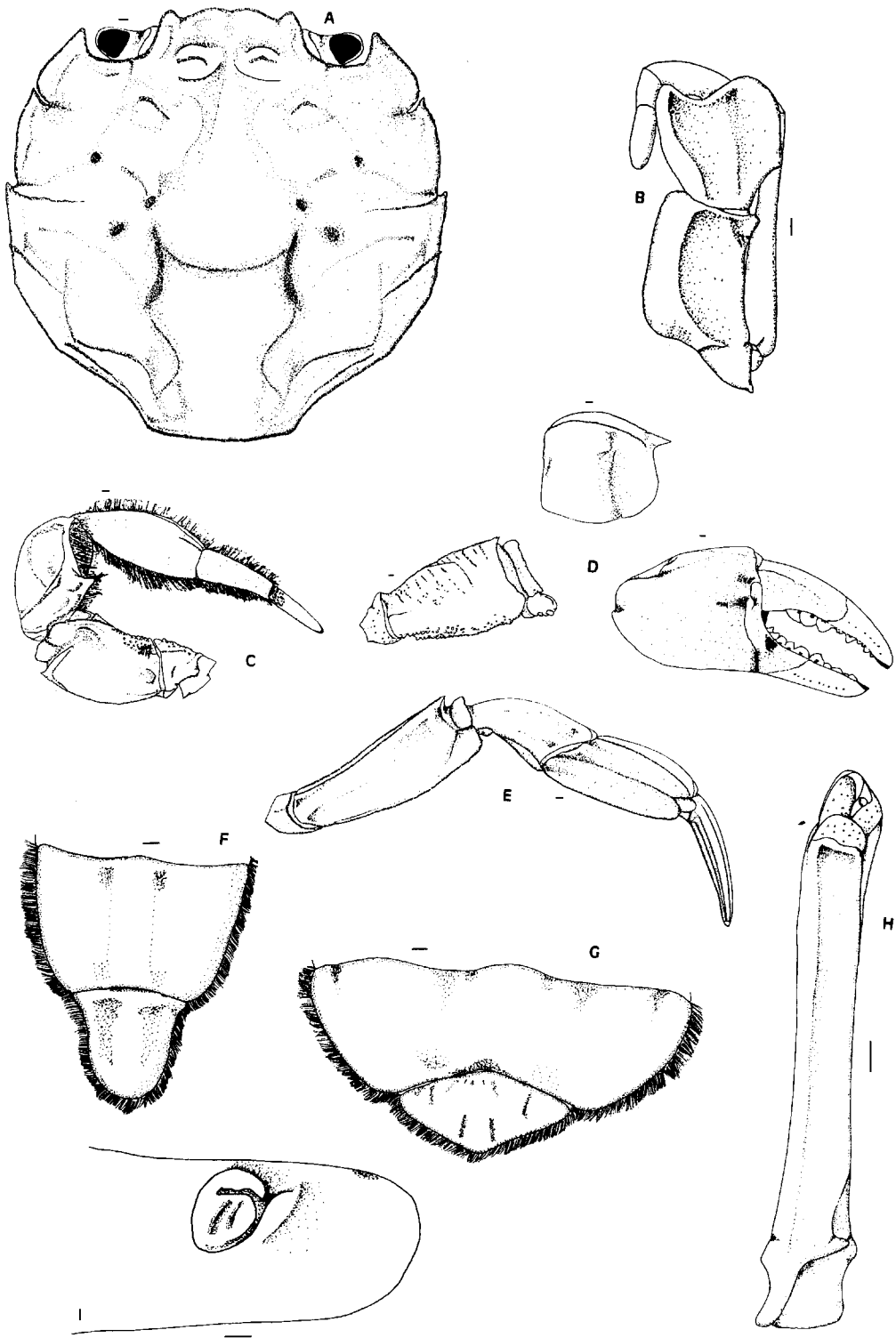


Fig. 5. *Eriocheir japonica* (de Haan, 1835) (male, a, b, c, d, e, f, h, 71.8 mm x 65.6 mm, ZRC.1997.565; female, g, i, 58.0 mm x 49.0 mm, ZRC.1997.565); a) carapace; b) third maxilliped; c) dorsal view of left cheliped; d) ventral view of left cheliped; e) fourth ambulatory leg; f) male sixth abdomen somite and telson; g) female sixth abdomen and telson; h) G1; and i) vulvae.

narrowly rounded. Abdomen triangular (Fig. 5f). Telson transversely triangular (Fig. 5g). Penis at base of eighth sternite. G1 (Fig. 5h) long, slender, distal margin narrowly rounded, sloping shoulder shaped when viewed laterally, short, chitinous prominence, slightly curved dorsally outwards with subdistal lobe, genital opening at 1/3 distally. Tip of G1 reaching suture of sternite III/IV. G2 short, small. Vulva (Fig. 5i) on sixth sternite bluntly triangular, prominent, slightly concave dorsally.

Distribution. - Japan, southern China, west coast of Taiwan, Hong Kong, and south-eastern South Korea.

Remarks. - The original description given by de Haan (1853) was rather short and insufficient by modern standards. We have examined the paralectotypes of *E. japonica* in the RMNH as well as a large series of specimens from Japan and Taiwan, and a redescription, as well as detailed figures of the species is presented here. This is necessary in view of the confusion among some workers with regards to the identities of *E. japonica*, *E. sinensis* and *E. hepuensis* (e.g. Dai, 1991, 1993; Li et al., 1993; Chan et al., 1995). Contrary to their

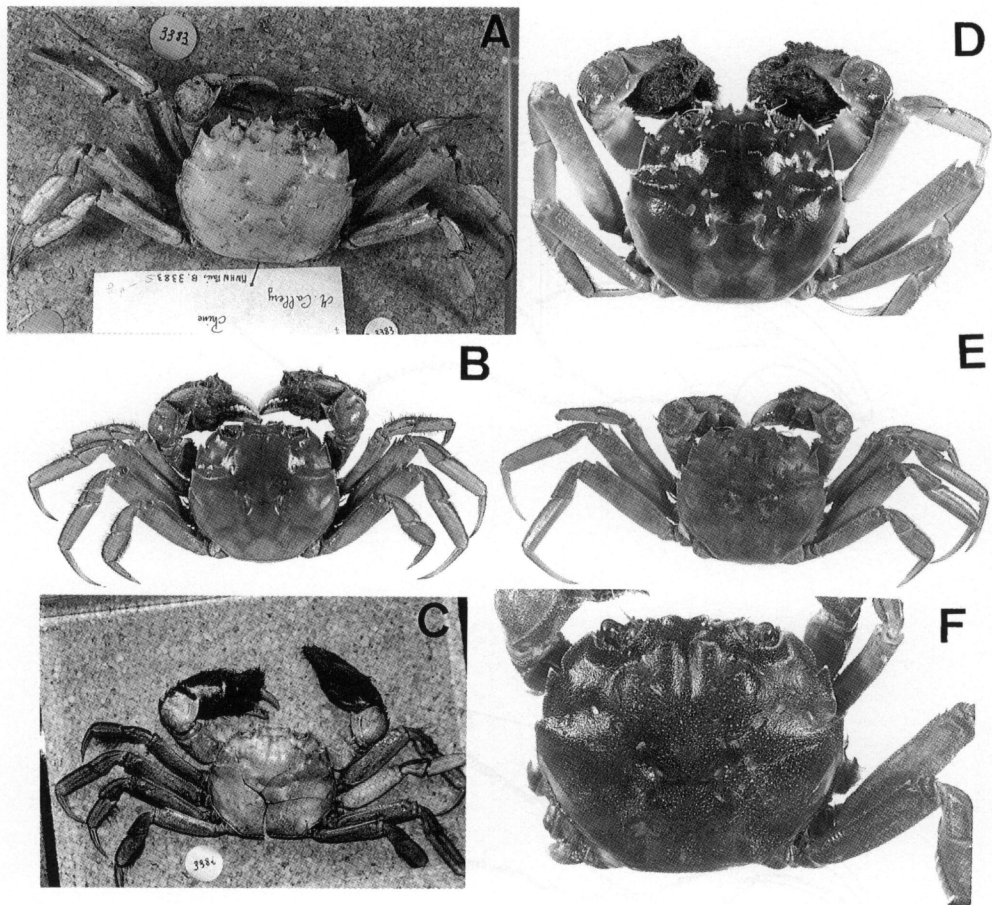
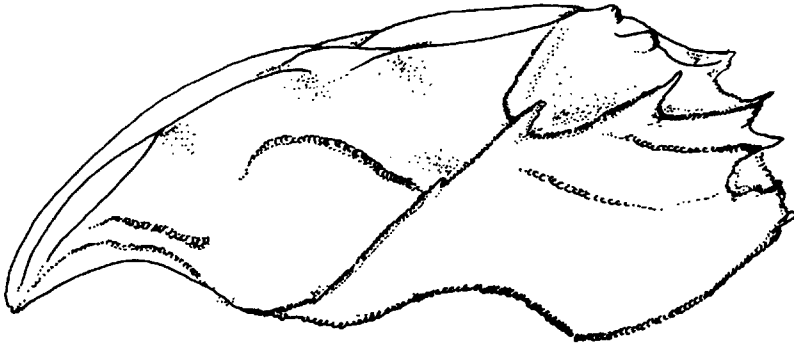


Fig. 6. Top view of a) *Eriocheir sinensis* H. Milne Edwards, 1854, lectotype, female, MNHN: B33835; b) *Eriocheir hepuensis* Dai, 1991, holotype, male, AS: GX899024A; c) *Eriocheir japonica* (de Haan, 1835), lectotype, male, MNHN: 3382; d) *Eriocheir sinensis*, male, 78.5 mm x 73.0 mm (ZRC.1997.558); e) *Eriocheir hepuensis*, male, 54.9 mm x 49.8 mm (ZRC.1997.560); f) *Eriocheir japonica*, male, 71.8 mm x 65.6 mm (ZRC.1997.565).

A



B



C

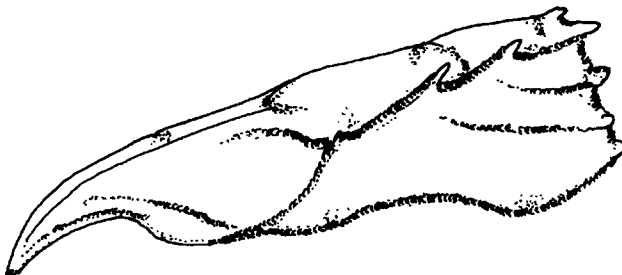


Fig. 7. Lateral view of a) *Eriocheir sinensis* H. Milne Edwards, 1854 (male, 78.5 mm x 73.0 mm (ZRC.1997.558); b) *Eriocheir hepuensis* Dai, 1991 (male, 54.9 mm x 49.8 mm (ZRC.1997.560); and c) *Eriocheir japonica* (de Haan, 1835) (male, 71.8 mm x 65.6 mm (ZRC.1997.565) showing the general physiognomy of the three species.

views, the morphology of *E. japonica* is very different from those of *E. sinensis* and *E. hepuensis* in terms of carapace physiognomy, structures of the frontal margin, fourth tooth of lateral margin, proto- and epi-gastric cristae, cheliped, fourth ambulatory leg, G1 and vulvae (Table 1). These differences are valid for all the adult specimens examined.

Chan et al. (1995) argued that the Taiwanese specimens were not *E. recta* Stimpson, 1858, and synonymised this species with *E. japonica*. The neotype of *E. recta* (see Stimpson, 1858), designated by Chan et al. (1995), was also examined. All the morphological characters are clearly that of *E. japonica*. The neotype male has been transferred to the ZRC.

Hoestlandt (1948) designated a de Haan specimen in the MNHN as the lectotype of *E. japonica*. All the other specimens in the RMNH are thus paralectotypes (Yamaguchi & Holthuis, 1993). This lectotype (MNHN 3382) could not be located during the second author's visit to Paris, and was regarded as misplaced (D. Guinot, pers comm.). Sometime later, with the help of the MNHN and Mr. Darren Yeo, this specimens was finally relocated and the photograph of this specimen was presented to the authors (Fig. 6c).

Size. - Sub-adult and adult from carapace size of approximately 40.0 x 38.0 mm and 60.0 x 51.0 mm onwards respectively.

GENERAL DISCUSSION

The differences between *E. sinensis* and *E. hepuensis* are summarised in Table 1. Not surprisingly, as in many decapod crustaceans, juveniles (15 mm carapace width and below) are difficult to differentiate with many of the characters either indiscernible, overlapping or undeveloped. Sub-adult and adult characters on the other hand, are consistently reliable. All the characters examined support our hypothesis that the northern and southern Chinese populations are morphologically distinct and should be regarded as separate species. The name *E. sinensis* is available for the northern population, and *E. hepuensis* for the southern population.

Li et al. (1993) had commented that there is only one species of mitten crab in China, and that both *E. japonicus hepuensis* (as the Zhujiang Mitten Crab) and *E. sinensis* should be regarded as synonyms of *E. japonica*. This recommendation was made on the basis on their analysis of 15 morphological traits and 27 gene loci of crabs mainly from Guangzhou Province in southern China (near Hong Kong). They utilised specimens of *E. sinensis* from Kunshan in Shanghai (northern China), *E. japonica* from Aotou and Yantian in Guangzhou (southern China), as well as a population of *E. sinensis*-like specimens from Lianhuasan in Guangzhou which they regarded as consubspecific with *E. japonicus hepuensis* (commonly called Zhujiang Mitten Crab) as described by Dai (1991). In their report, Li et al. (1993) only mentioned the locations where samples were collected but did not discriminate between them, except for a sample of *E. japonica* from Kagoshima, Japan (three males and three females) which was collected for them and was used for morphological comparisons only (Li et al., 1993: 105). For their Chinese specimens, they only designated them as northern or southern ("Zhujiang") mitten crabs but did not identify or state which and how many of each "type" were obtained from each of their sampled localities (Li et al., 1993: 104). Thus there is no positive evidence to show that that the specimens they utilised are *E. sinensis* or *E. hepuensis*. And there is also a possibility that their "Zhujiang" mitten crabs were actually *E. japonica*!

Table 1: Key morphological differences between *Eriocheir sinensis* H. Milne Edwards, 1854, *E. hepuensis* Dai, 1991, and *E. japonica* (de Haan), 1835.

Characters	<i>Eriocheir sinensis</i>	<i>Eriocheir hepuensis</i>	<i>Eriocheir japonica</i>
Physiognomy of carapace	very convex (Fig. 6a)	slightly convex (Fig. 6b)	relatively flat (Fig. 6c)
Frontal teeth	medial teeth acutely triangular and sharp, medial cleft deep V-shaped. (Fig. 2a)	medial teeth slightly triangular and blunt, medial cleft wide U-shaped. (Fig. 4a)	medial teeth blunt, smooth, 2 slightly triangular and sharp lateral (Fig. 5a)
Epigastric and protogastric crest	Very strong, high and sharp (Fig. 7a)	Weak, low and granular (Fig. 7b)	low, weak, blunt (Fig. 7c)
Merus of cheliped length : width ratio	long and slim 1: 2.20 (Fig. 2d)	short and stout 1: 2.10 (Fig. 4d)	short and broad 1: 2.09 (Fig. 5d)
Distal tooth of cheliped	strong and sharp (Fig. 2d)	weak and sharp (Fig. 4d)	weak and blunt (Fig. 5d)
Fourth leg: propodus length : width ratio	long and slender 1: 2.8 (Fig. 2e)	short and broad 1 : 2.7 (Fig. 4e)	broad and short 1: 2.5 (Fig. 5e)
Fourth leg: dactylus	long and slender (Fig. 2e)	shorter and thicker (Fig. 4e)	dorso-ventrally compressed (Fig. 5e)
sixth abdominal somite:			
a) male	latero-distal margin arched.	lateral margins arched at 1/2 length from distal end	latero-distal margin slightly arched
length : width ratio	1:1.2 (Fig. 2f)	1:2.4 (fig. 2g)	1:1.1 (Fig. 4f)
b) female	lateral margins arched at 1/3 length from distal end	latero-distal margin roundish	latero-distal margin roundish and smooth
length : width ratio	1:2.1 (Fig. 4g)	1:1.0 (Fig. 5f)	1.22 (Fig. 5g)
Telson:			
male	distal end narrow	distal end narrow	distal end rounder
length : width ratio	1:1.8 (Fig. 2f)	1:3.66 (Fig. 2g)	1 : 1.8 (Fig. 4f)
female	distal end wider and rounder	distal end very broad and roundish	distal end very wide and roundish
length : width ratio	1 : 3.5 (Fig. 4g)	1:1.18 (Fig. 5f)	1:1.36 (Fig. 5g)
G1	genital pore very near distal end (Fig. 2h)	genital pore 1/2 length from distal end (Fig. 4h)	genital pore at 1/3 length from the distal end (Fig. 5h)
Vulvae	Semicircular, very concave dorsally (Fig. 2i)	triangular, slightly concave dorsally (Fig. 4i)	bluntly triangular, not concave dorsally (Fig. 5i)

Li et al. (1993) commented that whilst their alloenzyme data permitted the segregation of these populations into two general groups, one with *E. sinensis* and *E. japonicus hepuensis* together and the other with only *E. japonica*, the genetic differences were too small to warrant recognising them as separate species.

These arguments were based on the analysis of the populations they utilised from Lianhuasan, supposedly of "*E. japonicus hepuensis*", but were not from the type locality of the subspecies (Beibu Gulf, southern China). For genetic data to be effective in determining taxonomic affiliations, it is important to ascertain the source or "purity" of the stock tested. The uncertainties noted above cast some doubts over the validity of the genetic data presented in Li et al. (1993). Interestingly, a study by Xie (1996) using on RAPD methods on nucleic DNA shows that *E. sinensis* and *E. hepuensis* are very different. The specimens used were wild-caught specimens from Shanghai (*E. sinensis*) and Hepu in Beibu Gulf (*E. hepuensis*). It is important to note here that the specimens used in Xie's study were hand-caught from the wild, and all aquaculture efforts in the Beibu area use only local seed stock (i.e. *E. hepuensis*) and not *E. sinensis* or crabs from other parts of China (Y. X. Cai, pers. comm.). It must be noted, however, the methodologies for DNA and alloenzyme are quite different and the results not always parsimonious.

Moreover, it is well known that when the mass culture of the economically important *E. sinensis* started in 1970s (Peng, 1986; Li et al., 1993; Cai Y.X., pers. comm.), these crabs have been brought all over in China for aquaculture ventures, including to Guangzhou (third author, unpublished data). Our examination of numerous '*E. japonica*' specimens collected between 1930-1970 from southern China especially in locations like Fujian and Guangzhou (Fig. 8) has shown that many of these are actually *E. hepuensis* indicating that *E. hepuensis* had already existed in this area well before the introduction of *E. sinensis* in 1973. There are possibilities that there are already feral populations of *E. sinensis* in southern China due to the current extensive culture of the species. Therefore, the Lianhuasan population could possibly be *E. sinensis*, a mixture of *E. sinensis* s. str. and *E. hepuensis*, or even hybrids of the two. In fact, Li et al. (1993) themselves had also commented that genetic variation was greatest for LHS (Lianhuasan), indicating the gene pool may have been enriched through seed crab releases over many years" (p. 113) and "... seed crab releases have successfully enhanced mitten crab catches in the Zhujiang River ..." (p. 114).

Li et al. (1993) also cited literature (Peng, 1986; Zhao et al., 1988) stating that *E. japonica* had been successfully hybridised with *E. sinensis* and the resulting animals closely resemble the Zhujiang Mitten Crabs. Existing literature records, and large numbers of specimens we have examined of these two species do not support the contention that they can hybridise naturally. There have not been any reports of intermediates or possible hybrids of *E. sinensis* and *E. japonica* in the wild. Zhao et al. (1988) cited Peng's results but no experimental details or results like the ability of the offspring from these hybridisations to perpetuate successfully were given or observed such events in the wild. Peng's (1986) results are also very difficult to interpret. He stated "... according to initial studies, the 'Zhujiang mitten crab' is the offspring of the *E. sinensis* in the Zhujiang river, but not a new species..." (Peng 1986: 19) but he provided no details, data or any analysis to justify this statement.

The morphological data of 15 character sets based on actual structural differences in the structures of the frontal teeth, epibranchial teeth, progastric crests and male first gonopod were summarised by PCA into a graph. It grouped *E. sinensis* and *E. japonica* into two discrete sets. The morphological data of the "*E. japonicus hepuensis*" population, however,

straddled the *E. sinensis* and *E. japonica* sets. On basis of this overlap, as well as literature stating that "... the frontal teeth changes with growth of the carapace" (p. 113), they argued that the different populations of *E. sinensis*, *E. japonica* and "*E. japonicus hepuensis*" only represented ecophenotypes and are probably conspecific. However, this is not enough to prove that these taxa are conspecific.

The morphological characters used at present for distinguishing *E. sinensis* and *E. hepuensis* are very consistent. The morphological characters utilised by Li et al. (1993), viz. structures of the frontal teeth (acuity and sharpness of the frontal teeth, and depth of the median cleft), epibranchial teeth (strength of the fourth tooth), progastric crests (strength) and the first male gonopod (meristic data from the distal part), represent only part of a suite of morphological differences between the species. There are other more clear-cut and useful characters like physiognomy of the carapace, strength of the epigastric crests, proportions

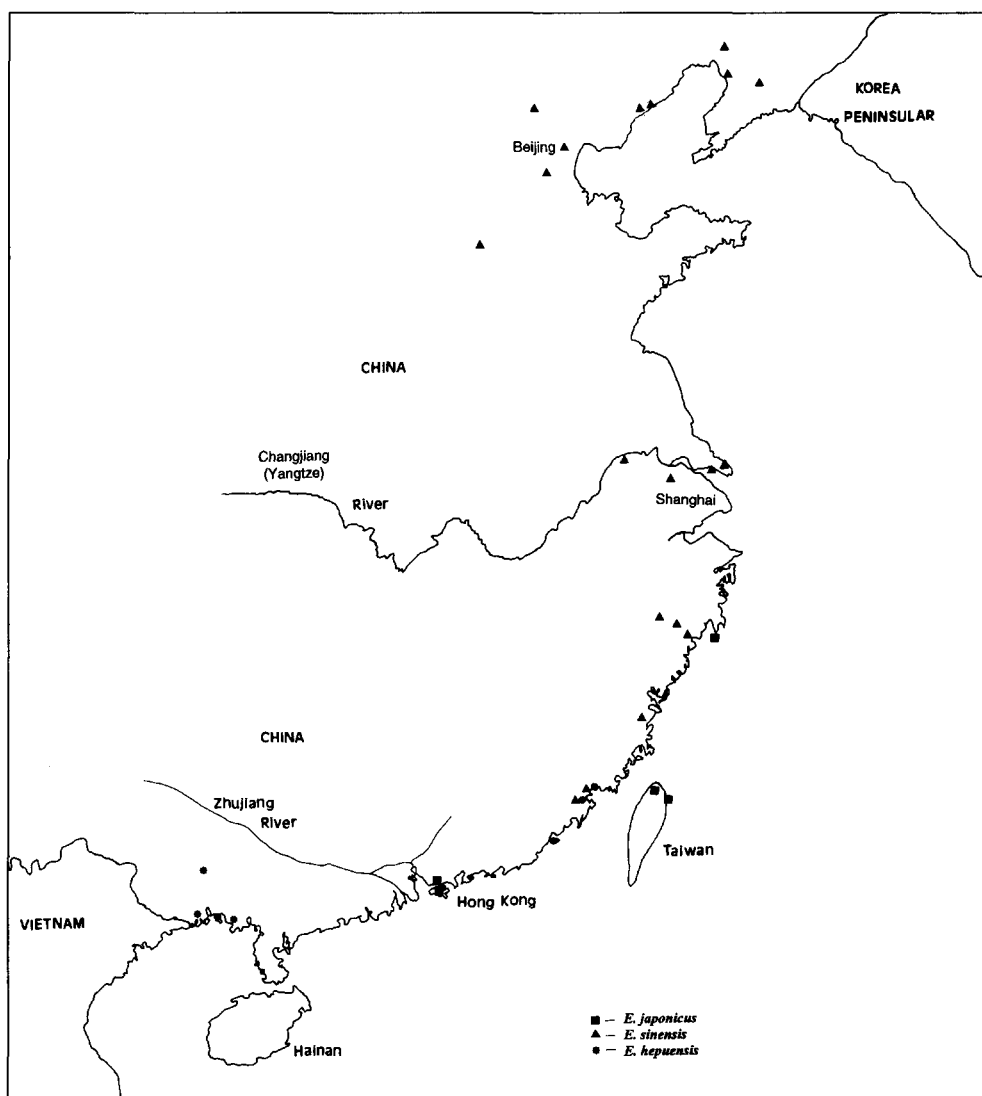


Fig. 8. Distribution of *Eriocheir sinensis* H. Milne Edwards, 1854, *E. hepuensis* Dai, 1991 and *E. japonica* (de Haan, 1835) along the coast of China.

and degree of setation of the various segments of the ambulatory legs and chelipeds, proportions of the overall male gonopod (not just the distal part), male and female abdomens, and female vulvae were not considered. Present statistical analysis (using SAS/STAT® programme) of all these characters on 247 specimens of *E. sinensis* and 101 specimens of *E. hepuensis* show conclusively that the two species can be segregated easily with the above-mentioned characters (see Table 2). Another important point to note here is that morphological analyses of this nature should be carried out using adults. Studies on juveniles of the various *Eriocheir* species show that some of the characters (notably the frontal and epibranchial teeth) are more variable when the specimens are small. We have found that whilst there are certainly ontogenic morphological changes which are allometric, they nevertheless usually occur within fixed ranges (Ng et al., in prep). As noted earlier, the variation has even led to the assignment of names to aberrant juveniles of *E. sinensis* in Europe! As such, we are still able to separate out most of the smaller or sub-adult specimens using the characters specified earlier. The more juvenile specimens pose more problems for identification than the adults but the characters noted worked in almost all cases (see Table 2). In a few cases where some of the characters are not reliable, we are usually able to ascertain that it was because of physical damage, post-damage growth or prior injury.

Table 2. Statistical Analysis of the various characters of *E. sinensis* and *E. hepuensis*:

Character/ Species	Remarks	<i>E. sinensis</i>	<i>E. hepuensis</i>
Carapace:	Probability test	Frequency	Frequency
Physiognomy	convex	0.86	0.16
	flat	0.14	0.85
frontal teeth	sharpness	0.98	0.02
	bluntness	0.02	0.98
P < 0.001			
Fourth Ambulatory leg propodus	Width : Length ratio T-test	2.84 ± 0.21	2.67 ± 0.17
P < 0.001			
First male gonopod	T-test	2.17 ± 0.023	1.78 ± 0.13
P < 0.001			
Female genital pore	T-test	0.377 ± 0.056	0.457 ± 0.075
P < 0.001			
Sixth Abdominal somite male	Width : Length ratio T-test	1.16 ± 0.17	1.12 ± 0.08
P > 0.05			
female	T-test	2.39 + 0.33	2.09 + 0.36
P < 0.001			
Telson male	Width : Length Ratio T-test	1.84 ± 0.14	1.77 ± 0.46
P > 0.05			
female	T-test	3.66 + 0.52	3.52 + 0.46
P > 0.05			

Our statistical results were also grouped into a Principal Component Analysis (PCA) graph (Fig. 9a, b) for both sexes in the present study. There is little overlap between the two groups which clearly showed that they are not ecophenotypes and are definitely not ecospecific. The overlap could be due to occasional and accidental mix-up of specimens or from physical damages. The second author has examined six specimens (three males, three females), a loan from Dr. Shen Qi, SCSIO, Academia Sinica, Guangzhou, China from Lianhuashan, very likely the preserved specimens from Li et al.'s (1993) studies, and they are clearly *E. hepuensis*.

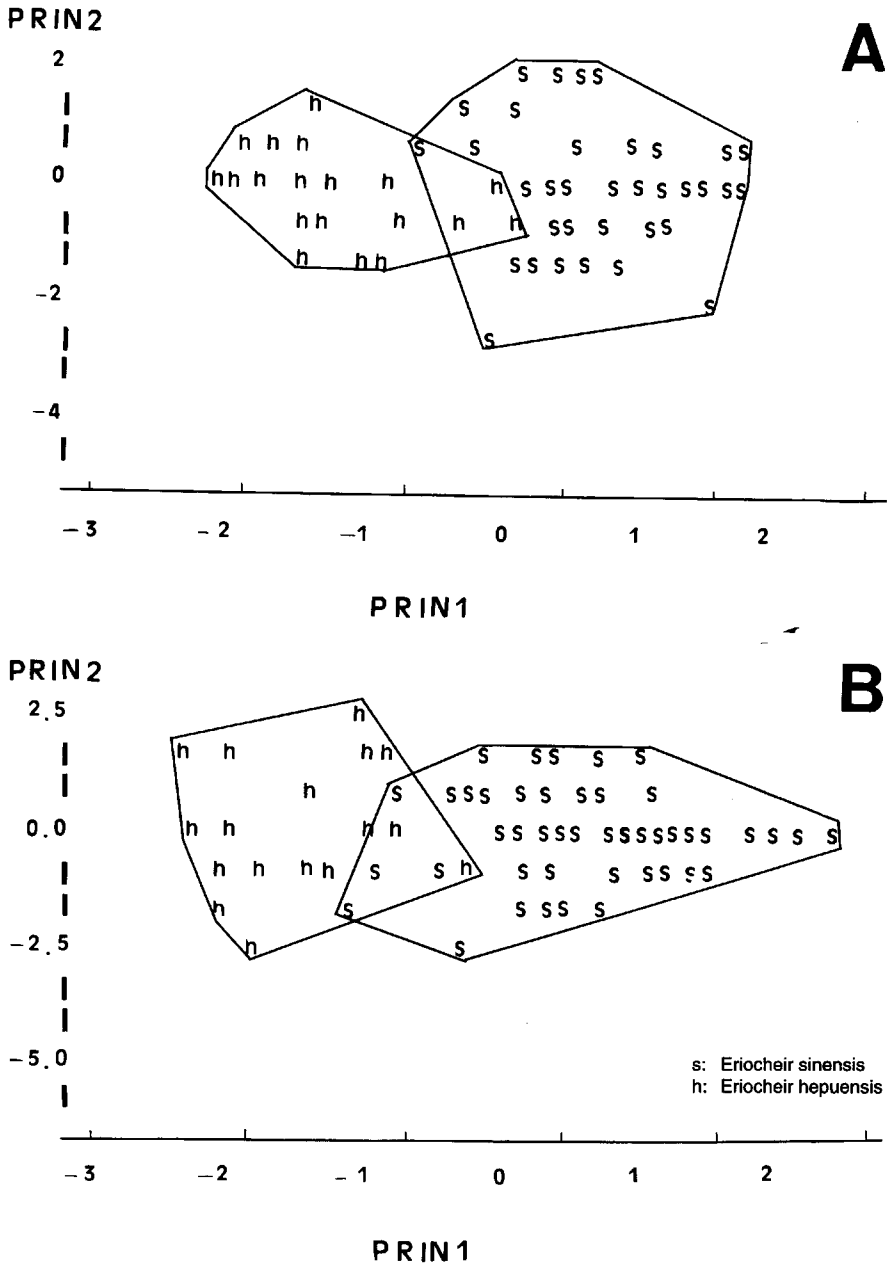


Fig. 9. PCA of *Eriocheir sinensis* H. Milne Edwards, 1854, and *Eriocheir hepuensis* Dai, 1991. a) for female, and b) male specimens.

Li et al. (1993) further argued that since *E. sinensis* is also known in Europe and North America due to "... its strong dispersal ability conflicts with supposedly restricted distributions of *E. sinensis* and *E. japonica*" (p. 113). This is wholly incorrect as the larvae did not disperse there naturally (see earlier), but have been introduced accidentally. And larval dispersion is often closely associated with currents of a region. In fact, the notion that larvae are totally at the mercy of currents alone is now generally acknowledged to be simplistic. Studies have shown that larvae are able to adjust their behaviour and depth of occurrence to ensure they return to or near where they hatched (e.g. Cronin & Forward, 1982, 1986; Forward, 1987, 1989 etc.).

The supposedly strong dispersal abilities of the larvae of *Eriocheir*, as argued by Li et al. (1993) is a definite oversimplification. The presence of *E. sinensis* in Europe is through human intervention (albeit accidentally) (Panning, 1939, Christiansen, 1969), as is believed to be its occurrence in North America (Nepszy & Leach, 1976; Cohen & Carlton, 1997). Panning (1939) mentioned that "Their presence in Germany was probably made possible [by] larvae brought to Germany on commercial vessels. When the ships happened to fill their ballast water tanks in central or north Chinese ports during the larvae's spawning time, the 1.7 to 5 mm larvae of the mitten crab would, of course, get into the tanks, and again when the tanks were emptied in the German port, the young mitten crabs ... would, of course, get into one of the German rivers emptying into the North Sea" (p. 363). The introduction of the mitten crabs into the San Francisco Bay of North America was probably similar - "... when the empty ships leaves ports in Europe and Asia, ballast water is pumped into them for stability in crossing. This ballast water, which is said to contain some larval stage of the mitten crab, is then pumped back out when they are filled with cargo in the ports of San Francisco Bay" (R. B. Donor & G. Miller, pers. comm. to the second author).

Our data, based on a much larger series of specimens of all the taxa in question, conflicts very sharply with Li et al.'s (1991) conclusions. We have found that the morphological characters (Table 1) of *E. japonica* are very stable and consistent with most literature that this is a good species. Both *E. sinensis* and *E. hepuensis* are not synonyms of *E. japonica*.

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