A REVIEW OF THE COMMON JAPANESE CALLIANASSID SPECIES, *CALLIANASSA JAPONICA* AND *C. PETALURA* (DECAPODA, THALASSINIDEA)

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ABSTRACT

Two common Japanese callianassid species, *Callianassa japonica* Ortmann, 1891 (= *C. californiensis* var. *japonica* Bouvier, 1901 and *C. harmandi* Bouvier, 1901) and *C. petalura* Stimpson, 1860, specifically under the generic name *Callianassa*, could be reconfirmed as good species after examining the syntypes of *C. californiensis* var. *japonica* Bouvier, 1901 and of *C. harmandi* Bouvier, 1901.

ZUSAMMENFASSUNG

Die Untersuchung der Syntypen von *Callianassa californiensis* var. *japonica* Bouvier, 1901 und *C. harmandi* Bouvier, 1901 hat ergeben, daß sich die beiden in Japan verbreiteten Arten *C. japonica* Ortmann, 1891 (= *C. californiensis* var. *japonica* Bouvier, 1901 und *C. harmandi* Bouvier, 1901) und *C. petalura* Stimpson, 1860, speziell unter dem Gattungsnamen *Callianassa* als gute Arten erwiesen haben.

INTRODUCTION

Since 1969 (cf. Sakai, 1969) *Callianassa japonica* Ortmann, 1891 and *C. petalura* Stimpson, 1860 have been recognized as common callianassid species of Japan. Recently, however, Manning & Tamaki (1998: 891) reviewed these species and pointed out that *C. subterranea* var. *japonica* Ortmann, 1891 [= *C.* (*Trypaea*) *harmandi* sensu De Man, 1928], *C. harmandi* Bouvier, 1901 [= *C.* (*Trypaea*) *japonica* sensu De Man, 1928], and *C. petalura* Stimpson 1860, are present in the Japanese callianassid fauna under a new generic name, *Nihonotrypaea* Manning & Tamaki, 1998. Though it was subsequently pointed out that

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Nihonotrypaea is a synonym of *Callianassa* (cf. Sakai, 1999: 129), the opinion of Manning & Tamaki (1998) still causes confusion with regard to the common Japanese species of *Callianassa*. This is because, Tamaki et al. (2000: 182) mentioned three Japanese species of callianassids, under the name *Nihonotrypaea*, based on the larval development pattern and on the ecospecies concept in larval stages, thus neglecting knowledge of sexual dimorphism in adult and larval stages as well as morphological variation in the cheliped.

METHODS

Two syntypes of these Japanese callianassids, i.e., of *C. californiensis* var. *japonica* Bouvier, 1901 and of *C. harmandi* Bouvier, 1901, lodged in the Muséum National d'Histoire Naturelle, Paris, were examined. However, the holotype of *C. subterranea* var. *japonica* Ortmann, 1891 in the Musée Zoologique de l'Université Louis Pasteur & de la Ville de Strasbourg, Strasbourg, turned out to be missing. For this reason, the description of *C. subterranea* var. *japonica* Ortmann, 1891 was used for careful comparison with the above-mentioned syntypes in Paris.

Abbreviations include: C, cornea width; EW, eye width; CL, carapace length; CW, carapace width; Z, zoeal stage; MNHN-Th, thalassinid collection of the Muséum National d'Histoire Naturelle, Paris; BLT, Biological Laboratory, Shikoku University, Tokushima; ZLF, Zoological Laboratory, University of Kyushu, Fukuoka.

MATERIAL EXAMINED

(1) MNHN-Th 70, one male (TL/CL 34.0/8.0) with the larger cheliped, which is defined as the male larger cheliped with "the *Californiensis*-type" (fig. 2C). Registered as *C. californiensis* var. *japonica* Bouvier, 1901, syntype, from the surroundings of Tokyo, Japan.

(2) MNHN-Th 80, three males (TL/CL 38.0/8.0; 34.0/7.1; 26.0/6.0), and two females (TL/CL 34.0/7.0; 28.0/5.8); three detached male larger chelipeds, which are defined as the male larger cheliped of "the *Harmandi*-type" (fig. 2A), and two detached female larger chelipeds (fig. 2B). Registered as *C. Harmandi* Bouvier, 1901, syntypes, from Tokyo Bay, Japan.

(3) MNHN-Th 437, one male (TL/CL 45.0/11.5) with the larger cheliped of the *Harmandi*-type (fig. 3E) from Yantai (Chefoo), Shantung Peninsula, East China Sea, China. Registered as *C. californiensis* var. *japonica* Bouvier, 1901.

(4) MNHN-Th 496, 21 detached male larger chelipeds of the *Harmandi*-type (fig. 3A, B, C), and one detached male larger cheliped of the *Californiensis*-type. Registered as *C. japonica* Ortmann, 1891, leg. Franck, 1895, from Japan.

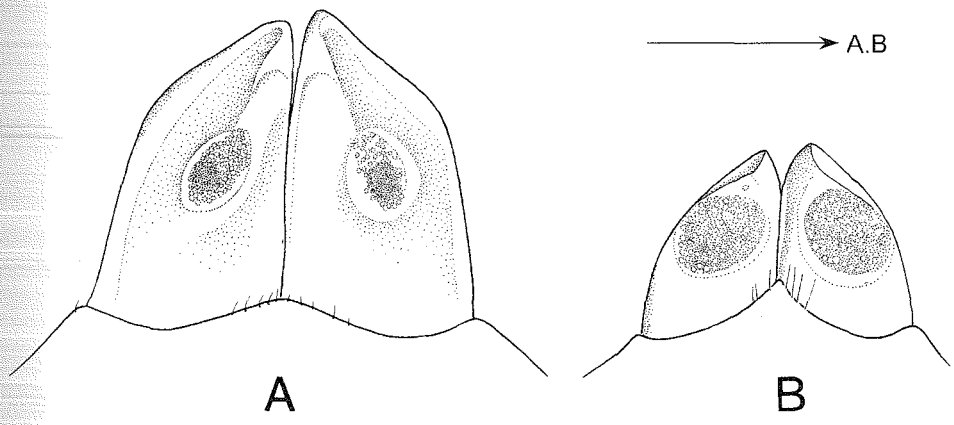

Fig. 1. *Callianassa japonica* Ortmann, 1891. A-B, front and eyes, dorsal view. A, ZLF 9041, male of *C. japonica* Ortmann, 1891 with the larger cheliped of the *Japonica*-type, from Momoji beach, Hakata Bay, Fukuoka; B, ZLF 12638, *C. japonica* Ortmann, 1891 with the larger cheliped of the *Californiensis*-type, from Arasaki, Sagami Bay. A-B, scale equals 1 mm.

(5) MNHN-Th 507, three detached male larger chelipeds of the *Harmandi*-type; two detached male larger chelipeds of the *Californiensis*-type; and one detached male smaller cheliped (fig. 3D). Registered as *C. japonica* Ortmann, 1891 leg. Franck, from Japan.

DISCUSSION

Manning & Tamaki (1998: 889) recognized three species of *Callianassa* in Japanese waters, i.e., *C. japonica*, *C. harmandi,* and *C. petalura*, and mentioned that, although De Man (1928) assigned the wrong name to *C. japonica* and *C. harmandi*, those two species are recognizable as good species, and state: "The two species [i.e., *C. harmandi* and *C. japonica*] can be distinguished by the size of their cornea alone, as shown by De Man (1928)." They showed the original citations for the two species without any comments on *C. californiensis* var. *japonica* Bouvier, 1901 as follows:

(1) *Callianassa subterranea* var. *japonica* Ortmann, 1891: 56, pl. 1 fig. 10a [= *Callianassa* (*Trypaea*) *Harmandi* sensu De Man, 1928: 13, pl. 3 fig. 6c],

(2) *Callianassa Harmandi* Bouvier, 1901: 333 [= *Callianassa* (*Trypaea*) *japonica* sensu De Man, 1928: 13, pl. 5 fig. 10e].

The holotype of *C. subterranea* var. *japonica* Ortmann, 1891 was, unfortunately, not accessible, because it is missing after having been examined by Manning & Tamaki (in litt.: M.-D. Wandhammer, after B. Kensley), and a more detailed account of the Japanese species has not yet been published by them. Thus, the Japanese callianassid species are revised as follows:

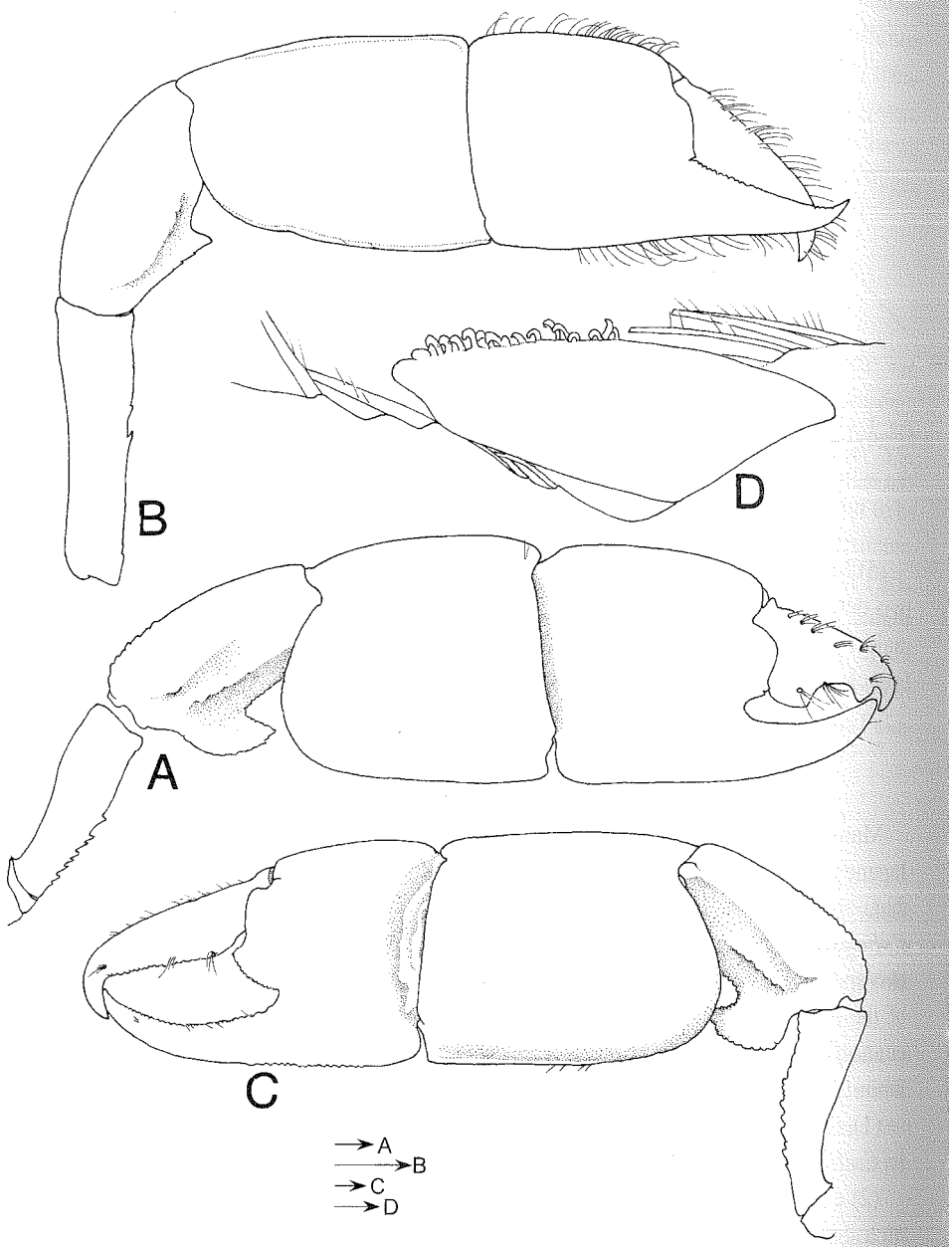

Fig. 2. *Callianassa japonica* Ortmann, 1891. A, male larger cheliped of the *Harmandi*-type, detached from the body distal to the merus; B, female larger cheliped; C, male larger cheliped in the *Californiensis*-type; D, appendix interna on pleopod 3. C-D, MNHN-Th 80, syntypes of *C. harmandi* Bouvier, 1901 from Tokyo Bay. A-C, scale = 1 mm; D, scale = 1/10 mm.

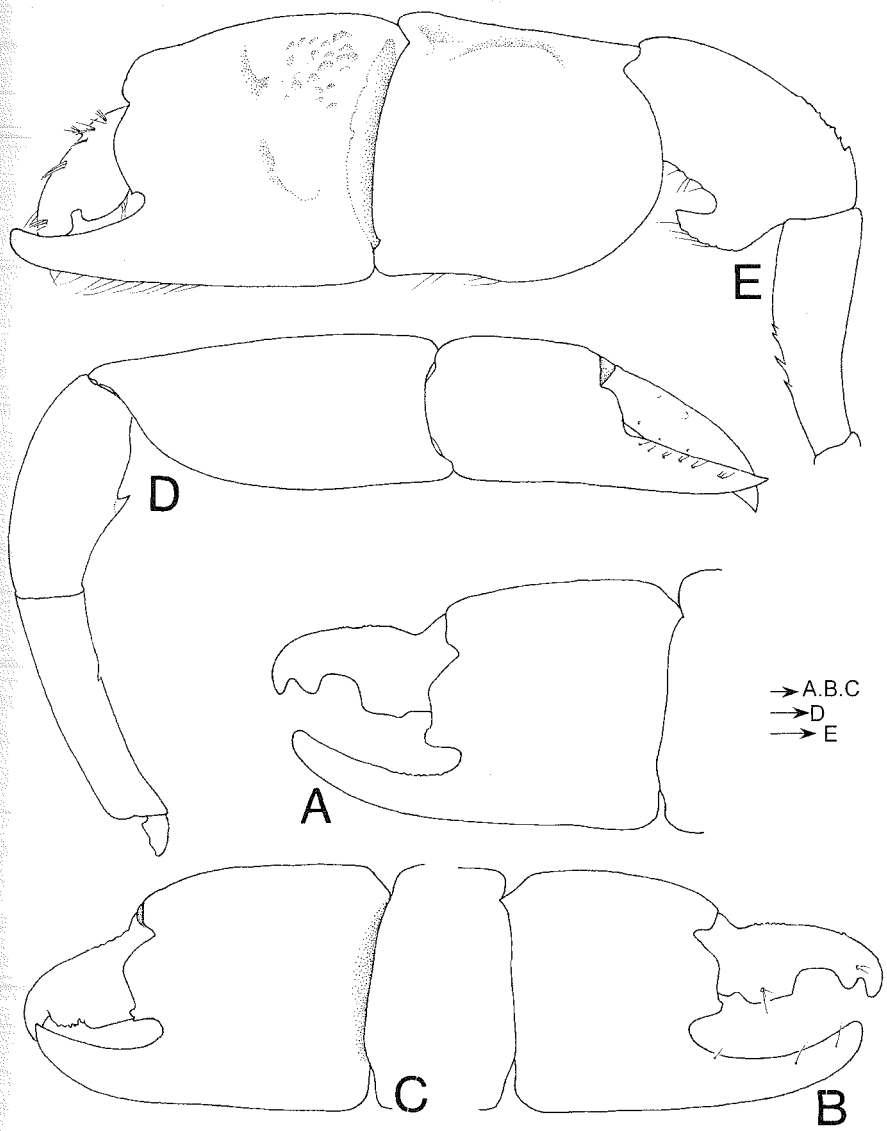

Fig. 3. *Callianassa japonica* Ortmann, 1891. A-C, E, male larger chelipeds of the *Harmandi*-type; E, one detached male smaller cheliped. A-C, MNHN-Th 496 from Japan; D, MNHN-Th 507 from Japan, leg. Franck; E, MNHN-Th 437 from Yantai (Chefoo), Shantung Peninsula, East China Sea, China, May 1925, leg. C. F. Wang. Scale = 1 mm.

1. The holotype of *C. subterranea* var. *japonica* Ortmann, 1891 is shown as a female by Ortmann. However, it is obvious that Ortmann's original figure (cf. fig. 4A) is based on a male for the reason that the merus of the larger cheliped is armed with a stubby ventral tooth, and the carpus is subquadrate in shape, and those forms are similar to those in *C.* (*Trypaea*) *harmandi* sensu De Man, 1928: 13, pl. 3

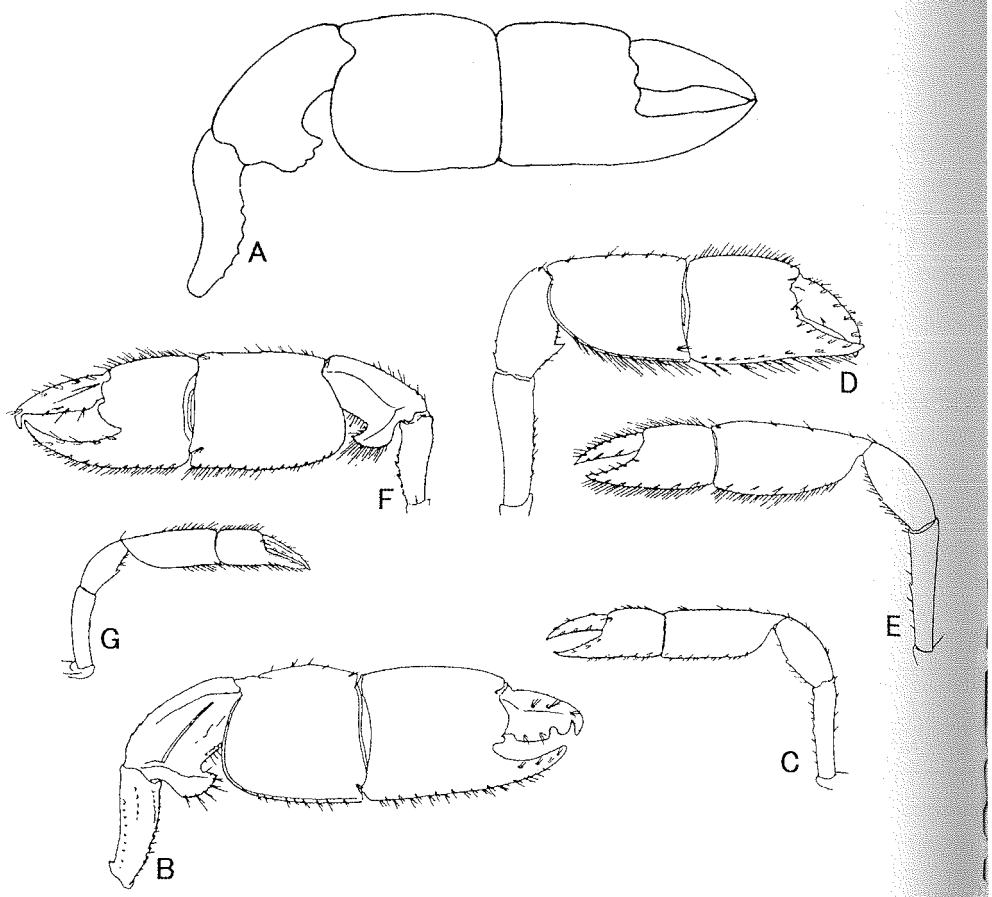

Fig. 4. *Callianassa japonica* Ortmann, 1891. A, larger male cheliped of holotype of *C. subterranea* var. *japonica* Ortmann (after Ortmann, 1891, pl. 1 fig. 10a); B, male larger cheliped of *C.* (*Trypaea*) *harmandi* sensu De Man (after De Man, 1928, pl. 3 fig. 6c); C, do., male smaller cheliped (after De Man, 1928, pl. 3 fig. 6i); D, female larger cheliped of *C.* (*Trypaea*) *japonica* sensu De Man (after De Man, 1928, pl. 5 fig. 10e); E, do., female smaller cheliped (after De Man, 1928, pl. 5 fig. 10h); F, male larger cheliped of *C. californiensis* var. *japonica* sensu De Man (after De Man, 1928, pl. 4 fig. 9); G, do., male smaller cheliped (after De Man, 1928, pl. 4 fig. 9c).

fig. 6c (cf. fig. 4B). The cutting edge of the dactylus is, however, different in shape in both forms: in *C. subterranea* var. *japonica* the cutting edge of the dactylus is not armed with any teeth, while in *C. harmandi* sensu De Man it proximally bears a long, truncate tooth, the free margin of which is finely denticulate; between this tooth and the tip a much smaller tooth is found, half as broad as the other one, conical, rounded, and with the free border also finely denticulate; it is separated from the truncate tooth by a rounded, sharp notch (De Man, 1928: 15). The shapes of the dactyli in both male specimens are really different from each other, which, however, is interpreted as variation within the same species (Sakai, 1969: 212). As

cited above, Manning & Tamaki (1998) thought that *C.* (*Trypaea*) *harmandi* sensu De Man, 1928 (fig. 4B) is different from *C. harmandi* Bouvier, 1901 (fig. 2A). However, those two species show the same form of dactylus, carpus, and merus, so that there are no reasons to discriminate *C. subterranea* var. *japonica* Ortmann from *C. harmandi* Bouvier.

2. Manning & Tamaki (1998) stated that *C. harmandi* Bouvier, 1901: 333 (cf. fig. 2A) is identical with *C.* (*Trypaea*) *japonica* sensu De Man, 1928: 13, pl. 5 fig. 10e (cf. fig. 4D).

Before discussing the above citations, it is necessary to review the syntype specimens of *C. harmandi* Bouvier. Although Bouvier (1901: 334) mentioned that *C. harmandi* was described from one male and three females, the syntypes of *C. harmandi* Bouvier, 1901: 333 (MNHN-Th 80) comprise three male specimens, and three detached male larger chelipeds of the *Harmandi*-type (fig. 2A) and also two female specimens and two detached female larger chelipeds (fig. 2B). All of these male larger chelipeds agree with his description in shape, i.e., "the cutting edge of the dactylus bears a broad tooth at the proximal third, and a crescent and a narrow but deep concavity in the distal margin". ["Le doigt mobile présente à sa base une large dent tronquée qui occupe presque le tiers de sa longueur; vient ensuite une profonde échancrure de même étendue, puis une dent obtuse très saillante qui est séparée de la pointe, très recourbée, par une échancrure étroite et profonde dans laquelle vient s'engager la pointe de l'index". Bouvier, 1901: 334]. Regarding the measurements, those specimens do not always agree with Bouvier's description, measuring 30 mm in body length, 7.5 mm in the chela of the larger cheliped, and 6.7 mm in carpus length. One male specimen among three male specimens is, however, herein designated as the lectotype, measuring 38.0 mm in body length, 8.5 mm in the chela of the larger cheliped, 6.5 mm in carpus length, though those exact measurements are, respectively, slightly larger than the values given by Bouvier (1901). The other two males, nevertheless, are not to be considered typical, because they are smaller than the above-mentioned male, and, in addition, Bouvier designated only one male for his type, though it is unclear which one. The other two females can probably be considered paralectotypes, although he mentioned three females, so the number of individuals is not coincident. These observations result in the type-material of *C. harmandi* Bouvier to consist in reality of one male and two female specimens.

The newly designated male lectotype of *C. harmandi* Bouvier, 1901 can be compared with *C.* (*Trypaea*) *japonica* sensu De Man, 1928. That author (De Man, 1928) showed two figures for the female larger (cf. fig. 4D) and smaller chelipeds (cf. fig. 4E). In *C.* (*Trypaea*) *japonica* sensu De Man, 1928, however, Manning & Tamaki (1998) concluded that "*C. Harmandi* Bouvier, 1901: 333 (male)" is the same as "*C.* (*Trypaea*) *japonica* sensu De Man, 1928: 13, pl. 5

fig. 10e (female)" without considering their sexual dimorphism. This act proves that their proposition is really inconsistent, because it is irrelevant to compare the male specimen of *C. harmandi* Bouvier (cf. fig. 2A) with the female one of *C. (Trypaea) japonica* sensu De Man, 1928 (cf. fig. 4D, E), as this species shows strong sexual dimorphism in the larger chelipeds.

I examined the specimen of *C. californiensis* var. *japonica* (MNHN-Th 70), and confirmed it as Bouvier's syntype, being a male measuring 34 mm in total length. However, Bouvier (1901) treated it as a female, just as in the case of *C. subterranea* var. *japonica* Ortmann, 1891, despite his description showing that the only character for this variety is the development of the ventral tooth of the merus in the larger cheliped (fig. 2C) ["les seuls caractères qui l'en distinguent sont le développement un peu plus grand de la dent du méropodite du grand chélipède, ..." Bouvier, 1901: 333], and further indicated the broad interspace between the fingers of the larger cheliped ["l'écartement des doigts qui est très prononcé à cause de la faible largeur des doigts à leur base, ..." Bouvier, 1901: 333], of which the dactylus is acutely incurved distally (fig. 2C). From those characteristics, Bouvier's (1901) original description refers to a male with the larger cheliped of the *Californiensis*-type, and not to a female, because in females the merus does not bear such a stubby ventral tooth, but a small triangular one (fig. 4D; Sakai, 1969, pl. 9 fig. a).

Consequently, the type-specimen of *C. californiensis* var. *japonica* Bouvier is a male, which is very similar to *C. subterranea* var. *japonica* Ortmann, 1891, pl. 1 fig. 10a. The only difference between the two varieties is, however, represented by the cutting edge of the dactylus of the larger cheliped. In Bouvier's specimen the dactylus of the larger cheliped is acutely incurved distally (fig. 2C), while in Ortmann's figure it is tapering distally (fig. 4A).

3. I was informed by Dr. A. Tamaki (in litt.) that in *C. harmandi* the cornea occupies more than half the length (50%) of the eye-width in cross section, and in *C. japonica* between one-third to one-fifth the length (30-20%) of the eye-width. By examining the form of the cornea in my own specimens (Sakai, 1969) (table I), it turned out that there is no correlation in the size and shape of cornea to eye-width between the two species [i.e., *C. harmandi* and *C. japonica*], the proportion is not always the same in both eyes, and there is no correlation in growth. The material with the *Japonica*-type cheliped shows that the cornea occupies 30-80%, and the material of the *Harmandi*-type the cornea occupies 31-59%. Yet, the material of the *Californiensis*-type, a male and a female, has this value at 72% (ZLF 12638), with a triangular eye, different from other types (fig. 1B), which is a higher percentage of the cornean part than in the *Japonica*- and the *Harmandi*-types. In fresh material, the cornea is largely rounded as shown for *C. japonica* by De Man (1928, pl. 5 fig. 10). However, in alcohol material the cornea becomes transparent, or various

TABLE I

Measurements of *C. japonica* in the *Californiensis*-, *Japonica*-, and *Harmandi*-types of male chelipeds (respectively, Calif-, Jap-, and Harman-type) and their correlations (%)

Cheliped type	Cat. No.	TL/CL	Left eye C/EW	%	Right eye C/EW	%	Locality
Calif-type	ZLF 12638	37.0/8.5	0.34/0.50	72	0.41/0.54	76	Arasaki, Sagami Bay, 08.v.1964, leg. H. Kurata
(Female)	ZLF 12638	35.0/7.0	0.36/0.50	72	0.36/0.54	67	Arasaki, Sagami Bay, 08.v.1964, leg. H. Kurata
Jap-type	ZLF 9022	22.0/5.3	0.27/0.41	66	0.27/0.34	80	Momoji, Hakata Bay, 07.iv.1963, leg. K. Sakai
Jap-type	ZLF 9046	40.0/9.0	0.31/0.56	56	0.28/0.61	56	Momoji, Hakata Bay, 09.iv.1969, leg. K. Sakai
Jap-type	ZLF 3002	40.5/13.0	0.18/0.59	30	0.23/0.59	34	Kanazawa-Hatkei, Tokyo Bay, 05.i.1961, leg. K. Sakai
Jap-type	ZLF 9051	51.0/11.2	0.36/0.70	51	0.56/0.80	70	Momoji, Hakata Bay, 09.iv.1963, leg. K. Sakai
Jap-type	ZLF 9041	55.0/12.5	0.50/0.90	56	0.45/0.80	56	Momoji, Hakata Bay, 09.iv.1963, leg. K. Sakai
Harman-type	ZLF 9047	39.0/8.2	0.20/0.54	37	0.25/0.59	41	Momoji, Hakata Bay, 09.iv.1963, leg. K. Sakai
Harman-type	ZLF 9037	45.0/9.5	0.34/0.68	50	0.36/0.72	50	Momoji, Hakata Bay, 09.iv.1963, leg. K. Sakai
Harman-type	ZLF 9039	45.0/10.0	0.33/0.65	50	0.32/0.54	59	Momoji, Hakata Bay, 09.iv.1963, leg. K. Sakai
Harman-type	ZLF 9017	46.0/11.0	0.35/0.65	54	0.25/0.70	36	Momoji, Hakata Bay, 30.v.1958, leg. a teacher
Harman-type	ZLF 9007	48.0/10.8	0.22/0.70	31	0.35/0.80	44	Najima, Hakata Bay, 05.v.1954, leg. S. Miyake
Harman-type	ZLF 9035	48.0/10.0	0.32/0.65	49	0.39/0.76	51	Momoji, Hakata Bay, 09.iv.1963, leg. K. Sakai
Harman-type	BLT 8243	54.0/11.0	0.32/0.75	43	0.32/0.68	47	Yoshino-gawa, Tokushima, 1999, leg. K. Sakai
Harman-type	ZLF 9050	/13.5	0.27/0.68	40	0.32/0.86	37	Momoji, Hakata Bay, 09.iv.1963, leg. K. Sakai

shapes of its pigmentation are observed: for example, the blackish pigments in the cornea are shrunken to be irregularly located in the material of the *Harmandi*-type, or become faint brown and centrally concentrated in the material of the *Japonica*-type (cf. fig. 1A, ZLF 9041).

Another error might be pointed out in Bouvier's (1901) description of *C. californiensis* var. *japonica*. He mentioned that the carpus of the smaller cheliped bears a small ventral tooth ["enfin la présence d'une épine bien nette sur le bord inférieur du carpe du petit chélipède."] However, such a spine is usually found on the merus of the smaller cheliped, but not on the carpus.

The sample MNHN-Th 507 comprises three male larger chelipeds of the *Harmandi*-type and two male larger chelipeds of the *Californiensis*-type. In the sample MNHN-Th 496, there are 21 detached male larger chelipeds of the *Harmandi*-type (figs. 2A, 3A-C, 3E, 4B); one male larger cheliped of the *Californiensis*-type (figs. 2C, 4F), and one female cheliped (figs. 2B, 4D) are found together. This fact suggests that *C. harmandi* and *C. japonica* are to be considered the same species, as shown by Sakai (1969). As demonstrated in my revision published in 1969, two forms of male chelipeds of the *Harmandi*-type and the *Californiensis*-type are attributed to one species, *C. japonica*, so that, according to art. 23.1; 23.3.1. of the new Code (ICZN, 1999), *C. harmandi* is to be treated as a synonym of *C. japonica*.

C. petalura Stimpson, 1860 is to be handled as another species, different from *C. japonica* Bouvier, 1901 (= *C. californiensis* var. *japonica*; and *C. harmandi*) in morphology and habitat, because in *C. petalura* the male larger cheliped bears an elongate palm ["... manus elongata, quam carpus angustior; palma quam carpus non brevior, ..." Stimpson, 1860: 92]. This fact is also proven by the larval morphology of the species (Miyabe et al., 1998: 102; Tamaki et al., 2000: 187). They say that "it was confirmed to discriminate larvae of *C.* [not *N.* = *Nihonotrypaea*] *petalura* from those of the other two species (*C. japonica* and *C. harmandi*) for the Z1 to Z3 stage, and all the examined Z3 material of *C. japonica* and *C. harmandi* could be discriminated from each other based on the developmental conditions of the pereiopods". The latter statement is, however, difficult to be accepted, because the sexual dimorphism in the larval stages has not yet been revealed in *C. japonica* and *C. harmandi*. In addition, the size-frequency distributions of larvae in both species given by Tamaki et al. (2000: 187) is only a range of ecospecies, which is not effective to solve the morphological diversity in taxa.

Nihonotrypaea was already synonymized with *Callianassa* by me (Sakai, 1999: 129), as the form of maxilliped 3 is variable in *Callianassa* and the appendices internae on the endopods of the pleopods are triangular and separated (fig. 2D), not fused with the endopod in the adult as shown in De Man's figure (De Man, 1928, pl. 5 fig. 10l).

RESULTS

1. The common Japanese callianassid forms comprise two species: *Callianassa japonica* Ortmann, 1891 (*C. californiensis* var. *japonica* and *C. harmandi*), type locality, Tokyo Bay; and *C. petalura* Stimpson, 1860, type locality, Izu-Shimoda, oceanfront beach in the environment of the pan-Japanese waters.

2. *Callianassa californiensis* var. *japonica* Bouvier, 1901, male (not female as Bouvier mentioned in 1901) (TL/CL 34.0/8.0) with the larger cheliped (fig. 2C) from the surroundings of Tokyo is designated as the lectotype of *C. californiensis* var. *japonica* (MNHN 70).

3. *Callianassa californiensis* var. *japonica* Bouvier, 1901 is a subjective synonym of *C. japonica* Ortmann, 1891.

4. The holotype of *Callianassa subterranea* var. *japonica* Ortmann, 1891 from Tokyo Bay is missing.

5. The holotype of *Callianassa subterranea* var. *japonica* Ortmann is defined as a male (not female) by Ortmann's original figure of the larger cheliped (Ortmann, 1891: 56, pl. 1 fig. 10a).

6. The syntypes of *Callianassa harmandi* Bouvier, 1901 are recognized to consist of one male (TL/CL 38.0/8.0) and two females (TL/CL 34.0/7.0; 28.0/5.8).

7. *Callianassa petalura* Stimpson, 1860 is confirmed as a good species, different from *C. japonica* Bouvier, 1901.

8. Manning & Tamaki (1998) pointed out that *C. subterranea* var. *japonica* Ortmann, 1891: 56, pl. 1 fig. 10a [= *C.* (*Trypaea*) *harmandi* sensu De Man, 1928: 13, pl. 3 fig. 6c, i], and *C. harmandi* Bouvier, 1901: 333 [= *C.* (*Trypaea*) *japonica* sensu De Man, 1928: 13, pl. 5 fig. 10e] are distinct. However, their action includes many inconsistencies, and is not acceptable, because *C. subterranea* var. *japonica* Ortmann, 1891: 56, pl. 1 fig. 10a is not based on a female but on a male; this means that it is impossible to compare *C. subterranea* var. *japonica* Ortmann with *C.* (*Trypaea*) *Harmandi* sensu De Man, 1928: 13, pl. 3 fig. 6c, i, showing a male larger cheliped of the *Harmandi*-type. Secondly, *C. Harmandi* Bouvier, 1901: 333 is not the same as *C.* (*Trypaea*) *japonica* sensu De Man, 1928: 13, pl. 5 fig. 10e, because Bouvier's species is based on a male specimen, while De Man's species is based on a female specimen.

9. Tamaki et al. (2000) described *Callianassa japonica* and *C. harmandi* chaotically, as they did not discriminate the female morphology for each species; nevertheless, they failed to properly observe the cornea, two species [i.e., *C. harmandi* and *C. japonica*] were distinguished by the size of their cornea alone and, in addition, they neglected the presence of *C. californiensis* var. *japonica* Bouvier, 1901, which three forms are usually found together in the same collection.

10. It is not possible to classify these callianassid taxa (cf. Tamaki et al., 2000) without taking into account sexual dimorphism.

11. The ecospecies recognized in larval stages, as reported by Tamaki et al. (2000) are not always applicable to the taxa as a whole, as the adults may exhibit other patterns.

12. Two species, *C. japonica* and *C. harmandi* are different in burrowing holes, and spawning seasons (Tamaki in litt.), though also morphological features,

including the size of their cornea alone, or their larval sizes, show the differences between two distinct species. However, differences such as burrowing holes and spawning seasons might be recognized as characterizing two ecospecies.

13. *Nihonotrypaea* Manning & Tamaki, 1998 is not considered a distinct genus, and it should be treated as a synonym of *Callianassa* Leach, 1814, as indicated by Sakai (1999: 129).

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