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Variations in the Characters of *Platorchestia pacifica* and *Demaorchestia joi* (Amphipoda, Talitridae, Talitrinae) with Revised Diagnoses Based on Specimens from Japan

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Abstract: Seventy-three male specimens of "*Platorchestia platensis*" from Japan were inspected on 13 morphological characters. Most characters revealed high variation. The coxa and propodus of gnathopod 2 and the carpus of pereopod 7 indicated that the specimens comprised two species: *Platorchestia pacifica* Miyamoto and Morino, 2004 and *Demaorchestia joi* (Stock and Biernbaum, 1994) sensu lato. Both species were rediagnosed. *Demaorchestia hatakejima* Lowry and Myers, 2022 was synonymized to *P. pacifica*. A key to allied species in *Platorchestia* and *Demaorchestia* from Japan and the surrounding countries was given.

Keywords: *Platorchestia*; Demaorchestia; intraspecific variation; Japan

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1. Introduction

To provide the background of the present study, a brief history on the taxonomy of the sea-shore "*Platorchestia*" species from Japan and the surrounding countries is reviewed. Until the beginning of the 1980s, *Orchestia platensis* Krøyer, 1845 had been recognized as a common seashore talitrid species occurring worldwide [1–3]. In Japan, Iwasa [4] was the first to document this species with a description and illustrations based on specimen(s) from "Birô" (=Hiro'o) in Hokkaido, northern Japan. After that, Stephensen [5] studied amphipod specimens forwarded from a Japanese scientist for identification, and described specimens of *O. platensis* from the coast of Mie, central Japan. Morino [2] again described *O. platensis*, with figures, on the basis of specimens from Tanabe Bay, Wakayama, central Japan. He recorded this species from seashores throughout Japan, from Hokkaido to Okinawa.

Bousfield [6] revised the concept of the family Talitridae, as well as several component genera from the North Pacific region. He introduced new taxonomic characters to reflect natural (phyletic) species groupings and established new genera, one of which was the genus *Platorchestia*. This genus received six species of the genus *Orchestia* (*P. platensis*, *P. crassicornis* (Derzhavin, 1937), *P. pachypus* (Derzhavin, 1937), *P. japonica* (Tattersall, 1922), *P. zachsi* (Derzhavin, 1937), and a new species *P. chathamensis*). *Platorchestia crassicornis* was resurrected by Bousfield [6], which was originally described as a new species of the genus *Talorchestia* from the Russian coast and had long been synonymized with *O. platensis* (see Bulycheva [7]). Bousfield [6] identified Morino's specimens of *O. platensis* (from Wakayama) as *P. crassicornis*, though the revised diagnoses of *P. crassicornis* by Bousfield [6] was problematic, since it was not strictly concordant with the original description.

Jo [8] critically studied the specimens of the Talitridae from the Korean coasts and recognized four species; three of them belonging to *Platorchestia* (*P. crassicornis*, *P. pachypus*, and *P. munmui* new species). He confirmed the distinction between *P. crassicornis* and *P. platensis* and revised the diagnoses of both species. Jo [8] identified all of the specimens of *O. platensis* described by Iwasa [4], Stephensen [5], and Morino [2] as *P. crassicornis*, and regarded *P. platensis* as a species geographically restricted to the Atlantic coasts.

Miyamoto and Morino [9], in a study of the Talitridae from Taiwan, revised the genus *Platorchestia*, proposing three subgroups defined by the degree of sexual dimorphism. They described a new species from the seashore with the name of *Platorchestia pacifica*, and redescribed *P. joi* (Stock and Biernbaum, 1994) (the proposed name for homonymous *P. crassicornis* (Derzhavin, 1937)). These two species, together with *P. platensis*, *P. pachypus*, and *P. munmui* composed one of the three subgroups, suggesting close relationships among the five species. Miyamoto and Morino [9] identified Morino's specimens as *P. pacifica* and Iwasa's specimens as *P. joi.*

Serejo and Lowry [10] described a new species, *Platorchestia paraplatensis*, from Southwestern Australia. They compared the new species with *P. platensis* (the paralectotypes from Uruguay) and *P. pacifica* (original description), and summarized characters to discriminate the three species.

Kim and Min [11] recorded *Platorchestia monodi* (Mateus, Mateus and Afonso, 1986) from the seashore and river mouth of Korea. Recently, Lowry and Myers [12] recognized the Korean material of *P. monodi* as a distinct species, for which they erected a new species, *Platorchestia koreaensis*.

Kim, Jung, and Min [13] described a new species, *Platorchestia parapacifica*, based on specimens collected from the beaches in Korea, which resembled *P. pacifica, P. platensis,* and *P paraplatensis*. Kim, Jung, and Min [13] gave a morphological character matrix to distinguish eight *Platorchestia* species (*P. parapacifica, P. pacifica, P. joi, P. munmui, P. platensis, P. paraplatensis, P. ashmoleorum,* and *P. monodi* (=*koreaensis*)).

Lowry and Myers [12] established the subfamily Platorchestiinae to accommodate 15 genera, including *Platorchestia*. This treatment is a follow-up of Myers and Lowry [14], in which they performed a morphological cladistical analysis and proposed new categories at the family level (epifamilies and subfamilies) to classify 117 genera of the Talitridae. Lowry and Myers [12] also instituted three new genera (*Cocorchestia, Demaorchestia, Insularorchestia*) in the Platorchestiinae. *Demaorchestia* Lowry and Myers, 2022 consists of five species (*D. parapacifica*, the new species *D. hatakejima*, the new species *D. mie*, *D. joi,* and the new species *D. pseudojoi*). Among these five species, the following three species are based on the descriptions of specimens from Japan or Taiwan: *Demaorchestia hatakejima* Lowry and Myers, 2022 is based on the description of *O. platensis* from Wakayama by Morino [2]; *D. mie* Lowry and Myers, 2022 is based on the descriptions of *O. platensis* from Mie by Stephensen [5]; and *D. pseudojoi* is based on the description of *Platorchestia joi* from Taiwan by Miyamoto and Morino [9].

In summing up these references, two species of *Platorchestia* (*P. pacifica* and *P. pachypus*) and three species of *Demaorchestia* (*D. hatakejima, D. joi,* and *D. mie*) have been recorded in the seashore of Japan. Judging from their geographical affinity, *Platorchetia munmui* (Korea), *P. koreaensis* (Korea), *Demaorchestia pseudojoi* (Taiwan), and *D. parapacifica* (Korea) retain the possibilities of being found from Japan. However, no rigorous treatment with the current concepts on the "*Platorchestia platensis*" species group has so far been conducted on specimens from Japan.

Therefore, as a next step to these reviews, their conclusions are to be confirmed based on the specimens. Secondly, size-dependent characters have been adopted in these studies, e.g., antennal incrassation and the shape of the palm on male gnathopod 2. These characters will be more reliable if the characters are informed by the body size (see Myers and Lowry [15]). Also, the indication of the range of variation in characters will be helpful to discriminate closely related species. The precise morphological characterization of taxa is a prerequisite to the molecular approach, a powerful tool to elucidate their identities and relationships among them.

In this paper, specimens of the "*Platorchestia platensis*" species group from the seashore of Japan are examined morphologically to identify the species, and the variation in selected diagnostic characters are documented to evaluate their reliability.

2. Materials and Methods

Seventy-three male specimens of "*Platorchestia platensis*" from 29 localities (#1–#29), from Hokkaido to Okinawa, were analyzed. Nine specimens from three consequent seasons were examined in the collection from Hatakejima Island, Wakayama (#19), since from this collection the type specimens of *P. hatakejima* were selected (Lowry and Myers [12]; pers comm.). For each of the other localities, one to four specimens were inspected. All of the specimens are deposited in the collection of the National Museum of Nature and Science, Tsukuba (NSMT-Cr).

Materials Examined

#1: 3 males: 8.8 mm (NSMT-Cr 27043), 11.5 mm (NSMT-Cr 27042), 12.5 mm (NSMT-Cr 27041); Sakanoshika (seashore), Wakkanai, Hokkaido; 24 June 1971; H. Morino coll.

#2: 2 males: 9.2 mm (NSMT-Cr 27268), 10.2 mm (NSMT-Cr 27269); Lake Abashiri (brackish lake shore), Abashiri, Hokkaido; 18 May 2004, K. Wada coll.

#3: 3 males: 10.6 mm (NSMT-Cr 27033), 11.3 mm (NSMT-Cr 27034), 12.0 mm (NSMT-Cr 27032); Aikappu (seashore), Akkeshi, Hokkaido, 22 June 1971; H. Morino coll.

#4: 3 males: 9.0 mm (NSMT-Cr 27024), 1.0 mm (NSMT-Cr 27026), 12.0 mm (NSMT-Cr 27025: Esashi-oyama (seashore), Hokkaido; 18 June 1971; H. Morino coll.

#5: 1 male 11.2 mm (NSMT-Cr 27226); Torikarasu-hama (seashore), Oshima-ohshima Is., Hokkaido; 10 October 1990; Y. Harada and K. Kuribayashi coll.

#6: 1 male 10.8 mm (NSMT-Cr 27017); Togahama (seashore), Oga, Akita; 16 June 1971; H. Morino coll.

#7: 3 males: 10.2 mm (NSMT-Cr 27052), 10.5 mm (NSMT-Cr 27051), 12.0 mm (NSMT-Cr 27053); Takashiro-hama (seashore), Onagawa, Miyagi: 27 June 1971, H. Morino coll.

#8: 3 males: 10.2 mm (NSMT-Cr 27310), 10.2 mm (NSMT-Cr 27311), 12.0 mm (NSMT-Cr 27312); Hiraiso (seashore), Hitachinaka, Ibaraki; 5 November 2015; H. Morino coll.

#9: 2 males: 10.8 mm (NSMT-Cr 27011), 12.0 mm (NSMT-Cr 27012); Shinpo (seashore), Noto, Ishikawa; 14 June 1971; H. Morino coll.

#10: 2 males: 11.0 mm (NSMT-Cr 27314), 13.0 mm (NSMT-Cr 27315); Akasaki (seashore), Tsuruga, Fuki; 6 June 1976; H. Miyamoto coll.

#11: 2 males: 10.5 mm (NSMT-Cr 27336), 11.0 mm (NSMT-Cr 27335); Saburi River (estuary), Ooi, Fukui; 6 May 1977; H. Miyamoto coll.

#12: 2 males: 10.4 mm (NSMT-Cr 27003), 12.2 mm (NSMT-Cr 27004); Takahama (seashore), Ooi, Fukui; 24 May 1971; H. Morino coll.

#13: 2 males: 9.0 mm (NSMT-Cr 27237), 10.1 mm (NSMT-Cr 27236); Daito Fisheries Port (seashore), Isumi, Chiba; 23 June 1994; H. Morino coll.

#14: 3 males: 11.0 mm (NSMT-Cr 27057), 12.0 mm (NSMT-Cr 27058), 13.0 mm (NSMT-Cr 27059); Uchiura Bay (seashore), Amatsu-kominato, Chiba; 29 June 1971; H. Morino coll.

#15: 2 males: 10.2 mm (NSMT-Cr 27353), 11.0 mm (NSMT-Cr 27352); Funemisaki (seashore), Torishima Is., Tokyo; 29 January 2017; T. Torii coll.

#16: 1 male 8.0 mm (NSMT-Cr 27217); Minamijima Is., Ogasawara, Tokyo; 13 August 1989; H. Morino coll.

#17: 3 males: 9.2 mm (NSMT-Cr 27065), 9.5 mm (NSMT-Cr 27066), 10.2 mm (NSMT-Cr 27064); Koajiro (seashore), Misaki, Kanagawa; 30 June 1971; H. Morino coll.

#18: 2 males: 11.0 mm (NSMT-Cr 27323), 12.0 mm (NSMT-Cr 27322): Kawajiri River (estuary) Wachi, Tahara, Aichi; 24 November 1974; H. Miyamoto coll.

#19: 3 males: 12.0 mm (NSMT-Cr 27284), 12.4 mm (NSMT-Cr 27285), 14.3 mm (NSMT-Cr 27286); 13 Mar. 1972; 3 males: 7.8 mm (NSMT-Cr 27298), 8.0 mm (NSMT-Cr 27296), 8.0 mm (NSMT-Cr 27297); 13 August 1972; 3 males: 8.8 mm (NSMT-Cr 27305), 10.8 mm (NSMT-Cr 27304), 11.0 mm (NSMT-Cr 27303); 13 December 1972; Hatakejima Is. (seashore), Tanabe Bay, Wakayama; H. Morino coll.

#20: 4 males: 9.2 mm (NSMT-Cr 26996), 10.0 mm (NSMT-Cr 26997), 11.0 mm (NSMT-Cr 26995), 11.2 mm (NSMT-Cr 26994); Suetsune (seashore), Tottori; 22 May 1971; H. Morino coll.

#21: 1 male 8.5 mm (NSMT-Cr 27092); Bentenzaki, Tamano, Okayama; 24 September 1971; H. Morino coll.

#22: 3 males: 8.0 mm (NSMT-Cr 27100), 8.0 mm (NSMT-Cr 27102), 9.2 mm (NSMT-Cr 27101); Karakohama (seashore), Imabari, Ehime; 25 September 1971; H. Morino coll.

#23: 1 male 10.0 mm (NSMT-Cr 27265); Shigenobu River (estuary), Matsuyama, Ehime; 19 April 2004; K. Wada coll.

#24: 2 males: 7.5 mm (NSMT-Cr 27116), 9.0 mm (NSMT-Cr 27115); 30 September 1971; Urado (seashore), Higashi-minamiura, Kochi; 30 September 1971; H. Morino coll.

#25: 2 males: 10.8 mm (NSMT-Cr 26979), 12.5 mm (NSMT-Cr 26980): Tsuyazaki (seashore), Fukuoka; 12 May 1971; H. Morino coll.

#26: 3 males: 10.1 mm (NSMT-Cr 26986), 11.0 mm (NSMT-Cr 26987), 12.5 mm (NSMT-Cr 26988); Sesegushi (seashore), Kagoshima; 17 May 1971; H. Morino coll.

#27: 3 males: 7.5 mm (NSMT-Cr 27082), 8.2 mm (NSMT-Cr 27083), 9.0 mm (NSMT-Cr 27081); Akaogi (seashore), Amami-Ohshima Is., Kagoshima; 30 July 1971; H. Morino coll.

#28: 2 males: 8.2 mm (NSNT-Cr 27138), 9.8 mm (NSMT-Cr 27139); Awase Port (seashore), Awase, Okinawa Is., Okinawa; 27 March 1975; H. Morino coll.

#29: 3 males: 8.8 mm (NSMT-Cr 27146), 9.2 mm (NSMT-Cr 27145), 11.1 mm (NSMT-Cr 27144); Sonai, Iriomote Is., Okinawa; 10 March 1975; H. Morino coll.

The following morphological characters were inspected for each specimen by use of a dissection microscope or a compound microscope. The body lengths (from the tip of the head to the tip of the telson along the straightened dorsal margin) were measured before the inspection.

(1) Antenna 1: the number of marginal robust setae on peduncular article 3.
(2) Antenna 2: the developmental stage of the incrassation of the peduncle.

1. None (Figure 1A);

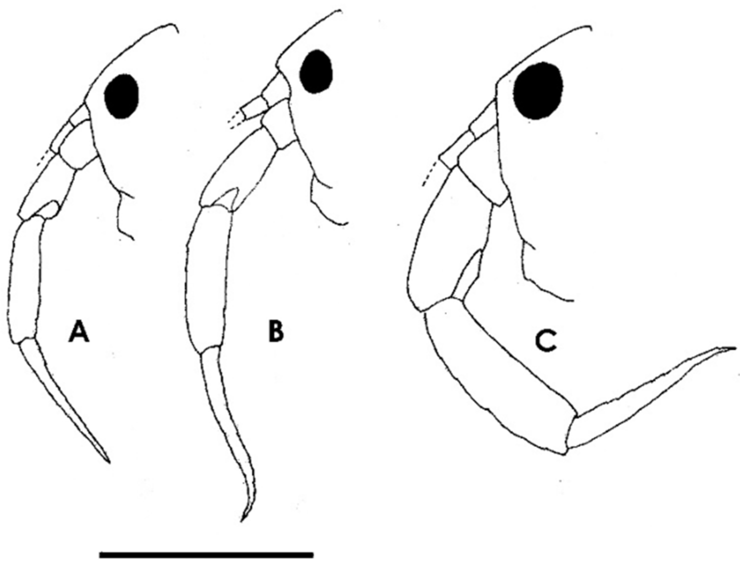

Figure 1. Antenna 2. (**A**): non-incrassate, (**B**): slightly incrassate, (**C**): distinctly incrassate. Scale: 2 mm.

2. Slight (Figure 1B);
3. Distinct (Figure 1C).

(3) Gnathopod 1: cusp on the dactylus.

1. None (Figure 2A);

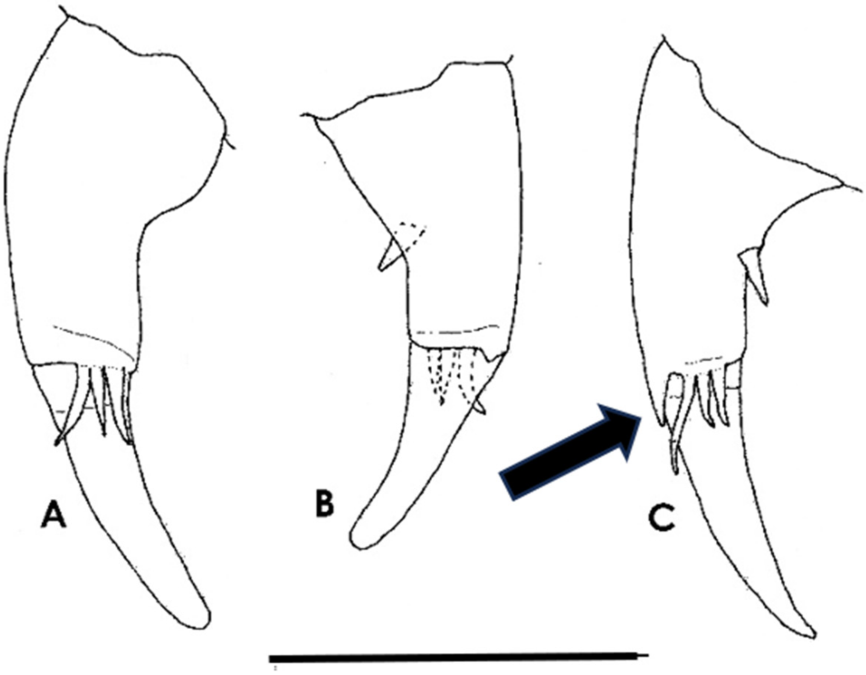

Figure 2. Dactylus of gnathopod 1. Arrow: cusp. (**A**): non-cuspate, (**B**): rudimentary cuspate, (**C**): distinctly cuspate. Scale: 0.2 mm.

2. Rudimentary (Figure 2B);
3. Distinct (Figure 2C).

(4) Gnathopod 1: the length ratio of the propodus to carpus.
(5) Gnathopod 2: posterior cusp on the coxa.

1. None (Figure 3A) or blunt (Figure 3B);

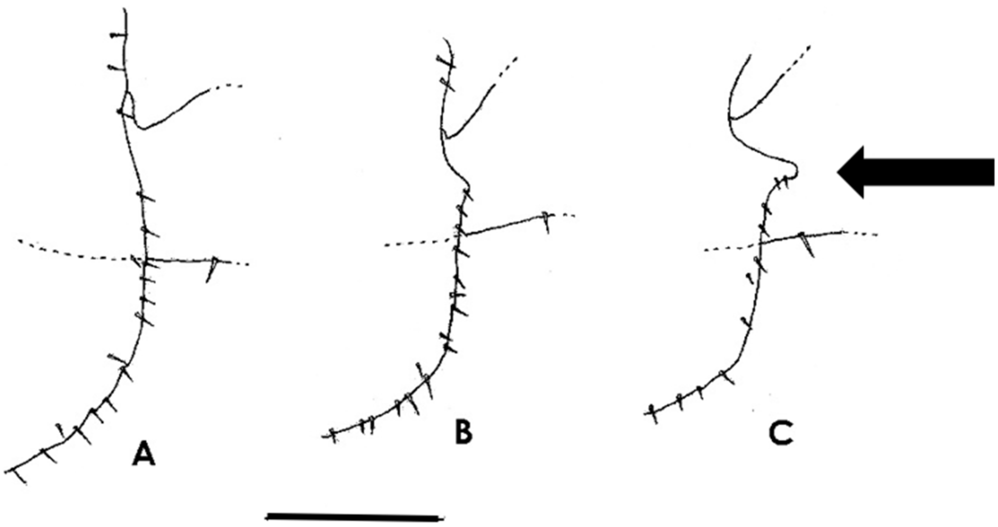

Figure 3. Posterior margin of coxa of gnathopod 2. Arrow: cusp. (**A**): non-cuspate, (**B**): bluntly cuspate, (**C**): sharply cuspate. Scale: 0.4 mm.

2. Medium;
3. Sharp (Figure 3C).

(6) Gnathopod 2: the developmental stage of the mid-notch on the palmar margin.

1. None (Figure 4A);

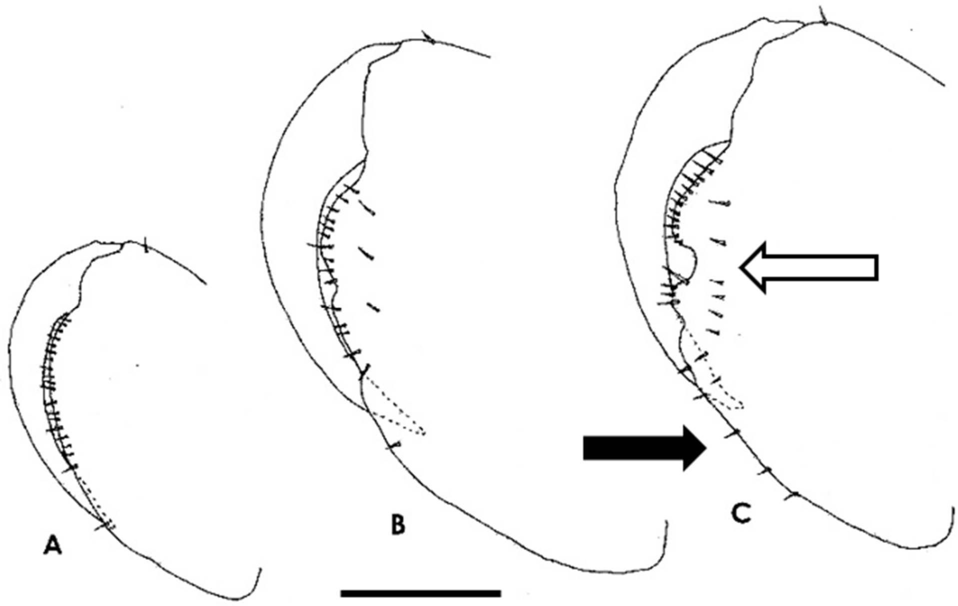

Figure 4. Propodus of gnathopod 2. White arrow: mid-notch; black arrow: marginal robust setae. (**A**): non-notched, (**B**): slightly notched, (**C**): distinctly notched. Scale: 0.4 mm.

2. Slight (Figure 4B);
3. Distinct (Figure 4C, white arrow).

(7) Gnathopod 2: the number of robust setae on the posterior margin of the propodus (Figure 4C, black arrow).
(8) Pereopod 4: the ratio of carpus length to width
(9) Pereopod 6: the development of the protrusion on the posterior lobe of the coxa

1. Not protruded (right angled) (Figure 5A);

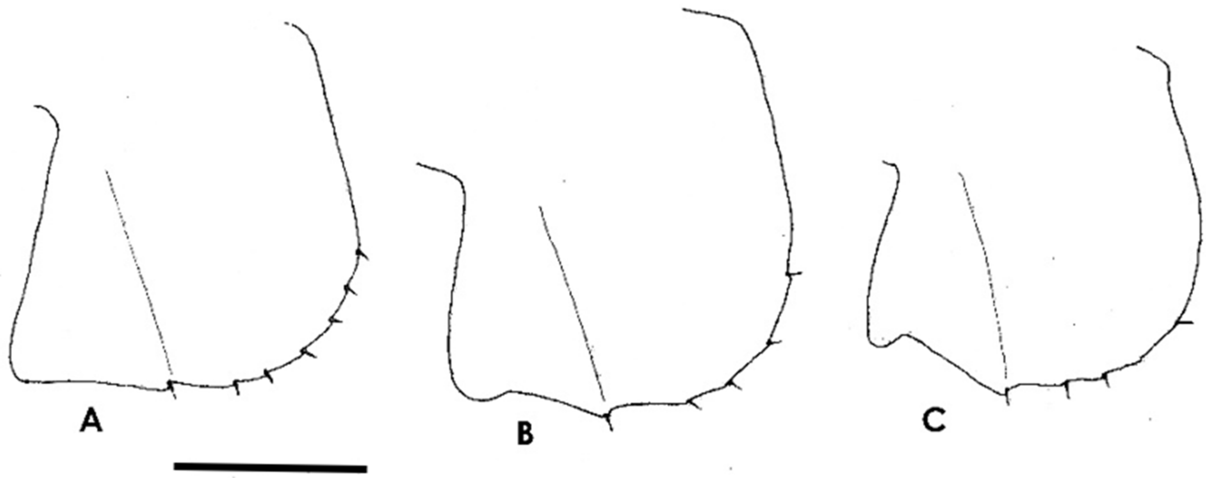

Figure 5. Posterior lobe of the coxa of pereopod 6. (**A**): not protruded, (**B**): slightly protruded, (**C**): distinctly protruded. Scale: 0.4 mm.

2. Slightly protruded (Figure 5B);
3. Distinctly protruded (Figure 5C).

(10) Pereopod 7: the developmental stage of the incrassation of the carpus.

1. None (Figure 6A);

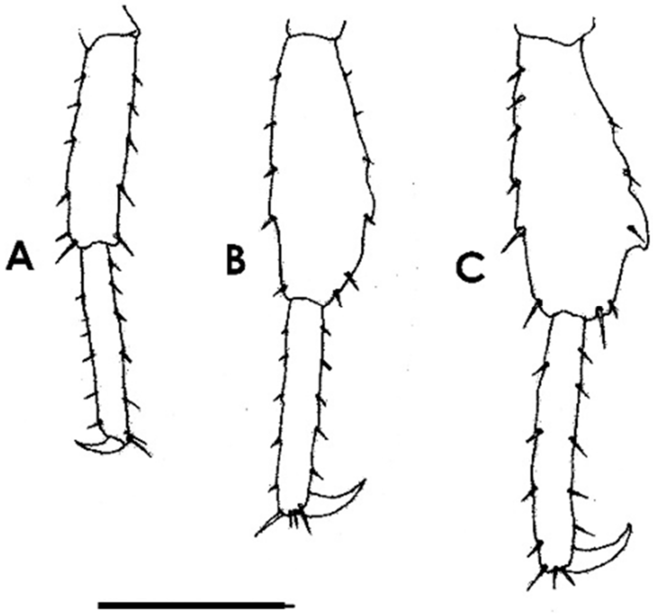

Figure 6. Carpus of pereopod 7. (**A**): non-incrassate, (**B**): slightly incrassate, (**C**): distinctly incrassate. Scale: 1 mm.

2. Slight (Figure 6B);
3. Distinct (Figure 6C).

(11) Pleopods 2 and 3: the number of robust setae on the outer margin of the peduncle.

Serejo and Lowry [10] referred to the position of the group of marginal robust setae on pleopod peduncles (e.g., medial or proximal). In the present analysis, the total number of the robust setae was counted since the positioning of setae groups was often not possible.

(12) Telson: the number of robust setae per lobe.

Kim, Jung, and Min [13] discriminated three states in the number of setae groups on the telson (one, two, or three groups). However, the recognition of the group was often difficult so that herein the total number of the robust setae was counted on the left lobe of telson.

The analyses of the results proceeded with three steps. First, the specimens examined were tentatively identified to species following the diagnoses given by Miyamoto and Morino [9], *Platorchestia pacifica* (P-type) or *Platorchestia joi* (J-type). In this process, the number of marginal setae on the posterior margin of the propodus of gnathopod 2 was given priority, since this is one of the meristic characters and thus practical to discriminate as compared to gradual, size-dependent ones, such as the incrassation of appendages; they also showed a trend of two clusters. Secondly, character states or measurements in each of the other characters were separated into P- or J-type to be compared between both types to confirm the species identity and to delimit the variation. Those characters with a dichotomous trend were described primarily. Lastly, the revised characters of each type were compared with the descriptions of species known from Japan and the adjacent regions. Statistical tests were performed using regression analysis via Microsoft Excel 2021 (ver. 2309).

3. Results

3.1. The Number of Marginal Robust Setae on the Propodus of Gnathopod 2

The number of the setae varies from 0 to 7, exhibiting two clusters, 0–2 and 4–6 (rarely 7) with the intermediate 3 (2 specimens) (Figure S1). The first cluster shows a normal distribution with the mode of 1 seta, and suggests size-dependency, while the second cluster shows more or less uniform distribution and no trend with respect to the body size. The first cluster coincides with the diagnosis of *Platorchestia pacifica* (sensu Miyamoto and Morino, 2004) and the second one with that of *P. joi* (sensu Miyamoto and Morino, 2004). Although Miyamoto and Morino [9] mentioned this character for *P. joi* as being three or more (3–5), here the intermediate two specimens are allocated to *P. pacifica*. Hereafter, specimens with three or less marginal setae are allotted to P-type, and those with four or more setae are allotted to J-type. Figure S2 gives the size frequency distributions of the specimens of P- and J-types. The two distributions are not different from each other but the number of specimens of both types is disproportionate: that of P-type is five times higher than that of J-type.

3.2. Posterior Cusp on Coxa of Gnathopod 2

Specimens of P-type show sharp, rarely medium, cusps, while those of J-type show blunt ones (Figure S3). A clear difference is admitted between both types with respect to this character.

3.3. The Incrassation of the Carpus of Pereopod 7

The specimens of P-type show all of the three stages of incrassation, from none to distinct, and a size-dependent trend. Most of the large males (larger than 11 mm) show incrassation (Figure S4). The specimens of J-type, on the other hand, show no sign of incrassation, except one specimen (Figure S4). For large males, there is a clear difference between both types.

3.4. Cusp on Dactylus of Gnathopod 1

Specimens of P-type show all of the three states, from none to distinctly cuspate dactylus, for almost all size classes (Figure S5). On the other hand, all specimens of the J-type display non-cuspate dactylus (Figure S5). As will be discussed later, the high variation in this character in P-type casts problems for the generic position of P-type.

3.5. The Number of Marginal Robust Setae on Peduncular Article 3 of Antenna 1

The specimens of P-type show 1–4 setae, with a mode of 2–3, whereas those of J-type show two, rarely one, setae (Figure S6); both show size dependency ($p < 0.01$; P-type: r = 0.680, J-type: r = 0.769).

3.6. The Incrassation of Peduncle of Antenna 2

In both types, small specimens (ca. 8 mm) show all of the stages from none to distinctly incrassate, and large ones (more than 11 mm) display a distinctly incrassate peduncle (Figure S7). In P-type, this was size-dependent ($p < 0.01$; r = 0.527).

3.7. The Length Ratio of the Propodus to the Carpus of Gnathopod 1

The specimens of P-type show a length ratio range of 0.58–0.74 with a mean value of 0.674, while the length ratio range of J-type was 0.57–0.68 with a mean value of 0.641 (Figure S8). There is no difference between both types and no size dependency in both types ($p > 0.05$).

3.8. Mid-Notch on Palm of Gnathopod 2

The specimens of both types exhibit a similar pattern (Figure S9). Larger males show more developed stages (P-type, $p < 0.01$; r = 0.655), although the smaller specimens of P-type show variable developmental stages. Most of the larger males (more than 11 mm) show distinctly developed stages in both types.

3.9. The Ratio of Carpus Length to Width of Pereopod 4

The specimens of P-type show a length ratio range of 1.13–1.78 with a mean value of 1.428 (Figure S10), while those of J-type show a range of 1.33–1.71 with a mean value of 1.483. There is no difference between the types, and no size dependency in either type ($p > 0.05$).

3.10. Protrusion on Coxa of Pereopod 6

In specimens of P-type, most of the size classes exhibit all of the three states of development (Figure S11). In J-type, larger males tend to have a less protruded state, although it is not significant ($p > 0.05$).

3.11. The Number of Marginal Robust Setae on the Peduncle of Pleopod 2 and Pleopod 3

For pleopod 2, the specimens of P-type exhibit a range of 3–15 with a mode of 8, which correlates to the body length ($p < 0.01$; r = 0.708), while those of J-type have a range of 6–17 with a mode of 11 (Figure S12). The numbers in J-type tend to be higher than those of P-type. The same trend is demonstrated in those of pleopod 3 (Figure S13). The specimens of P-type have a range of 2–13 with a mode of 9; J-type specimens have a range of 6–16 and a mode of 11.

3.12. The Number of Robust Setae on Left Lobe of Telson

The specimens of P-type show a range of 5–13 with a mode of 7, and J-type specimens have a range of 8–12 with a mode of 9 (Figure S14). These numbers in J-type tend to be higher than those in P-type, although the range of the latter is included within the range of the former.

The results of these analyses on P- and J-type specimens are summarized in Table 1, together with the information cited from the descriptions of the species concerned.

Table 1. Characters and states for examined specimens and species of *Platorchestia* and *Demaorchestia*.

	Specimen or Species	**P-Type**	**J-Type**	***P. crassicornis***	***P. joi***	***P. pacifica***	***P. para-pacifica***	***P. munmui***	***P. monodi***
	Author(s) referred to	present paper	present paper	Jo [8]	Miyamoto & Morino [9]	Miyamoto & Morino [9]	Kim et al. [13]	Jo [8]	Kim & Min [11]
	Body length (mm)	7.5–14.3	8.0–12.0	12.5	8–11	10	19.2	13.2	9.3
	Taxonomic opinions of Lowry & Myers, 2022 [12]			*D. joi*	*D. pseudojoi*	*D. pacifica* (*D. mie* and *D. hatakejima*)	*D. parapacifica*		*P. koreaensis*
	Characters								
1	Gn 2, number of setae on propodus	0–2, rarely 1	4–6, rarely7	7 (fig), several (text)	3–5	0	1 (fig), bare (text)	1	1 (fig), bare (text)
2	Gn 2, cusp on coxa	S, rarely M	B	B or M	B	S	S	S	S (fig), obtuse (text)
3	Per 7, incrassation of carpus	D *, S, N	N, rarely D	N or S	N or S	D	D	D	N
4	Gn 1, cusp on dactylus	D, R, N	N	N	N	D, R	N	D	D
5	Ant 1, number of setae on peduncular article 3	1–4 ** (2, 3)	2, rarely 1	2 (Kim et al., [13])	0	1, 2	4	1, 2	1 (Kim et al. [13])
6	Ant 2, incrassation of peduncle	2, 3 **, rarely 1	1–3	3	2, 3	3	3	3	2
7	Gn 1, length ratio of propodus to carpus	0.58–0.74 (0.674)	0.57–0.68 (0.641)	0.63	0.71 (fig), ca 0.6 (text)	0.71 (fig), ca 0.6 (text)	0.66 (fig), 0.63 (text)	0.73	0.69 (fig), 0.63 (text)

Table 1. *Cont.*

Specimen or Species		P-Type	J-Type	*P. crassicornis*	*P. joi*	*P. pacifica*	*P. para-pacifica*	*P. munmui*	*P. monodi*
8	Gn 2, mid-notch on palm	1–3 **	2, 3	3	2	1, 2	3	3	2
9	Per 4, ratio of carpus length to width	1.13–1.78 (1.428)	1.33–1.71 (1.483)	1.48	1.69	1.64	1.31	1.09 (fig), ca 1.0 (text)	1.77
10	Per 6, protrusion of lobe on coxa	1–3	1–3	1 or 2	1, 2	3	2, 3	1	1
11	Pl 2, number of setae on peduncle	3–15 (8) **	6–17 (11)	10~	4 (fig), several (text	3	7	5	1
12	Pl 3, number of setae on peduncle	2–13 (9) **	6–16 (11)	10~	8	9	9	9	2
13	T, number of setae on left lobe	5–13 (7) **	8–12 (9)	8	8	6	10	8	5

1. Parentheses after ranges mean mode values or mean values; 2. Asterisks indicate size dependency. Double asterisks indicate significant values; 3. In the case that measured values or expressions are different between the texts and figures in literatures, each case is shown.

4. Discussion

Most of the characters treated here display a rather high degree of variation, especially the number of robust setae on pleopods 2 and 3, and the telson lobe. The length ratio of the propodus on gnathopod 1 to the carpus was previously introduced by Bousfield [6] to distinguish *P. crassicornis* from *P. platensis*, though it shows no significant differences among specimens of both types and the species cited in Table 1. The development of protrusion on the anteroventral corner on the posterior lobe of the pereopod 6 coxa has been adopted to discriminate species [10,12,13,15]. However, the present study indicates that all of the states of the protrusion, from none to distinctive, appear in all size classes in both types, evincing its unstableness. It is advisable for other species to be examined for variation in these characters.

Cusps on the dactylus of gnathopod 1 also display variation in P-type specimens, from none to a distinctively cuspate state, but the dactylus is stably non-cuspate (simplidactylate) in J-type ones. This character is employed to establish the genus *Demaorchestia* Lowry and Myers, 2022, which is defined by having the non-cuspate dactylus, and thus differentiating it from the cuspidactylate *Platorchestia* sensu Lowry and Myers, 2022. However, as far as the P-type specimens are concerned, this concept is hard to accept. A high variation of the dactylar states may make the generic separation of *Demaorchestia* unreliable. As an alternative solution, the concept of the genus *Platorchestia* is expanded to encompass the variation of P-type. Until the variation of this character is examined for other *Platorchestia* species, the latter treatment is adopted here. Accordingly, P-type specimens are provisionally allotted to the genus *Platorchestia*.

In the character s of gnathopod 2 (the cusp on coxa and marginal robust setae) and pereopod 7 (the incrassation of carpus), P-type specimens also agree with *P. pacifica* Miyamoto and Morino, 2004, and J-type specimens with *Demaorchestia joi* (Stock and Biernbaum, 1994) sensu of Miyamoto and Morino, 2004 (see Table 1)

5. The Revised Diagnoses of *Platorchestia pacifica* and *Demaorchestia joi*

5.1. Platorchestia pacifica Miyamoto and Morino, 2004

(Japanese name: Taiheiyo-himehamatobimushi)
Platorchestia pacifica Miyamoto and Morino, 2004, pp.76–83, figs 4–7, Table 1.
Orchestia platensis: Morino, 1975, pp. 172–175, figs 1–3.
Demaorchestia hatakejima Lowry and Myers, 2022, pp. 11–12, fig. 5.

Diagnosis (Large males mean larger than 11 mm body length.)

Body size medium (up to 15 mm). Antenna 1 short, not reaching end of peduncular article 4 of antenna 2 ; peduncular article 3 has two or three (rarely one or four) marginal robust setae. Antenna 2, peduncle longer than flagellum, peduncular article 3 without a ventral plate; peduncular articles 4 and 5 slightly to distinctly (large males) incrassate in males. Mandible left lacinia 5-dentate. Maxilliped, outer margin of precoxa not stepped, palp article 2 with distomedial lobe, article 4 reduced, masked by apical robust setae. Gnathopod 1 sexually dimorphic, dactylus cusp varied: lacking, rudimentary, or distinct; in males, propodus strongly subchelate, carpus and propodus have dome-shaped pellucid lobes; in females, shallowly subchelate, lacking pellucid lobe. Gnathopod 2 in males is powerfully subchelate, coxa with sharp cusp on posterior margin, propodus posterior margin with 0–2, rarely 3, robust setae, palmar margin with U-shaped mid-notch in large males; in females, mitten-shaped, basis anteroproximally expanded. Pereopods 3–7 bicuspidactylate, propodus locking robust setae well-developed. Pereopod 4, coxa wider than deep, ratio of carpus length to width ca. 1.4 (1.13–1.78), dactylus base weakly concaved. Pereopod 6, protrusion of posterior lobe of coxa varied, from none to distinctly developed. Pereopod 7, carpus incrassate in large males. Coxal gill of pereopod 2 V-shaped, the gills of pereopods 3–6 convoluted. Pleopods well-developed: peduncles of pleopods 2 and 3, outer margin robust-setose. Uropod 1, peduncle distolateral robust seta shorter than subdistal one; inner ramus with outer and inner marginal robust setae, outer ramus marginally bare. Telson with apical and marginal robust setae, seven (5–13) in number.

Remarks

The relationships of *P. pacifica* with allied species are discussed in the order of geographical affinity.

Demaorchestia hatakejima Lowry and Myers, 2022 was instituted with the type specimens selected from the specimens of *P. pacifica* (Hatakejima Island, Wakayama in Japan). The original description was based on the illustration and description by Morino [2]. Since these were not prepared under the current concept, nine specimens from the same collection (#19 in *Material examined*) were carefully examined in this study, which revealed three states (N, R, D) in the dactylation of gnathopod 1 among them, and no difference was found which separated any of them from the other *P. pacifica* specimens. This result demonstrates that the new species for the Hatakejima population is not tenable.

Demaorchestia mie Lowry and Myers, 2022 from Mie in Japan is identified by: (1) an apically pinched dactylus of gnathopod 2, (2) the basis of pereopod 7 lacking a posterodistal lobe, and (3) the strongly serrated posterior margins of epimera (Lowry and Myers, 2022). One or two specimens selected from each locality of "P-type" were examined with respect to these three characters. All of them showed an apically pinched (strongly or smooth elongate) dactylus of gnathopod 2, pereopod 7 with a posterodistal lobe, and epimera with shallowly (not strongly) serrated posterior margins. Thus, no specimens of "P-type" fit into *D. mie*.

Platorchestia munmui and *Demaorchestia parapacifica* described from Korean coasts are very close to *Platorchestia pacifica. Platorchestia munmui* is separated from *P. pacifica* by the significantly lower ratio of carpus length to the width of pereopod 4 (see Table 1). *D. parapacifica* is separable from *P. pacifica* by the number of marginal setae on the peduncular article 3 of antenna 1 (*P. pacifica* with 1–3 (rarely 4); *P. parapacifica* with 4 setae). The type of *D. parapacifica* could represent the largest specimen of *P. pacifica*. A population analysis of *D. parapacifica* should be performed to settle this possibility.

Myers and Lowry [15] enumerated 11 species in the genus *Platorchestia*, among which *P. munmui* and *P. pachypus* are treated above or below, respectively. The six species, *Platorchestia ano* Lowry and Bopiah, 2013, *P. exter* Myers and Lowry, 2023, *P. negevensis* Myers and Lowry, 2023, *P. griffithsi* Myers and Lowry, 2023, *P. platensis* (Krøyer, 1845), and *P. smithi* Lowry 2012, are distinguished from *P. pacifica* by having a palmar margin of gnathopod 2 with a shallow or weak mid-notch (vs. a distinctly U-shaped mid-notch). *Platorchestia oliveirae* Myers and Lowry, 2023 differs from *P. pacifica* by the V-shaped mid-notch on the gnathopod palm and weakly incrassate pereopod 7 (vs. the U-shaped mid-notch and distinctly incrassate pereopod 7). *Platorchestia paraplatensis* Serejo and Lowry, 2008 has an elongate propodus on pereopod 7 (1.4 X carpus), while *P. pacifica* has a propodus shorter than the carpus.

Distribution. Japan (Hokkaido, Akita, Miyagi, Ibaraki, Ishikawa, Fukui, Chiba, Tokyo, Kanagawa, Wakayama, Tottori, Ehime, Kochi, Fukuoka, Kagoshima, Okinawa; see Appendix A for information of specimens), Taiwan, and Vietnam (not published).

5.2. Demaorchestia joi (Stock and Biernbaum, 1994)

(Japanese name: Kushi-himehamatobimushi new)
Talorchestia crassicornis Derzhavin, 1937, pp.108–109, Pl. 3, 1.
Orchestia platensis: Iwasa, 1939, pp. 275–261, figs 1–3, Pl. IX.
Platorchestia crassicornis: Jo, 1988, pp.161–167, figs 5–9.
Platorchestia joi Stock and Biernbaum, 1994, pp.800 (proposed name for homonymous *crassicornis*); Miyamoto and Morino, 2004, pp.70–76, figs 1–3.
Demaorchestia joi: Lowry and Myers, 2022, p.11 (comb. nov.)

Diagnosis

As *Platorchestia pacifica* except the following characters:

Body size medium (up to 13 mm). Antenna 1, peduncular article 3 with one or two marginal robust setae. Gnathopod 1, dactylus not cuspate. Gnathopod 2, coxa posterior margin with blunt cusp; in males, propodus posterior margin with 4–7 robust setae. Pereopod 7, carpus not incrassate. Telson with 9 (8–12) robust setae, apically and marginally.

Remarks

The characters in the male gnathopod 2, namely, a robust setose posterior margin of the propodus, and a blunt cusp of the coxa of gnathopod 2 are unique to *Demaorchestia joi* and *D. pseudojoi* Lowry and Myers, 2022 among *Platorchestia* and *Demaorchestia* species. *D. joi* is distinguished from *D. pseudojoi* by the following: (1) the labium with a vestigial inner lobe, (2) the elongate carpus of gnathopod 1 (more than 2 X width, and (3) the shape of the dactylus of pereopod 4 (Lowry and Myers, 2022). Since the carpus shape is the clearest among these characters, all of the J-type specimens were inspected for the carpus of gnathopod 1. The measurement reveals that the ratio of the carpus length to the width has a range of 1.85–2.31, with a mean value of 2.05. Thus, it is not possible to separate *Demaorchestia pseudojoi* from *D. joi* based on this character in our J-type specimens. The other characters mentioned above should be examined to settle the identity of the present specimens.

Distribution: Japan (Hokkaido, Fukui, Chiba, Aichi, Tottori, Okayama, Ehime; see Appendix A for information of specimens), Russia, Korea, and Taiwan.

6. A Key to the Species of the Genera *Platorchestia* and *Demaorchestia* from the Seashores of Japan and Korea (Based on Males)

1. Propodus palmar margin of gnathopod 2 sigmoid; carpus of pereopod 7 sexually dimorphic, oar-shaped. --- *P. pachypus* (Derzhavin, 1937)

--. Propodus palmar margin of gnathopod 2 with mid-notch; carpus of pereopod 7 incrassate or not sexually dimorphic. -- 2

2. Carpus of pereopod 7 incrassate (larger than 11 mm B.L.). --------------------------------3

--. Carpus of pereopod 7 not sexually dimorphic.--- 6

3. Length of carpus of pereopod 4 less than equal to its width. --------- *P. munmui* Jo, 1988

--. Length of carpus of pereopod 4 ca. 1.4 times as long as its width. ---------------------- 4

4. The number of marginal setae on peduncular article 3 of antenna 1 is four; dactylar cusp on gnathopod 1 distinct. ------------------------- *P. parapacifica* Kim, Jung and Min, 2013

--. The number of marginal setae on peduncular article 3 of antenna 1 is 1–3 (rarely 4); the dactylar cusp on gnathopod 1 lacking, rudimentary, or distinct. ------------------------ 5

5. Basis of pereopod 7 lacking posteroventral lobe, epimera posterior margins strongly serrated (after Lowry and Myers, 2022). ------- *Demaorchestia mie* Lowry and Myers, 2022

--. Basis of pereopod 7 has posteroventral lobe, epimera posterior margins not strongly serrated. -- *P. pacifica* Miyamoto and Morino, 2004

6. The number of setae on propodus posterior margin on gnathopod 2 is 4–6, rarely 7; posterior cusp of coxa on gnathopod 2 blunt. ----- *Demaorchestia joi* (Stock and Biernbaum, 1994) sensu lato

--. The number of setae on propodus posterior margin on gnathopod 2 is one; posterior cusp of coxa on gnathopod 2 distinct. ----------------- *P. koreaensis* Lowry and Myers, 2022.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d16010031/s1, Figure S1: Scatterplot of setae number against body length; Figure S2: Frequency distribution of body length; Figure S3: Frequency distribution of developmental states of cusp against body length; Figure S4: Frequency distribution of developmental stages of incrassation against body length; Figure S5: Frequency distribution of developmental states of cusp against body length; Figure S6: Scatterplot of setae number against body length; Figure S7: Scatterplot of developmental stages of incrassation against body length; Figure S8: Scatterplot of ratios against body length; Figure S9: Scatterplot of developmental stages of mid-notch against body length; Figure S10: Scatterplot of ratio against body length; Figure S11: Scatterplot of developmental states of protrusion against body length; Figure S12: Upper and middle: scatterplot of setae numbers on pleopod 2 against body length; Lower: frequency distribution of setae numbers on pleopod 2; Figure S13: Upper and middle: scatterplot of setae numbers on pleopod 3 against body length. Lower: frequency distribution of setae numbers on pleopod 3; Figure S14. Upper and middle: scatterplot of setae numbers on telson against body length. Lower: frequency distribution of setae numbers.

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Appendix A

Geographical information on each specimen of *Platorchestia pacifica* and *Demaorchestia joi*. Specimens inspected are classified into species and geographical areas in the prefecture.

Platorchesstia pacifica

Hokkaido: Sakanoshita, Wakkanai (NSMT-Cr 27041, 27042, 27043); Lake Abashiri, Abashiri (NSMT-Cr 27268); Aikappu, Akkeshi (NSMT-Cr 27032, 27033, 27034); Esashi-oyama (NSMT-Cr 27024, 27025, 27026)

Akita: Togahama, Oga (NSMT-Cr 27017)

Miyagi: Takashiro-hama, Onagawa (NSMT-Cr 27051, 27052, 27053)

Ibaraki: Hiraiso, Hitachinaka (NSMT-Cr 27310, 27311, 27312)

Ishikawa: Shinpo, Noto (NSMT-Cr 27011, 27012)

Fukui: Akasaki, Tsuruga (NSMT-Cr 27315); Saburi River, Ooi (NSMT-Cr 27335); Taka-hama, Ooi (NSMT-Cr 27003, 27004)

Chiba: Uchiura Bay, Amatsu-kominato (NSMT-Cr 27057, 27058, 27059)

Tokyo: Funemisaki, Torishima Is. (NSMT-Cr 27352, 27353); Minamijima Is., Ogasawara (NSMT-Cr 27217)

Kanagawa: Koajiro, Misaki (NSMT-Cr 27064, 27065, 27066)

Wakayama: Hatakejima Is., Tanabe Bay (NSMT-Cr 27284, 27285, 27286, 27296, 27297, 27298, 27303, 27304, 27305)

Tottori: Suetsune (NSMT-Cr 26995, 26996, 26997)

Ehime: Karakohama, Imabari (NSMT-Cr 27101, 27102)

Kochi: Urado, Higashi-minamiura (NSMT-Cr 27115, 27116)

Fukuoka: Tsuyazaki (NSMT-Cr 26979, 27980)

Kagoshima: Sesegushi (NSMT-Cr 26986, 26987, 26988): Akaogi, Amami-ohshima Is. (NSMT-Cr 27081, 27082, 27083)

Okinawa: Awase Port, Awase (NSMT-Cr 27138, 27139); Sonai, Iriomote Is. (NSMT-Cr 27144, 27145, 27146)

Demaorchestia joi sensu lato

Hokkaido: Lake Abashiri, Abashiri (NSMT-Cr 27269); Torikarasuhama, Oshima-ohshima (NSMT-Cr 27226)

Fukui: Akasaki, Tsuruga (NSMT-Cr 27314); Saburi River, Ooi (NSMT-Cr 27336)

Chiba: Daito Fisheries Port, Isumi (NSMT-Cr 27236, 27237)

Aichi: Kawajiri River, Wachi, Tahara (NSMT-Cr 27322, 27323)

Tottori: Suetsune (NSMT-Cr 26994)

Okayama: Bentenzaki, Tamano (NSMT-Cr 27092)

Ehime: Karakohama, Imabari (NSMT-Cr 27100); Shigenobu River, Matsuyama (NSMT-Cr 27265)

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