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A smaller species releases proportionally larger juveniles in *Apseudes* (Crustacea: Peracarida: Tanaidacea)

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Running titles. Juveniles in two *Apseudes* species

Abstract: We compared the body size (carapace width, CW) of the first free-living instar individuals, or mancae 2, and of the smallest ovigerous individuals, between two simultaneously hermaphroditic tanaidacean species, *Apseudes nipponicus* Shiino, 1937 and *Apseudes* sp. The former species is 2.2 times larger, with a CW of 2.61 mm in the smallest ovigerous individual, compared to 1.17 mm in the latter. Average CWs of manca 2 individuals were 0.51 mm (*A. nipponicus*; n = 3, 0.50–0.51 mm) and 0.38 mm (*Apseudes* sp.; n = 9, 0.38–0.39 mm), meaning that *A. nipponicus* mancae 2 were 20% as large as the smallest ovigerous individuals, whereas those of *Apseudes* sp. were 32% as large. The proportionally larger juveniles in the smaller species are consistent with the hypothesis that *Apseudes* sp. is progenetic, achieving earlier maturation as females.

Keywords: Apseudidae ● manca ● life history ● Malacostraca ● simultaneous hermaphrodite

Large size differences among congeneric species are common in Peracarida (Crustacea: Malacostraca), such as in the genera *Neognathophausia* in Lophogastrida (Pequegnat, 1965), *Bathynomus* in Isopoda (Lowry & Dempsey, 2006), and *Apseudes* in Tanaidacea. In *Apseudes*, *A. nipponicus* Shiino, 1937 is relatively large (Fig. 1A), with a body length (BL) of around 12 mm at first spawning; in contrast, *Apseudes* sp. sensu Kakui & Hiruta (2013) (hereafter "*Apseudes* sp.") is relatively small (Fig. 1C), with a BL of around 5 mm at first spawning (Kakui & Hiruta, 2023). Both species are simultaneous hermaphrodites (Kakui & Hiruta, 2013, 2023).

Upon finding that masculinization in chelipeds was slighter in *Apseudes* sp. (the smaller species) than in *A. nipponicus* (the larger species), Kakui & Hiruta (2023) suggested that *Apseudes* sp. might be progenetic, achieving earlier maturation as females by reducing resource allocation to male secondary traits and growth. This raised the further question whether the large size difference between the species is evident earlier in ontogeny.

To address this question, we compared the body size of manca-2 individuals between *A. nipponicus* and *Apseudes* sp. Manca 2 is the stage at which individuals are released from the female brood pouch (i.e., the first free-living instar stage), characterized by lacking pleopods and any traces of pereopod 6, and having pereonite 6 similar in size to a pleonite (Larsen, 2003). As a proxy for body size, we measured the carapace width (CW) of the manca 2 individuals, because accurate measurements of BL are difficult due to deformation or lateral curvature of the body. CW correlates well with BL, and the slope of the regression line between BL and CW is the same in the two species (Kakui & Hiruta, 2023). For *A. nipponicus*, three captive-bred mancae 2 were measured; these were descendants of individuals collected in 2015 from an experimental aquarium at the Shimoda Marine Research Center, University of Tsukuba (see Kakui et al., 2017) and had been fixed and preserved in 70% ethanol in 2015. For *Apseudes* sp., nine captive-bred mancae 2 were measured; these were descendants of individuals collected in 2009 and 2010 in the Port of Nagoya Public Aquarium,

Japan (see Kakui & Hiruta, 2013) and were fixed and preserved in 99% ethanol on 7 June 2023. For both species, we used data from Kakui & Hiruta (2023) on CW in postmanca developmental stages (OL, oostegite lacking; Pr, preparatory; Ovi, ovigerous).

Body size is larger in *A. nipponicus* than in *Apseudes* sp. at both the manca 2 and ovigerous stages, though the size difference is greater at the ovigerous stage. Average CWs for mancae 2 were 0.51 mm (0.50–0.51 mm, n = 3) for *A. nipponicus* and 0.38 mm (0.38–0.39 mm, n =9) for *Apseudes* sp. (Fig. 1E); the value in the former was thus about 1.3 times that in the latter. The CW of the smallest ovigerous individual was 2.61 mm in *A. nipponicus* and 1.17 mm in *Apseudes* sp. (Kakui & Hiruta, 2023); CW in the former was about 2.2 times that in the latter. The *A. nipponicus* manca 2 is 20% the size of the smallest ovigerous stage, whereas the *Apseudes* sp. manca 2 is 32%. Compared to *A. nipponicus*, *Apseudes* sp. releases relatively large mancae 2.

Relatively few studies have provided size data on both mancae 2 and the smallest ovigerous individuals for species in Apseudidae (e.g., Schmidt et al., 2002; Esquete et al., 2012; Kakui et al., 2019). We are unaware of any previous comparison of the size difference between the manca 2 stage and the smallest ovigerous individuals among congeneric apseudid species. Our observation of a smaller species releasing proportionally larger juveniles, however, should be treated with caution, as our data are limited and knowledge on reproduction and life cycles among apseudids remains insufficient. Many abiotic/biotic factors, such as temperature, age, intermolt lengths, or growth increment per molt, may affect the size of eggs or hatchlings and the length of the period from the juvenile to ovigerous states. In any case, producing relatively large mancae 2 is consistent with the hypothesis that *Apseudes* sp. is progenetic.

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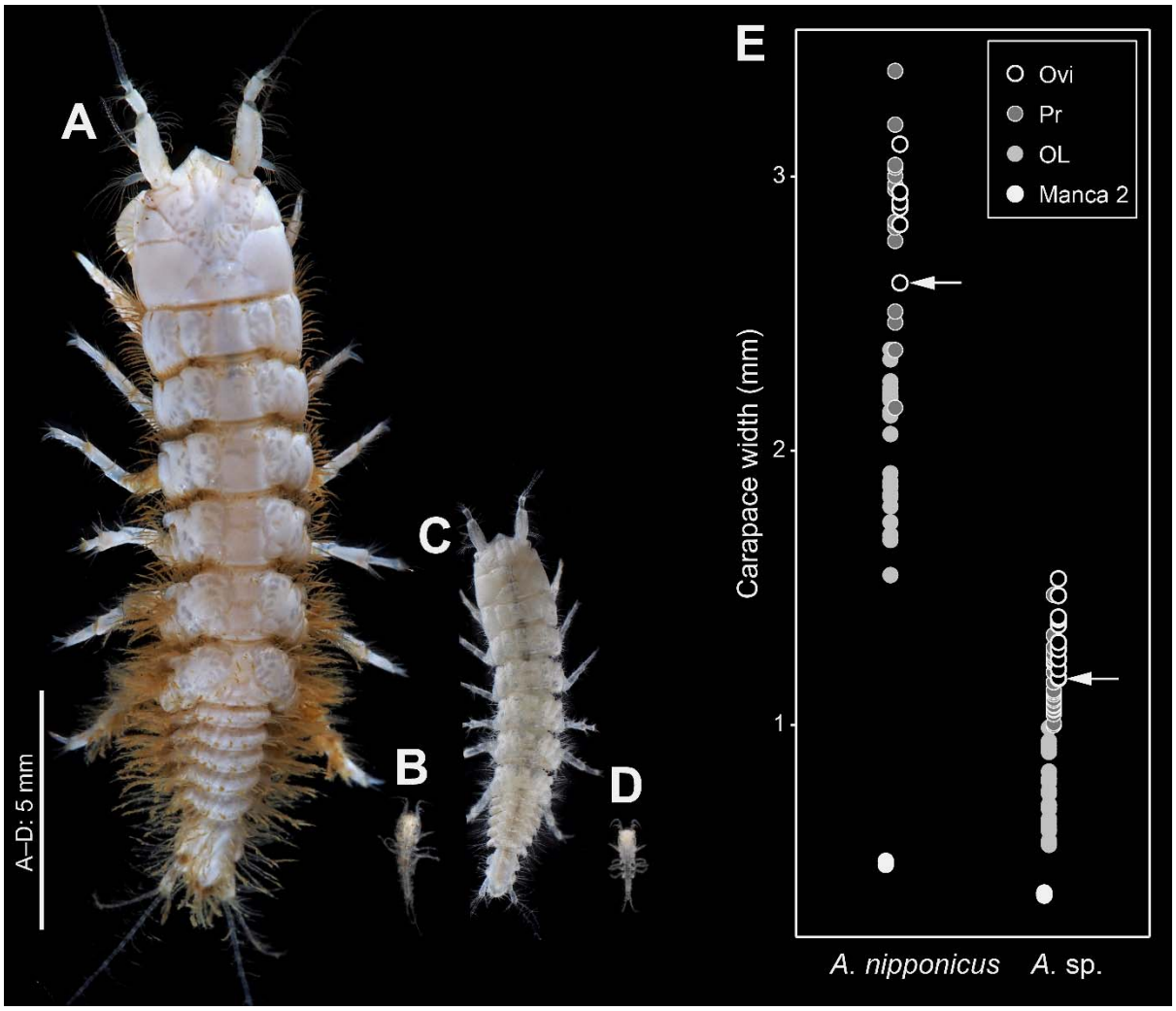

Captions for figures

Figure 1. Habitus and the relationship between carapace width and developmental stage in *Apseudes nipponicus* and *Apseudes* sp. **A, B.** *Apseudes nipponicus*, postmanca individual (CW = 3.38 mm) (A) and manca 2 (B). **C, D.** *Apseudes* sp., postmanca individual (CW = 1.52 mm) (C) and manca 2 (D). **E.** Relationship between carapace width and developmental stage in the two species. OL, oostegite lacking; Ovi, ovigerous; Pr, preparatory. Arrows, the smallest ovigerous individual observed for each species.