

A case of Intersexuality in the Sea Spider, *Cilunculus armatus* (Pycnogonida; Ammotheidae)

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ABSTRACT—An intersexual specimen of the sea spider, *Cilunculus armatus*, having female and male characteristics together with some intermediate ones was collected from Sagami Bay. Eggs are seen through the cuticle of each femoral segment of walking legs. At the same time, cement gland, peculiar to male, is also found on the same segment of each walking leg, but somewhat atrophied and distally shifted. Genital pore opening on the second coxal segment of each walking leg as seen in female is of intermediate size between the sizes of both sexes. Oviger is intermediate in size and shape, and the number and distributional pattern of ovigerous compound spines are also intermediate.

INTRODUCTION

A number of cases of the sexual abnormality, such as the gynandromorphism and the intersexuality, have been reported in arthropods, especially in insects [7], malacostracan crustaceans [3, 4] and spiders [12].

Pycnogonids are dioecious, except for a hermaphrodite species, *Ascorhynchus corderoi* [1]. No intersexuality has been described and gynandromorphs have been known only in the following four cases. Losina-Losinski [9] reported a bilateral gynandromorphic specimen of *Asc. abyssi* from the Greenland Sea. Child [5] examined various grades of gynandromorphism in *Anoplodactylus portus* from the Pacific entrance of the Panama Canal. Child and Nakamura [6] found a gynandromorph of *Ano. gestiens* from Sagami Bay, and described it with a few possible gynandromorphic specimens of *Ano. jonesi* (loc. undescribed).

In the present study, we describe for the first time an intersexual specimen of *Cilunculus armatus*, found among over 1500 specimens newly collected from Sagami Bay.

MATERIALS AND METHODS

A specimen of *Cilunculus armatus* (Böhm, 1879) with characters of both sexes was collected by dredge from the sandy bottom at about 40 m in depth off the coast of Shimoda, near the top of Izu Peninsula, Central Japan, 24 March 1990. After fixation with 70% ethanol, the specimen was examined under a stereomicroscope, compared with eight normal male and eight normal female specimens collected by the same dredging.

RESULTS

We newly collected 1535 specimens of *Cilunculus armatus*, and found only one specimen with characters of both sexes. We also reexamined other 1009 preserved specimens which had been collected from the same locality, but could not find any more.

Sexual characters

The present specimen has both ovarian eggs as a female character and cement gland as a male character in the femoral segment of each walking leg, other than the regenerating first right (1R) leg (Fig. 1). There are also some curiosities in several sexual characters of the present specimen especially on morphological features of cement gland, genital pore, oviger, and ovigerous compound

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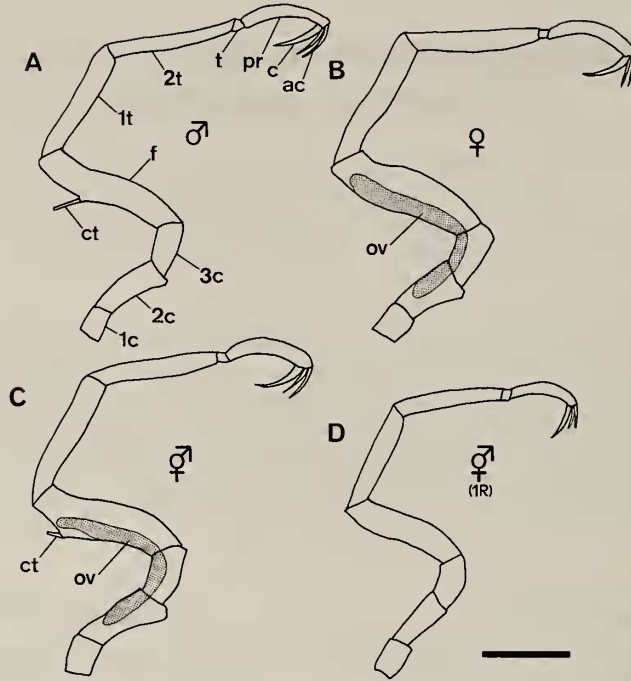


FIG. 1. Walking legs. Setae and spines are omitted. A, Normal male; B, Normal female; C, Intersexual specimen; D, 1R leg of intersexual specimen. ac, accessory claw; c, claw; ct, efferent tube of cement gland; f, femur; 1c, first coxa; 1t, first tibia; ov, ovary; pr, propodus; 2c, second coxa; 2t, second tibia; t, tarsus; 3c, third coxa. Bar=1.0 mm.

TABLE 1. Comparison of some sexual characteristics in an intersexual specimen with those in normal males and females +=present. -=absent

	Normal males	Intersexual specimen	Normal females
Oviger 6-8th segments	long hairy	intermediate a little hairy	short not hairy
6th seg.	swollen	intermediate	not swollen
Distribution of compound spines	0:2:1:2	3:2:1:2	3:3:1:2
Cement gland	+	+ (somewhat reduced)	-
Genital pore	3rd & 4th legs small (50×40 μm)	all legs (exc. regenerating 1R) intermediate (75×50 μm)	all legs large (120×100 μm)
Gonad			
Ovary	-	+	+
Testis	+	not visible	-

spine.

Cement gland was found in all the normal males examined and in the present specimen. In normal male, cement gland was well-developed in the

femoral segment of each walking leg, and its long external tube with an opening was protruded dorsally at distal one-third of this pedal segment (Fig. 2A). The present specimen had somewhat

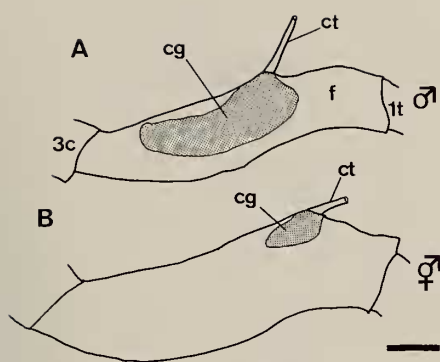


FIG. 2. Comparison of cement glands. A, Normal male; B, Intersexual specimen. cg, cement gland; ct, efferent tube of cement gland; f, femur; lt, first tibia; 3c, third coxa. Bar=0.25 mm.

atrophied cement gland with shorter tube bearing an opening in the femoral segment of each walking leg other than the 1R leg (Fig. 2B). The tube was shifted more distally than normal one (Fig. 2B).

Genital pore with single cuticular lid was situated on the ventral surface of the second coxae of

all the walking legs in female, and on the same position of the third and fourth walking legs in male. The female genital pore was larger than male one (Table 1, Fig. 3A, C). The present specimen had genital pore in all the walking legs other than the 1R leg, whose size was intermediate between that in male and female (Table 1, Fig. 3B).

Male oviger was larger than female one (Table 2, Fig. 4A, C), and its sixth segment was prominently stout and hairy (Fig. 5A). Oviger in the present specimen was mostly similar in shape and in size to the female one (Fig. 4B, C), but its sixth segment was more hairy than that in female (Fig. 5B). Several apical segments of the oviger had some compound spines (Fig. 5), arranged in different patterns between sexes: In each of normal males, the seventh ovigerous segment had no spines, the eighth two, the ninth one, and the tenth two (0:2:1:2) (Fig. 5A), while in each of normal females, these spines were arranged in 3:3:1:2 (Fig. 5C). In the present specimen, however, they were arranged in 3:2:1:2 (Fig. 5B).

TABLE 2. Comparison of lengths of external body parts in intersexual specimen with those in normal 8 males and 8 females. Mean \pm SE (Range). measured in mm

	Normal males	Intersexual specimen	Normal females
Proboscis	2.10 \pm 0.071 (1.89–2.42)	2.21	2.31 \pm 0.060 (2.11–2.63)
Trunk	2.67 \pm 0.112 (2.05–3.11)	2.71	2.80 \pm 0.092 (2.26–3.05)
Abdomen	1.13 \pm 0.061 (0.92–1.39)	1.18	1.15 \pm 0.041 (0.95–1.32)
Chelifore	0.44 \pm 0.011 (0.39–0.50)	0.47	0.43 \pm 0.016 (0.37–0.50)
Palp	2.35 \pm 0.075 (1.97–2.68)	2.82	2.59 \pm 0.093 (2.21–3.08)
Oviger	3.83 \pm 0.085 (3.45–4.13)	2.84	2.40 \pm 0.076 (2.13–2.82)
Lateral process	0.39 \pm 0.019 (0.32–0.47)	0.37	0.35 \pm 0.020 (0.26–0.45)
Leg			
1st coxa	0.46 \pm 0.023 (0.37–0.58)	0.45	0.38 \pm 0.019 (0.32–0.47)
2nd coxa	0.74 \pm 0.038 (0.58–0.92)	0.76	0.69 \pm 0.026 (0.58–0.79)
3rd coxa	0.53 \pm 0.025 (0.37–0.63)	0.68	0.64 \pm 0.023 (0.58–0.76)
femur	1.39 \pm 0.039 (1.27–1.53)	1.55	1.53 \pm 0.036 (1.37–1.68)
1st tibia	1.36 \pm 0.043 (1.18–1.50)	1.47	1.44 \pm 0.025 (1.34–1.53)
2nd tibia	1.29 \pm 0.054 (1.00–1.50)	1.45	1.47 \pm 0.024 (1.42–1.58)
tarsus	0.16 \pm 0.010 (0.13–0.21)	0.16	0.17 \pm 0.005 (0.16–0.18)
propodus	0.93 \pm 0.030 (0.79–1.08)	0.97	0.98 \pm 0.015 (0.95–1.05)
claw	0.60 \pm 0.019 (0.53–0.68)	0.58	0.62 \pm 0.021 (0.55–0.71)
accessory claw	0.34 \pm 0.013 (0.29–0.37)	0.26	0.33 \pm 0.015 (0.29–0.39)
Cement gland tube	0.35 \pm 0.015 (0.26–0.42)	0.18	—

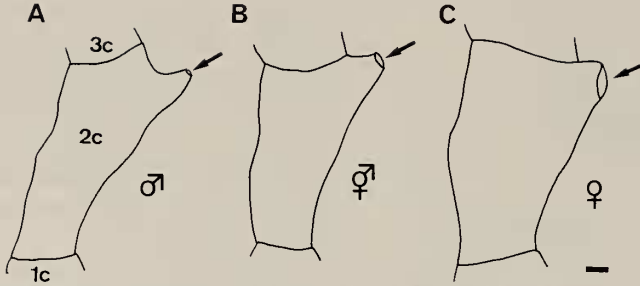


FIG. 3. Comparison of genital pores (arrows). A, Normal male; B, Intersexual specimen; C, Normal female. 1c, first coxa; 2c, second coxa; 3c, third coxa. Bar=0.1 mm.

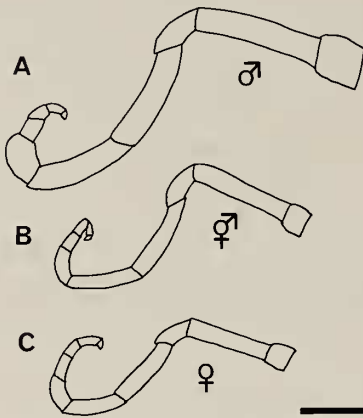


FIG. 4. Comparison of ovigers. Setae and compound spines are omitted. A, Normal male; B, Intersexual specimen; C, Normal female. Bar=0.5 mm.

Any male gonadal element could not be found by the present external observations.

Several sexual characters of the present specimen and normal males and females are summarized in Table 1.

Measurements of external body parts

In *Cilunculus armatus*, females were mostly larger than males (Table 2). Measurements of various parts of the present specimen lay mostly within the female range (Table 2). Normal female leg was stouter than normal male one (Fig. 1A, B). The leg of the present specimen was approximately similar in shape to the female leg (Fig. 1C).

Measurements of some external body parts of the present specimen and normal males and females are summarized in Table 2.

DISCUSSION

In the present specimen, we detected some male, female, and also intermediate characters. Existence of cement glands is a typical male character in *Cilunculus armatus* as in other pycnogonids, but in the present specimen, these glands are somewhat atrophied. The ovarian eggs and the genital pores situated on all the walking legs are female characters. Intermediate sexual characters are seen in size and shape of ovigers and genital pores, and, at the same time, in distributional patterns of ovigerous compound spines (see Table 1).

There are some descriptions incompatible with each other on the distributional pattern of these spines in *Cilunculus armatus*. Ortman [11] noticed compound spines on a probably female oviger; seventh and eighth segments with no spines, ninth with one, tenth with two (0:0:1:2). Loman [8] described the distributional pattern of the spines in both male and female ovigers as 1:2:1:2. Schimkewitsch [13] correctly illustrated female pattern as 3:3:1:2. Utinomi [14] described a female specimen with the 0:1:1:2 spines. Nakamura [10] recognized the difference in male and female patterns as 0:1:1:2, and 3:1:1:2, respectively.

In the present study, we determined correct numbers and distributional patterns of male and female ovigerous compound spines in *Cilunculus armatus*, and found an intermediate pattern in the present specimen.

Bacci [2] defined two main sexual abnormalities; the intersex as "an individual of unisexual species whose reproductive organs and (or) secondary sex characters are partly of one sex and partly of the

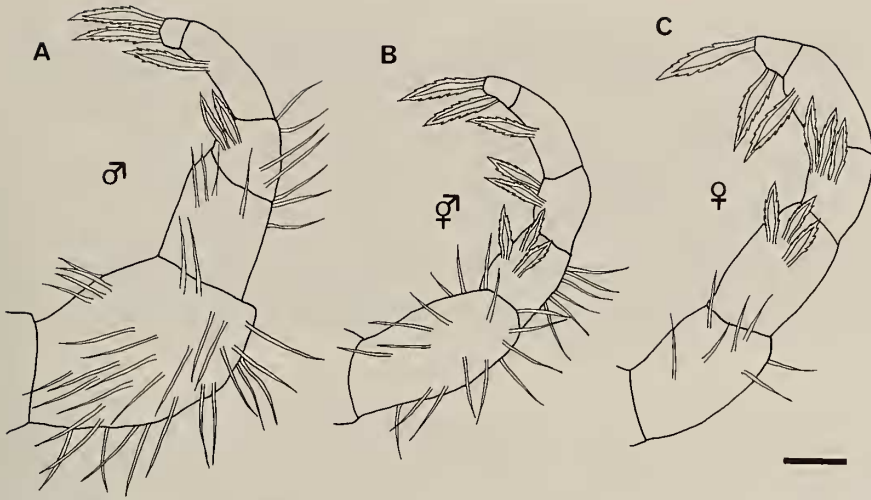


FIG. 5. Comparison of apical parts of ovigers. A, Normal male; B, Intersexual specimen; C, Normal female. Bar = 0.1 mm.

other although it does not show genetically different parts", and the gynandromorph as "an individual of a unisexual species containing a mosaic of genetically male and genetically female cells". According to Bacci's [2] definition, we diagnose the present specimen as an intersexual one.

Child and Nakamura [6] reported a gynandromorphic specimen in other pycnogonid, *Anoplodactylus gestiens*. The specimen had many female characteristics and a few male ones. Existence of the cement gland and the oviger is peculiar to males in *Anoplodactylus* species, but the gynandromorphic specimen has an atrophied cement gland only in the femoral segment of the fourth left leg and the ovigers, the left one being slightly deformed. The gynandromorphic specimen of *Ano. gestiens* has some close resemblances with the present intersexual specimen of *Cilunculus armatus*.

As the intact preservation of the present intersexual specimen is needed, histological, karyological and biochemical details were left untouched.

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