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A GYNANDROMORPH OF THE JAPANESE PYCNOGONID *ANOPLODACTYLUS GESTIENS* (ORTMANN)

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Abstract.—A single sexual mosaic or gynandromorph specimen was found among a very large series of the Japanese pycnogonid *Anoplodactylus gestiens* (Ortmann). The rarity and morphology of the specimen are examined and described, and its relationship with other arthropod and pycnogonid gynandromorphs is discussed.

Pycnogonids are normally dioecious and sexually dimorphic with testes or ovaries situated in each leg. In the few instances where sexual habits have been observed, the male accepts eggs released from the female's sexual pores, fertilizes them externally, cements the eggs together by use of femoral cement glands, and carries the eggs cemented to his ovigers until after hatching. The sexual habits, as far as we have been able to discover in the literature, are unknown for many genera, including those few species having parasitic or commensal larvae and young not carried by the male. It is therefore significant to discover a single apparent gynandromorph specimen among a very large sample of the pycnogonid *Anoplodactylus gestiens* (Ortmann, 1891), collected in Sagami Bay, Japan.

The occurrence of hermaphrodites and gynandromorphs among the Pycnogonida is extremely rare according to the literature. There are only three examples of these abnormalities on record. The first two references (to one hermaphroditic species and a gynandromorphic specimen of another species) are reviewed by Child (1978:134), and the third example, a gynandromorph series, is discussed in the same paper (Child 1978:135–141, figs. 1–4). Such abnormalities are apparently equally rare in other marine arthropods and there is only a very limited literature on the subject (Chace and Moore 1959:226–231, figs. 1–4; Froglia and Manning 1978:700, fig. 5; Manning and Holthuis 1981:62, fig. 14). The majority of papers concern bilateral gynandromorphs where half the animal has male characters including obvious coloration, and the other half has female characters with female coloration. It is to be assumed that where coloration is not a factor and where micro- or semimicroorganisms are concerned, a small number of hermaphrodites or gynandromorphs would pass unobserved, particularly when examining a large series of these organisms. It was therefore rewarding when one of us (Nakamura) discovered a single abnormal specimen while determining the sex of a series of 598 specimens of *Anoplodactylus gestiens* (Ortmann).

This pycnogonid is a fairly commonly captured endemic in the shallow waters of Japan and is listed in most taxonomic reports concerning Japanese collections. The collection in which this single gynandromorph was found was taken in a depth of 113 meters during a dredging-trawling survey by the R/V *Tansel Maru* of the Ocean Research Institute of the University of Tokyo, while sampling for certain common pycnogonids to be used in seasonal fluctuation studies of both numbers and sex frequency over a 28 month period (Nakamura and Sekiguchi, in press).

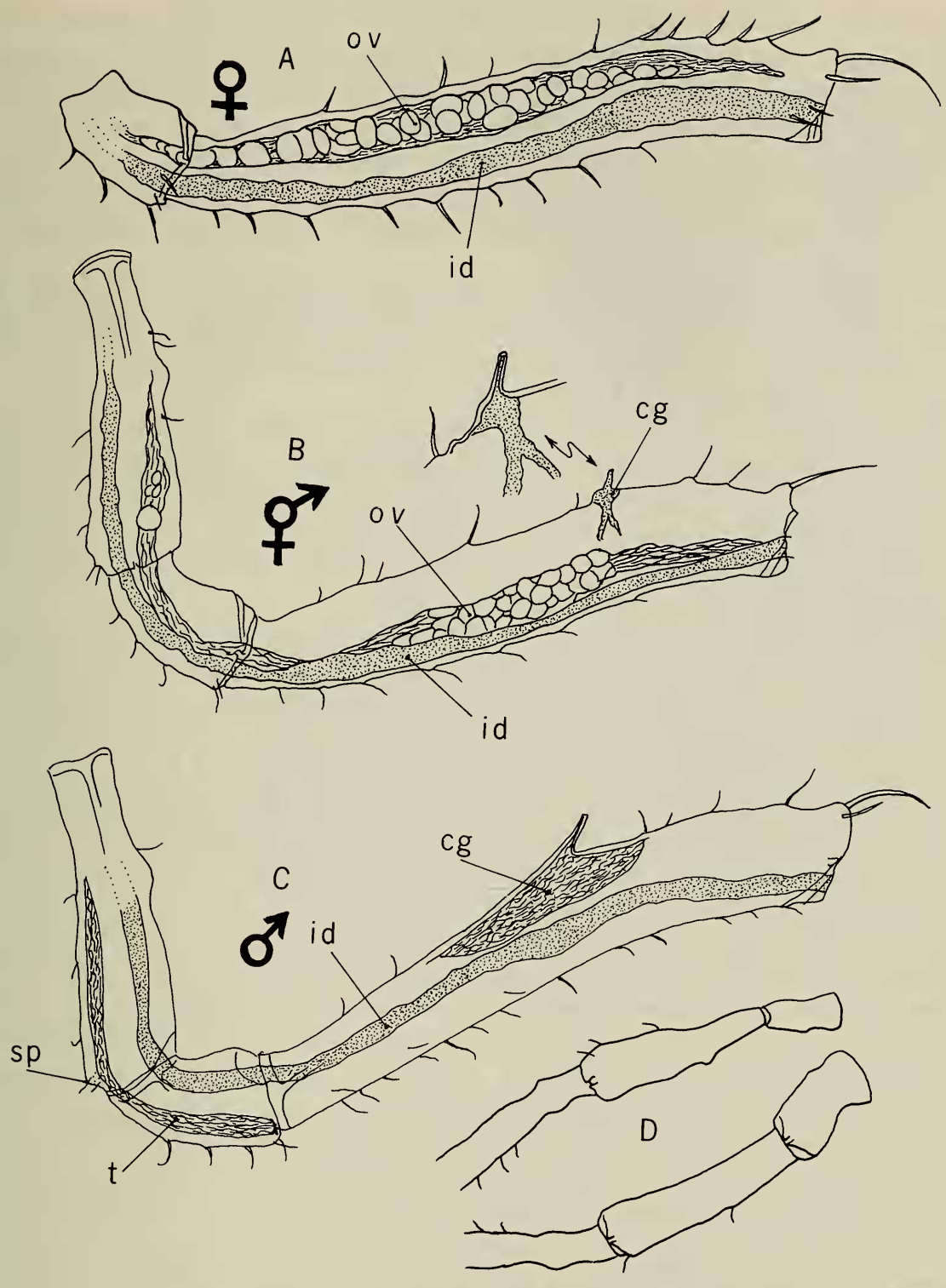

Fig. 1. *Anoplodactylus gestiens,* gynandromorph appendages: A, Normal female leg with ova; B, Leg L 4 of gynandromorph with enlargement of cement gland; C, Normal male leg; D, Proximal segments of gynandromorph ovigers, left at top, right at bottom. Abbreviations: ov, ovary with ova; id, intestinal diverticulum; cg, cement gland and tube; t, testes; sp, sexual pore.

Description of the Specimen

This specimen has characters of both male and female pycnogonids of the genus *Anoplodactylus*. Normally, gut diverticula extend out through most segments of each leg of a pycnogonid. The ovaries of the female lie dorsally to these diverticula and are usually confined to the first four segments of each leg (Fig. 1A). In

the male, the testes lie ventrally to the diverticula and are usually confined to the three coxae or the second and third coxae only (Fig. 1C). Testes are normally found in the posterior four legs or the posterior pair of legs only. Both sexes have sexual discharge pores placed ventrally on the second coxae; the female's on all eight legs and the male's corresponding to the occurrence of testes in the posterior legs. Normally only males of this genus have ovigers, the egg-carrying appendages to which the extruded eggs are cemented (except for a few enigmatic females of *Anoplodactylus jonesi* Child, 1974).

This apparent gynandromorph has ovigers like the male but with the left one slightly deformed (Fig. 1D), has female ovaries distended with ova in all eight legs, has sex pores on all eight legs, and has a femoral cement gland present but reduced or atrophied on leg L 4 (Fig. 1B).

Each set of coxae was carefully examined for the presence of testes, but aside from the darker opaque tubes of the gut diverticula and ovaries, none of the eight legs have any matter resembling a testes in the coxae. Unlike the hermaphrodite species (of a different genus) found by Marcus (1952), this specimen is apparently incapable of self-fertilization and thus is more properly termed a sexual mosaic or gynandromorph rather than an hermaphrodite.

The right oviger is normal to all appearances, but the left is slightly shorter with the two proximal segments reduced in diameter. The second segment tapers proximally and is expanded distally, forming a club-like shape. The normal cement gland in *Anoplodactylus gestiens* is an oblong opaque sac placed mid-dorsally in the femur and extending outside the integument in the form of a slanted tube as long as one-third the diameter of the segment. The cement gland present on leg L 4, the single leg out of eight with the gland in this specimen, is a tiny tube expanded at its base, and measures in length less than one-fourth the femur diameter. The gland within the segment has the shape of a small dark bifurcated tube. The space which would normally be taken up by a full-sized gland is lighter colored than the surrounding tissues as though the space were empty. The smaller cement gland is placed more toward the distal end of the femur than the normal mid-dorsal placement in the male leg. The seven other legs have no suggestion of cement glands and are apparently normal in all respects for an ovigerous female. All eight legs have normal sexual discharge pores on the second coxae.

There are other differences between this specimen and our series of *Anoplodactylus gestiens* specimens. These differences in the gynandromorph appear to fall within the range of non-sexual variation in the species. This is verified, except for a difference in specimen size, by the large series in hand. The ocular tubercle is shorter in the gynandromorph, but this tubercle varies in length through the series. The propodal lamina is slightly longer than usual in this specimen and corresponds to Stock's (1954:69) figure 31a of a propodus from a young female of the species. Some of the female lamina are shorter than this in our series of specimens.

The single major difference in the gynandromorph specimen is its reduced size. It measures only about three-fourths the size of a normal male of the species, and in pycnogonids the male is almost always smaller than the female. This could be attributed to the mosaic characters of the specimen, but with other sexual mosaic pycnogonids (Child 1978), little or no difference in size was found between normal and abnormal specimens.

Discussion

This single gynandromorph among 598 specimens of the same *Anoplodactylus* species affords no hint of the cause or origin of this abnormality in the population as sampled. Records were not made at the time of capture concerning associated fauna or bottom conditions, but the depth of 113 meters at which the sample was taken would preclude the influence of wave action, ship's wake, or other surface phenomena as a disturbance in the embryonic determination of sexual characters. On the other hand, it is entirely possible that this specimen developed in a different habitat and depth and only reached the sampling depth as an adult.

The fact that this isolated abnormality is not unique among the pycnogonids is of some interest. Gynandromorphy has been discovered among species of the genera *Anoplodactylus* and *Ascorhynchus*. *Anoplodactylus gestiens* is the second species of this genus in which gynandromorphs are known, the other being *A. portus* Calman, 1927 (Child 1978). The littoral gynandromorphs of *A. portus* were possibly caused by agitation of the eggs during the time of early embryonic determination and development by fast ships' propellers. This could account for the random nature of visible abnormalities rather than a bilateral appearance of the resulting gynandromorphs. A random gynandromorph pycnogonid has one leg with male characters, the next with female characters, the next with both male and female characters, and the next with only female characters, and so on, with no apparent pattern. This gynandromorph of *A. gestiens* has only one random character, that of the reduced cement gland on the left fourth leg. All of the legs have developing eggs and seven of the eight legs are normal female legs in appearance, while the specimen has fully developed male ovigers with the left oviger slightly deformed. There is no randomness in these last characters even though the presence of both ovigers and ovaries in a single specimen is contrary to the definition of this genus. The fact that both the reduced cement gland and the malformed oviger occur on the left side of the specimen may be due to coincidence or it may signify a form of bilateral mosaic, but there is no further evidence to support bilateralism.

The two species with abnormalities in the genus *Ascorhynchus* are *A. abyssi* Sars, 1877, and *A. corderoi* du Bois-Reymond Marcus, 1952. Losina-Losinsky (1964) described but did not figure an apparent bilateral of *A. abyssi* having male legs on one side and female legs with eggs on the other. Marcus, in describing her new species *A. corderoi,* listed several specimens with both testes and ovaries in the same legs, making this the only true hermaphrodite species known.

There is one other species of *Anoplodactylus, A. jonesi,* in which a few specimens out of all of those known, while not apparently gynandromorphs, have female legs lacking cement glands while at the same time having male ovigers. Based on our knowledge of the genus, there is as little explanation for this sexual combination as there is for the gynandromorph in *A. gestiens*. Perhaps it will be necessary to redefine the genus based on this occasional presence of otherwise absent characters for a few of the known species.

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