Redescription of the male copulatory organ of *Pisione crassa* YAMANISHI, 1976
(Annelida: Polychaeta: Pisionidae)

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スナゴカイ*Pisione crassa* YAMANISHI, 1976 の雄性交尾器官の再記載
（環形動物：多毛綱：ピシオネ科）

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抄録：日本の温帯海域の砂礫浜にふつうにみられる砂粒間陸生の多毛類 *Pisione crassa* の雄の交尾器官を、走査型電子顕微鏡 (SEM) を用いて観察した。また、生体についても生物顕微鏡を用いて観察した。ピシオネ科においてみられる交尾器官の形態は、きわめて複雑なことで知られておりが、SEM による観察報告はこれが最初である。その結果、本種の原記載においては見落とされていた、交尾器官本体が2本に分かれ螺旋形に巻いている点、交尾器官の先端を取り囲む鞘状のアーチ、その反対側にある三角形の耳たぶ状の構造、螺旋部の前方に起立するクチクラ質の膜、および後部の上向きの突起といった付属器官の存在が明らかになった。本種の完模式標本を生物顕微鏡によって再吟味した結果、上記の交尾器官本体の構造、および付属器官としてのアーチとクチクラ質の膜を確認することができた。

Abstract: The male copulatory organ of an interstitial polychaete *Pisione crassa*, a common inhabitant of marine sandy or gravelly beach in the temperate region of Japan, is examined by using a scanning electron microscope (SEM). A live material is additionally observed under a transmitted light microscope to survey its internal structure. This is the first record of SEM observation on the copulatory organ of the family Pisionidae whose structure has been known to be markedly complicated. The results have revealed the double-stemmed and spiral structure of the copulatory organ proper and the existence of such appendages as a sheath-like arc surrounding the end of copulatory organ, a triangular flap at the opposite side of the former, a cuticular membrane erecting anteriorly to the spiral part, and a posterior upward process all of which were overlooked in the original description. A reexamination of the holotype has confirmed the above-mentioned structure of the copulatory organ proper together with the existence of the arc and the cuticular membrane as appendages.

Key words: *Pisione crassa*; Polychaeta; copulatory organ; Japan; SEM observation.

*Pisione crassa* was discovered from the west coast of the Kii Peninsula and described as a new species by the present author (YAMANISHI, 1976). It is a minute, common inhabitant of sandy or gravelly marine beaches in the temperate region of Japan.

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Most species of the family are interstitial forms and are known to carry out true copulation (SCHROEDER and HERMANS, 1975) in their habitats to ensure fertilization. They have markedly complicated male copulatory organs on some body segments. Its structure is of high taxonomic value.

Of the seventeen known species of the genus *Pisione*, the copulatory organs have been described for thirteen species. In many species including *P. crassa*, however, their complicated three-dimensional structures have not been made clear in detail on account of the difficulties in the observation under light microscopic condition.

In the present study, the author examined the male copulatory organ of *P. crassa* by using a scanning electron microscope (SEM), which successfully revealed the exact feature of the organ, obviously far more complicated than that drawn in the original description. An additional observation was carried out on a live material. The holotype was also reexamined to confirm the results. Now the insufficient and erroneous description in the original paper (YAMANISHI, 1976: p.375, Fig.2-a) must be corrected.

Before going farther, the author wishes to express his sincere thanks to Prof. Eiji HARADA of the Seto Marine Biological Laboratory, Kyoto University, for facilitating the examination of the type material. Thanks are also due to Mr. Takayoshi NASU of the Osaka Museum of Natural History who kindly instructed him in handling the SEM.

MATERIALS AND METHODS

SEM material, having been preserved in 70% ethanol, was transferred into iso-Amyl Acetate after dehydrogenation, then dried in a critical point dryer and coated with Pt-Pd using an ion sputter.

A live material and the holotype was examined under transmitted light microscopes partly with aids of a DLL-type phase contrast equipment.

*SEM material:*

1. Mature male of 14mm long with 100 setigers. Copulatory organs from 53th to 64th setiger. Collected from Sumoto, Awaji Is., Hyogo Prefecture, the Inland Sea of Japan, on May 8, 1985 by the author; deposited in the Osaka Museum of Natural History (Lv 1224).

2. Mature male of 26mm long with 89 setigers. Copulatory organs from 57th to 64th setiger. Collected from Kirime, Inami-cho, Wakayama Prefecture, west coast of the Kii Peninsula, neighboring beach of the type locality, on April 27, 1990 by the author; deposited in the Osaka Museum of Natural History (Lv 1225).

*Live material:* Mature male of 14mm long with 67 setigers. Copulatory organs from 45th to 52th setiger. Collected from the Senri Beach (type locality), Minabe-cho, Wakayama Prefecture, west coast of the Kii Peninsula, on May 7, 1990 by the author. The material, bitterly damaged during observation, is not preserved.

*Holotype:* Mature male of 21mm long with 85 setigers. Copulatory organs from 58th to 63th setiger. Collected from the Senri Beach, on January 31, 1975 collected by the author; deposited in the Seto Marine Biological Laboratory (SMBL-Type 272).
BASIC ARRANGEMENT

On fertile segments of the mature male of *Pisione crassa*, the copulatory organ proper arises from the ventral side of the base of the main parapodial lobe, the position of the nephridial pore, and extends laterally as a large, paddle-like structure (Pl.1, figs.1,2; Pl.2, fig. 1) provided with many appendages. It is purely a secondary structure. The efferent duct of the sperm-sac enters into the copulatory organ and passes through it, opening at its end (Pl. 3, figs.1,2). Basally, the copulatory organ is divided into double stems, superior stem (SS) and inferior stem (IS), keeping connection by a thin membrane with each other (Pl.1, fig.2; Pl.2, fig.2). The sperm duct is carried in the superior stem. The end of the inferior stem is bilobed as if to support the former (Pl.1, figs.3,4; Pl.2, figs.4,5). The superior stem turns upwards and rotates anteriorly to form a spiral (SR) near its end (Pl.1, figs.1,5; Pl.2, figs.1,3; Pl.3, fig.2). Its end (E) is strengthened as a cuticular process, terminally bifid with the longer tip slightly recurved (Pl.1, figs.3,5; Pl.2, figs.3,4,5,6).

The ventral cirrus (V), a minute cirrophore on sterile segments, also develops as a stout, finger-like process on these segments, provided with stiff, short hairs (Pl.1, fig.2; Pl.2, fig.2). It arises from the ventral side of the main parapodial lobe and projects laterally in front of the copulatory organ of the same segment.

The rest of the parapodial elements, that is, the main parapodial lobe (PL) with bundle of setae (Pl.1, figs.1,2; Pl.2, figs.1,2), and the dorsal cirrus (D)(Pl.1, fig.1) remains unmodified.

APPENDAGES OF THE COPULATORY ORGAN

The antero-lateral, basal spot of the spiral part of the copulatory organ gives rise to a small, sheath-like arc (A) surrounding the cuticular end of the organ from above (Pl.1, figs. 3,4,5; Pl.2, figs.3,4,5).

On the posterior side of the spiral part, opposite to the arc, develops a minute, triangular flap (F) which projects laterally (Pl.1, figs.4,5; Pl.2, figs.1,4,5).

Anterior to the spiral region erects from the superior stem a broad, cuticular membrane (M) whose top swells as a spherical structure often bent anteriorly (Pl.1, figs.3,5,6; Pl.2, figs. 5,6). The lateral edge of the membrane is ornamented with numerous, more than ten transverse wrinkles (Pl.1, fig.3; Pl.2, figs.5,6).

The ventral margin of the inferior stem folds posteriorly with a minute upward process (PR)(Pl.2, fig.2).

REEXAMINATION OF THE HOLOTYPE

The disposition of the copulatory organ proper and other parapodial elements has already been clarified in the original description; however, the intricate structure of the copulatory organ together with its appendages was overlooked. As the results of the reexamination of the holotype, the double-stemmed, spiral structure of the copulatory organ proper (Pl.3, fig. 4) and the existence of such appendages as the sheath-like arc (Pl.3, fig.5) and the cuticular membrane with spherical structure and transverse wrinkles (Pl.3, fig.6) were confirmed.
REMARKS

The function of these appendages has not been clarified though presumed to serve as aids in copulation.

The feature that the main parapodial lobe with the complete bundle of setae on copulatory segment remains unmodified is common to such species as *Pisione remota*, *P. pusae* and probably *P. africana* (TENERELLI, 1965; STECHER, 1968; HARTMANN-SCHRÖDER, 1970). In the former two species, the copulatory organ also curves spirally near its end. However, the double-stemmed structure and the appendages mentioned above are quite unique to the present species.

LITERATURE


Explanation of Plate 1

1 - 6: SEM photos of the male copulatory organ of *Pisione crassa* YAMANISHI (*SEM material* 1).

1: Left side of the row of copulatory organs. Postero-dorsal view.
2: Left side of 9-11th copulatory segments. Same view.
3: Left side of 10th copulatory segment. Same view.
4: Left side of 13th copulatory segment. Same view.
5: Left side of 7th copulatory segment. Antero-dorsal view.
6: Left side of 3rd copulatory segment. Same view.