

Diplogonoporus fukuokaensis sp. nov. (Cestoda : Diphylobothriidae) from a girl in Japan

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Introduction

Cestodes of the genus *Diplogonoporus* are usually known to occur in cetaceans and pinnipeds with a few exceptions (dog, domestic mink and sea otter). *Diplogonoporus grandis* of these has been considered to be exclusively a parasite of man in Japan. The cases have been reported on 25 occasions during the period 1894-1957 (Morishita, 1962) and on further 25 occasions during the period 1960-1969 (Kamo, 1969), mostly in coastal populations West of Tokyo. The course of infection to man, however, is involved in mystery as yet, although several marine fishes have been suspected as the source by many authors. Moreover whether a single species is solely responsible for all these human cases or not, and whether *D. grandis* from man is conspecific to *D. balaenopterae* from whales or not, are the matters of primary concern from the taxonomic or epidemiological point of view.

During the course of reexamining some materials of *D. grandis* reported so far, the authors recognized a specimen apparently distinguishable from the standard form of *D. grandis*. The specimen formerly recorded as the 23rd case in Japan by Miyazaki (1954) is described here as a distinct new species of *Diplogonoporus*, which appears to be the first report of human infection with *Diplogonoporus* species other than *D. grandis* (Blanchard, 1894).

Report of the Case

The patient, M. T. was a 17-year-old high-school girl in Tamano City, Okayama Prefecture. She used to spend her school vacation at Fukuoka City or Nagasaki City, near the district where several cases of human diplogonoporiasis have been known to occur.

On some day in the spring of 1953 she noticed a white tapeworm (about 500 mm long by 10 mm wide) in the stool, and the similar worms were found on about four occasions until the summer of the year.

She was admitted to the hospital (The First Department of Internal Medicine, Faculty of Medicine, Kyushu University, Fukuoka) on 29th March, 1954, with the main complaint of slight general fatigue.

Physical examination revealed no abnormality. Roentgenograms of the chest were normal. The hemoglobin concentration was 78% (Sahli); erythrocyte count 360×10^4 ; leukocyte count 8,000, with neutrophils 55.2, eosinophils 2.4, basophils 0, lymphocytes 34.4, monocytes 8.0%. Examination of the feces revealed no occlusions blood, but an egg of the diphylobothriides was found.

On 30th March, she was given each 15 g of magnesium sulfate on two occasions at 6 p.m. and 10 p.m. with succeeding catharsis at 12 p.m. On 31st March she was treated with "kamala" (7.0 g) at 8.30 a.m., with magnesium sulfate (30 g) at 11 a.m., having a light lunch at noon, coming evacuation on two occasions, containing a complete

strobila with scolex on each occasion (2,380 mm long \times 10 mm wide; 4,130 mm long \times 15 mm wide). The former was recognized as *Diphyllobothrium latum*, and the latter was identified as *Diplogonoporus grandis* by Miyazaki (1954). She has never eaten raw fish such as salmon, trout, and cod, except for red trout, salted salmon and perhaps sardine.

Description of the Worm

Material examined:

The specimen from a 17-year-old girl designated provisionally *D. grandis* by Miyazaki (1954) was well relaxed. One almost complete strobila preserved in 10% formalin and two prepared slides bearing short series of segments at posterior end of strobila are both in excellent condition.

Certain portions of the preserved strobila were additionally chosen to be embedded by the paraffin method, serially sectioned at different levels transversely, sagittally, and horizontally at 10 to 15 μ , and stained in trichrome stain.

Diplogonoporus fukuokaensis sp. nov.

Diagnosis—Strobila rather delicate, without anterior attenuation, segmental margins parallel, with slight serration; dorsal and ventral surface without longitudinal grooves. Body length 3,815 mm (well relaxed strobila), with as many as 1,300 segments; maximum width, attained in posterior portion of strobila, 10 mm. All segments somewhat wider than long and as much as 0.8 mm thick; gravid segments from about 4 to 6 mm long by about 7 to 10 mm wide, with length/width ratios from 1:1.9 near middle of strobila to 1:1.7 near posterior end. Scolex oval, measuring about 1.3 mm long by 0.98 mm wide in ventral view; bothria slittlike, extending full length of scolex. Neck well developed, as much as 9 mm long by 1 mm wide. Segmental multiplication by means of transverse sub-division of primary segment not observed throughout strobila.

Genital *Anlagen* visible somewhere 80 mm posterior to scolex, in segments 2 mm wide. Genital organs arranged predominantly in double sets, exceptionally 3 sets in only a few segments, whereas single set occasionally seen in the ratio of about 70 to the first hundred segments, 30 to the second hundreds, 10 to the third and downwards, 25 to the posterior hundreds, and 20 to the posteriormost hundreds, respectively. Common genital atrium at some distance from anterior margin of segment, usually about one-third of segment length, and separated by very short distance equal to about one-tenth to one-twentieth of segmental width.

Cirrus sac thin-walled, pyriform, measuring about 600 by 360 μ , and extends dorso-anteriad through more than one-half of segment from opening in anterior floor of genital atrium. Seminal vesicle elongated, measuring about 310 by 160 μ , with walls of 5.0–16.2 μ thick, and situated slightly posterior to proximal end of cirrus sac. Subspherical testes compressed dorsoventrally, measuring 100 to 170 μ in greatest diameter, disposed in sheet in central portion of parenchyma excepting areas occupied by uteri and genital pores, confluent anterior to genital pores. In transverse sections at level of genital pores up to 40 testes, arranged in single layer, visible lateral to each genital pore; only a few visible in middle field; and in sagittal sections up to 29 testes to be seen.

Mass bundles of longitudinal muscle fibers pass through the body center—between the double sets of genital organs—like as a center axis. Inner layer of longitudinal muscle fibers as much as 40–80 μ , bordering the transverse muscles with 30–70 μ thick, composed of fibers collected into rather distinct bundles.

Vagina ventral and superficial, meandering dorso-ventrally near midline and opens in posterior floor of genital atrium. Each ovary situated ventrally at posterior margin of segment, consisting of elongate bilateral lobes with reticulate structure; medial lobes in contact, pushing back each other; lateral

lobes arched anterolaterad at midline. Vitelline follicles somewhat spherical and not very densely arranged, leaving a free zone around the uterus and the cirrus, overlapping lateral portions of ovarian lobes and ends of uterine loops, and usually confluent anteriorly both dorsally and ventrally. Individual vitelline follicles measure about 50 to 100 μ in greatest diameter.

Two uteri of a segment in contact with one another; anterior portion of each uterus form on each lateral side 4 to 5 loops, but indistinct on each median side. No distinct uterine loops observed when it becomes filled with eggs, and more strongly expanded in second to fourth loops than in anterior-most one, which usually runs anterior to level of genital pore. Uterine pore situated about 0.5 mm posterior from genital pore. Operculate eggs, measure 62.1 to 75.6 μ by 43.2 to 48.6 μ (av. 67.23 \times 45.63 μ) with thin shell (0.81 to 1.62 μ), slightly asymmetrical ovoid bearing apical knob.

Longitudinal nerve cords not so prominent but visible. Main excretory canals in medullary parenchyma not detected in gravid segments, but numerous ducts in cortical region.

Host...M.T., 17-year-old, highschool girl

Habitat...Digestive tract

Type locality...Fukuoka City, Kyushu, Japan

Type...Mounted and unmounted portions of strobila have been deposited in Department of Parasitology, Faculty of Medicine, Kyushu University, Fukuoka, Japan. No. DH 5423

Discussion

Cestodes of the genus *Diplogonoporus* form a highly specialized group consisting of a few members, though the taxonomic status of those assigned to the genus to be in the uncertainty and complexity.

Diplogonoporus balaenopterae Lönnberg, 1892 occurs in the sei whale, *Balaenoptera borealis* from the Arctic (Norway) (Lönnberg, 1892; Baer, 1932), the northern Pacific

(Japan) (Yamaguti, 1942), the northern Atlantic (South Georgia) (Markowski, 1955) and the Antarctic (Kamo *et al.*, 1966; Hirai *et al.*, 1970); in the minke whale, *Balaenoptera acutorostrata* from the Japan Sea (Iwata, 1940) and the northern Pacific (Japan) (Kamo *et al.*, 1967); in the fin whale, *Balaenoptera physalus* from the northern Pacific (Deliamure, 1955) and the northern Atlantic (South Georgia) (Markowski, 1955); in the blue whale, *Balaenoptera musculus* from the northern Atlantic (South Georgia) (Markowski, 1955) and the Antarctic (Hatano *et al.*, 1957); in the humpback whale, *Megaptera novaeangliae* from the northern Pacific (California) (Rausch, 1964); and in the domestic dog from Alaska (Rausch, 1964).

Diplogonoporus tetraapterus (von Siebold, 1848) occurs in harbor seal, *Phoca vitulina* (locality not given) (Markowski, 1952—von Siebold's type material); in the steller sea lion, *Eumetopias jubata* from the northern Pacific (Canada; Bering Sea) (Margolis, 1956; Rausch, 1964); in the sea otter, *Enhydra lutris* from the Pacific (Rausch, 1964); in the domestic mink, *Mustela vison* from Alaska (Rausch, 1964); in the fur seal, *Callorhinus ursinus* from Alaska (Rausch, 1964); in the harp seal, *Pagophilus groenlandicus* and the hooded seal, *Cystophora cristata* from the Arctic (Greenland) (Deliamure, 1966).

Diplogonoporus variabilis (Krabbe, 1865) is found from the bearded seal, *Erygnathus barbatus* in Iceland (Krabbe, 1865).

Diplogonoporus fasciatus (Krabbe, 1865) occurs in the ringed seal, *Pusa hispida* in the Arctic (Denmark) (Krabbe, 1865).

Diplogonoporus septentrionalis Cholodkovsky, 1915 is found from a seal, *Phoca* sp. in the Arctic (Siberia) (Cholodkovsky, 1915).

Diplogonoporus mutabilis Belopolskaia, 1960 is found from the harbor seal, *Phoca vitulina* in the northern Pacific (Japan) (Belopolskaia, 1960).

Diplogonoporus grandis (Blanchard, 1894) is found from man in Japan.

Some essentially diplogonadic cestodes in Alaska called by Wardle *et al.* (1947) as "type 3", by Stunkard (1948) as "Species No. 3" both from the fur seal, *Callorhinus ursinus*; by Stunkard (1948) as "Species No. 4" from the steller sea lion, *Eumetopias jubata* belong apparently to the genus.

The validity of some of these taxa seems to be uncertain, and our present knowledge cannot render any final decision until further information concerning their life cycles becomes available. Nevertheless, they may fall into at least two groups on the basis of some morphological criteria adopted to the mature strobila by Markowski (1952) or Rausch (1954).

The first group, "balaenopterae-type", possesses larger strobila (up to 10,000 mm long by 30 mm or more wide), the scolex with broader, deeply-folded margins of bothria, more variable numbers of additional sets of genital organs, and well developed inner layer of longitudinal muscles with fine, dense arrangement of muscle bundles. Usually associated with Cetaceans, especially Balaenopteridae. *D. balaenopterae* and *D. grandis* are included in this group.

The second group, "tetraapterus-type", has smaller strobila, up to 1,080 mm long (usually 600 mm or less) by up to 10 mm wide (usually 5.5 mm or less), the scolex with shallower, little-folded margins of bothria, smaller numbers of additional sets of genital organs, and rather weakly developed inner layer of longitudinal muscles with distinctly collected bundles of muscle fibres. Usually associated with Pinnipeds, especially Phocidae and Otariidae. *D. tetraapterus*, *D. variabilis*, *D. fasciatus*, *D. septentrionalis*, "type 3" of Wardle *et al.*, 1947, "Species No. 3" and "Species No. 4" of Stunkard, 1948, and perhaps also *D. mutabilis* may be included in this group.

The mass bundles of longitudinal muscle fibers passing through the body center, and the absence of segmental multiplication by means of transverse sub-division of primary segment, readily distinguish our specimen from the members of above mentioned two

groups of *Diplogonoporus*.

Diplogonoporus fukuokaensis can be distinguished further by differences in remarkably closer distance of paired genital sets (one-tenth to one-twentyth of segmental width) in each segment than any other species of the genus. It also has asymmetrically ovoid, thin-shelled eggs with broad apical knob different from those of other species. Incomplete, abnormal segmentation shown in some parts of strobila is similar to that observed in some members of the genus *Diphyllobothrium*.

Some characters of the specimen different from usual form of *D. grandis* were already noticed by Miyazaki (1954) in the report of the 23rd Case, while the similarity of this specimen to the Markowski's description of *D. tetraapterus* was indicated recently by Kamo (1969). However, the morphological characters of this specimen are quite unique as mentioned above, and then it is described here as a distinct species.

Information concerning its life cycle is quite absent, but the native host will be found in some marine mammals, as man should be an unusual host for the cestodes of this group.

Summary

A diplogonadic cestode, which has formerly been reported as *D. grandis* from the 23rd case of human diplogonoporiasis in Japan (Miyazaki, 1954), is described as *Diplogonoporus fukuokaensis* sp. nov. *D. fukuokaensis* is distinguished by the presence of mass bundles of longitudinal muscle fibers passing through the center axis of the body, the absence of segmental multiplications by means of transverse sub-division of the primary segment, the close situation of two genital sets in each segment, and the eggs, asymmetrically ovoid, with thin shell and large apical knob.

This is the first evidence of expectation to occurring of *Diplogonoporus* species other than *D. grandis* in man.

Acknowledgement

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一少女から見出された *Diplogonoporus fukuokaensis*
sp. nov. (福岡複殖門条虫, 新称)

加茂 甫

鳥取大学医学部医動物学教室

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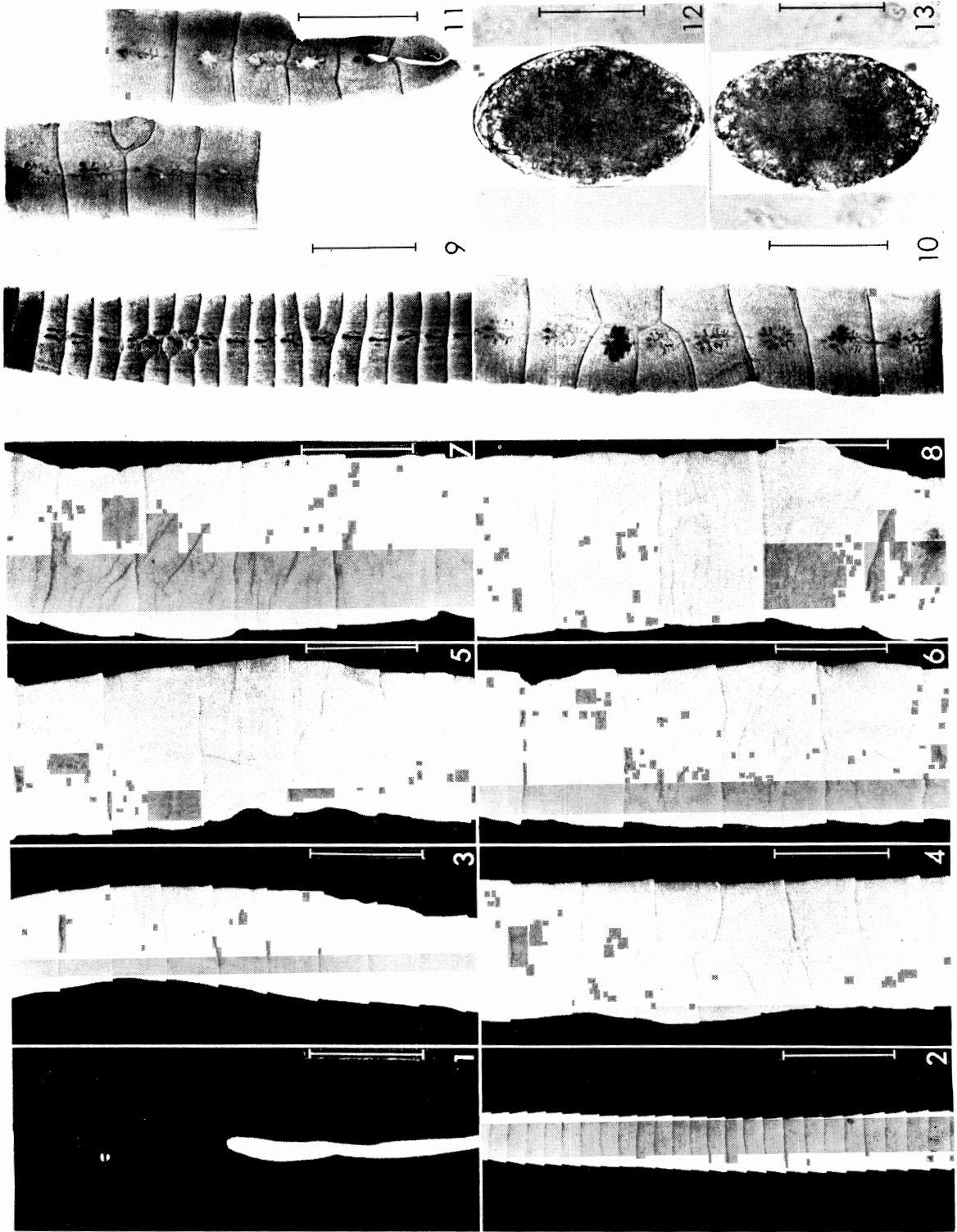
大複殖門条虫の第23例として福岡で一少女から駆出された標本は、いわゆる *D. grandis* とは異なる形態的特徴を示すことが報告当初から注目され(宮崎, 1954), また *D. tetraapterus* に近似する点の多いことも最近指摘されていたが(加茂, 1969), 精査して新種と判断され *Diplogonoporus fukuokaensis* (福岡複殖門条虫) と命名記載された。

Diplogonoporus 属は、そこに含まれる種類の中に独立性の確立していないものも多く、分類上かなりの混乱が見られるものであるが、現在の知見で少なくともつぎの2群にわけて考えることができる。すなわち、大形の体節を有し、頭節の吸溝縁の巻込みがやや深く、各片節の生殖器組数が多く変異に富み、縦走筋層はよく発達して微細な筋束が緻密に配列する、ナガスクジラ科を宿主

とする第1群 (balaenopterae 型) と、小形の体節を有し、頭節の吸溝縁の巻込みやや浅く、各片節の生殖器組数が多くなる傾向弱く、縦走筋層の発達やや弱く疎大な筋束がまばらに配列する。アシカ科、アザラシ科を宿主とする第2群 (tetraapterus 型) である。

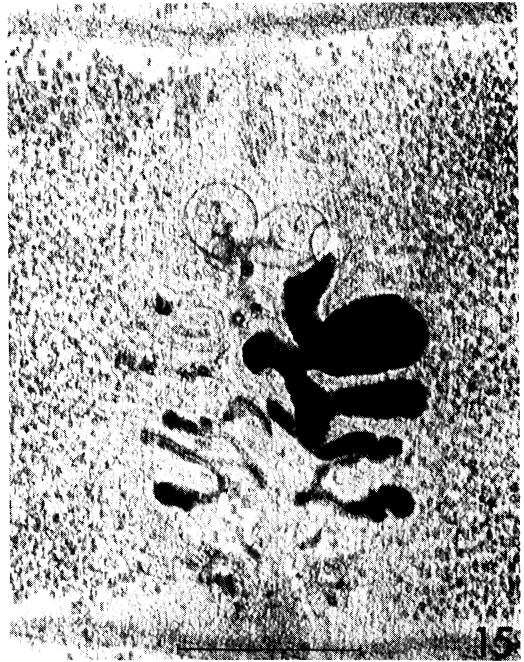
福岡複殖門条虫は、体の中央部を縦走する筋束群の存在と、複殖門条虫類に特有な横断線による分節像を示さないという顕著な特徴によつて、容易に上記2群の各種から区別され、また、きわめて接近してならぶ2組の生殖器や薄い卵殻に幅広い無蓋端突起をもつ、左右やや不整な虫卵なども他と異なる特徴を示している。

これは、人体寄生複殖門条虫がいわゆる大複殖門条虫ただ1種とは限らないことを示す最初の実例である。
[特別掲載]

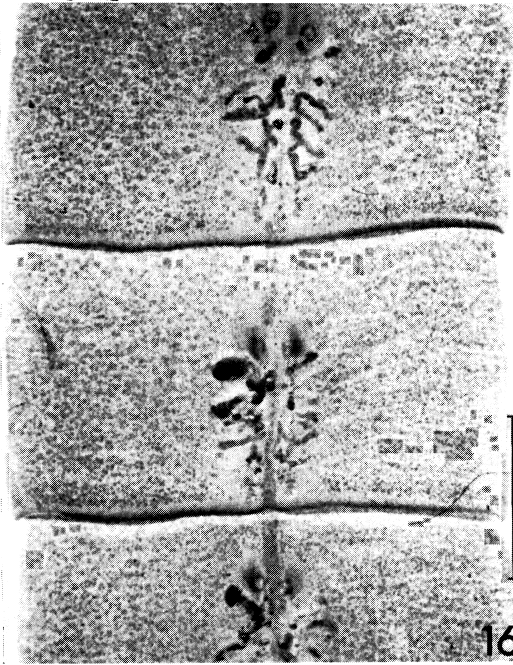




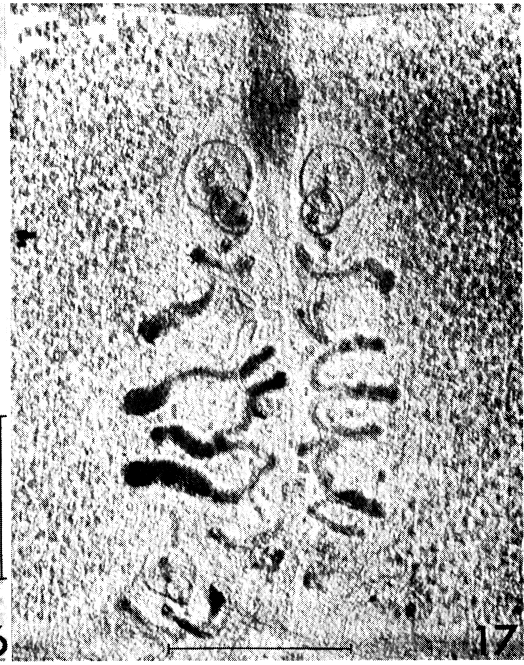
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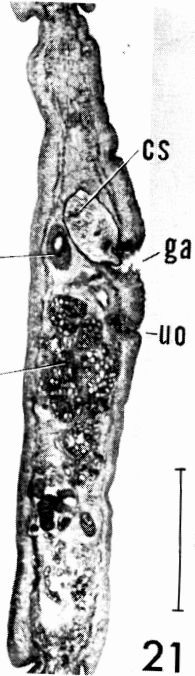
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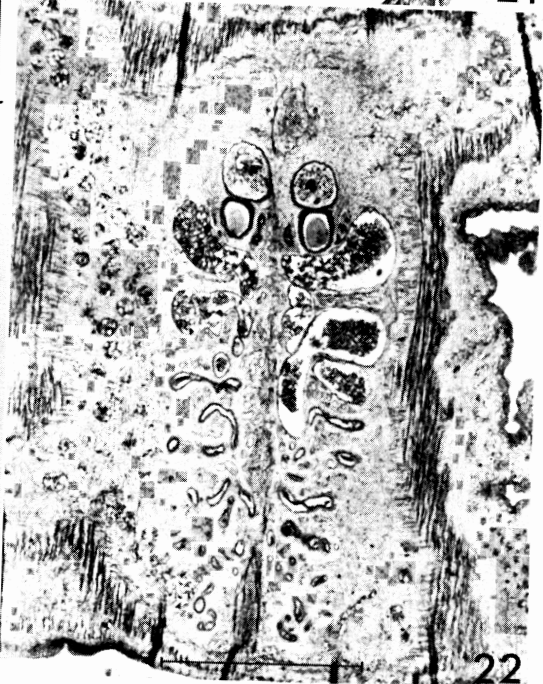
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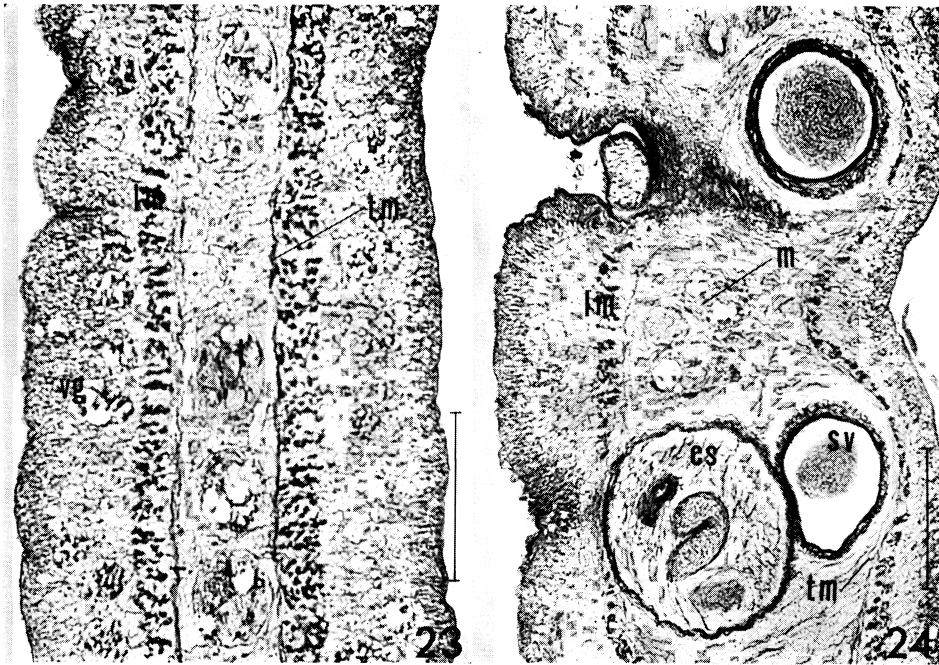
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Explanation of Plates

Diplogonoporus fukuokaensis sp. nov.

- Figs. 1 to 8 General features of proglottids at different portions—antieriormost, about 20 cm, 50 cm, 100 cm, 200 cm, 250 cm, 300 cm, and 350 cm, respectively, from anterior end—of strobila. (Scale: 7.0 mm)
- Fig. 9 Juvenile proglottids, showing genital *Anlagen* and some abnormal segments. (Scale: 3.0 mm)
- Fig. 10 Mature proglottids, including abnormal segments. (Scale: 10 mm)
- Fig. 11 Posteriormost proglottids, showing abnormal and fenestrated segments. (Scale: 10 mm)
- Figs. 12 and 13 Eggs from uteri. (Scale: 0.03 mm)
- Fig. 14 Scolex, ventral view. (Scale: 0.2 mm)
- Figs. 15 and 17 Abnormal arrangement of genital organs. (Scale: 1.0 mm)
- Fig. 16 Whole preparation of typical mature proglottids. (Scale: 3.0 mm)
- Figs. 18 and 19 Transverse section of segment, at each level of ovary and genital pores. (Scale: 1.5 mm)
- Fig. 20 Sagittal section of segment, showing mass bundles of longitudinal muscle fibres passing through body center. (Scale: 1.0 mm)
- Fig. 21 Sagittal section of segment through genital pores. (Scale: 1.0 mm)
- Fig. 22 Horizontal section of segment, showing mass bundles of longitudinal muscle fibres passing through body center. (Scale: 1.5 mm)
- Fig. 23 Portion of transverse section, showing details of longitudinal muscle layer. (Scale: 0.3 mm)
- Fig. 24 Portion of transverse section, showing mass bundles of longitudinal muscle fibres between two sets of genital organs. (Scale: 0.3 mm)

Abbreviations used in figures

cs=cirrus sac; ga=genital atrium; lm=longitudinal musculature;
 m=mass bundles of longitudinal muscle fibers;
 sv=seminal vesicle; t=testis; tm=transverse musculature;
 u=uterus; uo=uterine opening; vg=vitelline glands.