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MORPHOLOGICAL STRUCTURE OF THE LARVAL CESTODE TAENIA POLYACANTHA LEUCKART, 1856

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Abstract. Histological and histochemical methods have been used in our study on the morphological structure of larvae (armatetrathyridium) of the cestode species *Taenia polyacantha* Leuckart, 1856. The length of the larvae examined ranged from 5.3—5.8 mm. The invaginated scolex located on the widened anterior portion of the larval body was covered with a thick wall with a finely folded tegument. The width of the remaining bladder part was 2.3 to 2.5 mm; its heavily folded surface appeared as if segmented. This appearance has been ascribed to regressive changes described in the present paper.

The finding of larvae of *Taenia polyacantha* in rodents has frequently been reported in the literature. The adult cestode parasitizes the small intestine of *Vulpes v. vulpes*, *V. vulpes daurica*, *V. vulpes karagan*, *V. corsac*, *Alopex lagopus*, *Canis familiaris*, *C. lupus*, *Nyctereutes procyonoides* and other beasts of prey from the Holarctic region. Descriptions made from wholemounts are available of larval stages located in the abdominal cavity of almost all rodent species from the Holarctic region. As a result of a hardening and thickening of fixed larvae, their correct identification is often difficult. They are similar in their outer appearance to other larval cestodes of the "armatetrathyridium" type (Abuladze 1964). The present study is concerned with the morphology and structure of the larva of *T. polyacantha* investigated with histological and histochemical methods.

MATERIALS AND METHODS

In June 1975, we examined in postmortem a total of 38 specimens of small mammals from several localities in Sweden. We recovered a large number of larval *T. polyacantha* from the abdominal cavity of 3 specimens of *Clethrionomys rufocanus* captured in the vicinity of Hälnes.

Eight larvae were treated with histological methods. The material was fixed in 10% formalin, dehydrated and embedded in paraffin employing the procedure given in Pearse (1968) for histochemical tests. The reactions used were these: PAS (Pearse 1960) combined with acetylation and desacetylation and the saliva test for neutral mucosubstances; Alcian blue (Alcianblau 865 Fluka) pH 2.6 combined with methylation after Fischer and Lillie (1954) and demethylation (Spicer and Lillie 1959), Mowry's modification of the AB-PAS reaction for acid mucosubstances; DDD (2,2-dihydroxy-6,6-dinaphthyldisulphide) for SH groups of proteins; DDD combined with thioglycolic acid (Pearse 1960), PFA-AB (performic acid-Alcian blue) controlled with Alcian blue pH 0.2, and PAA-AF (peracetic acid-aldehyde fuchsine) for SH groups of proteins; Morel-Sisley's diazotisation test and the coupled tetrazonium (TK) reaction for tyrosine; DMAB (dimethylaminobenzaldehyde) for tryptophane. Of the histological methods we used Goldner's blue trichrome, Mallory's phosphowolfram haematoxylin, van Gieson's test, Gömori's impregnation test, Feulgen's nuclear test.

RESULTS

The length of the larvae examined ranged from 5.3—5.8 mm at a width of 3—3.5 mm (anterior portion) (Fig. 1). The invaginated scolex was covered with a fine, folded wall of a white colour. The surface of the remaining bladder portion (width 2.3—2.5 mm)

was heavily folded and therefore giving the impression of being segmented (Fig. 2). It had lost its bladder-like character because the original cavity was filled with connective tissue. Macroscopically, it resembled the connecting piece present in several multicephalic cestode larvae such as *Taenia twicheli*, *Multiceps endothoracicus* and others.

The invaginated scolex measured 650—680 μm in diameter and possessed 4 suckers

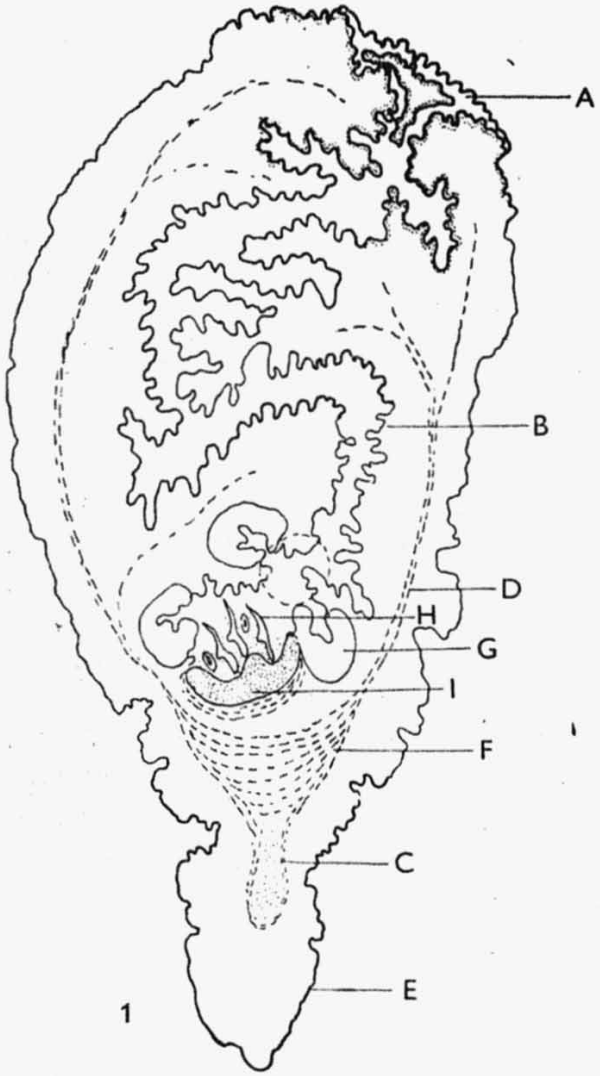

Fig. 1. Differentiated larva of *Taenia polyacantha*. The scolex part of the larva contains the well-developed opening part of the spiral canal with its remarkably thickened tegument. The rostellar area with completely differentiated hooks and suckers is bounded by a large receptaculum; its fibres extended to the pedunculate part of the larva line the remaining cavity of the reduced bladder.

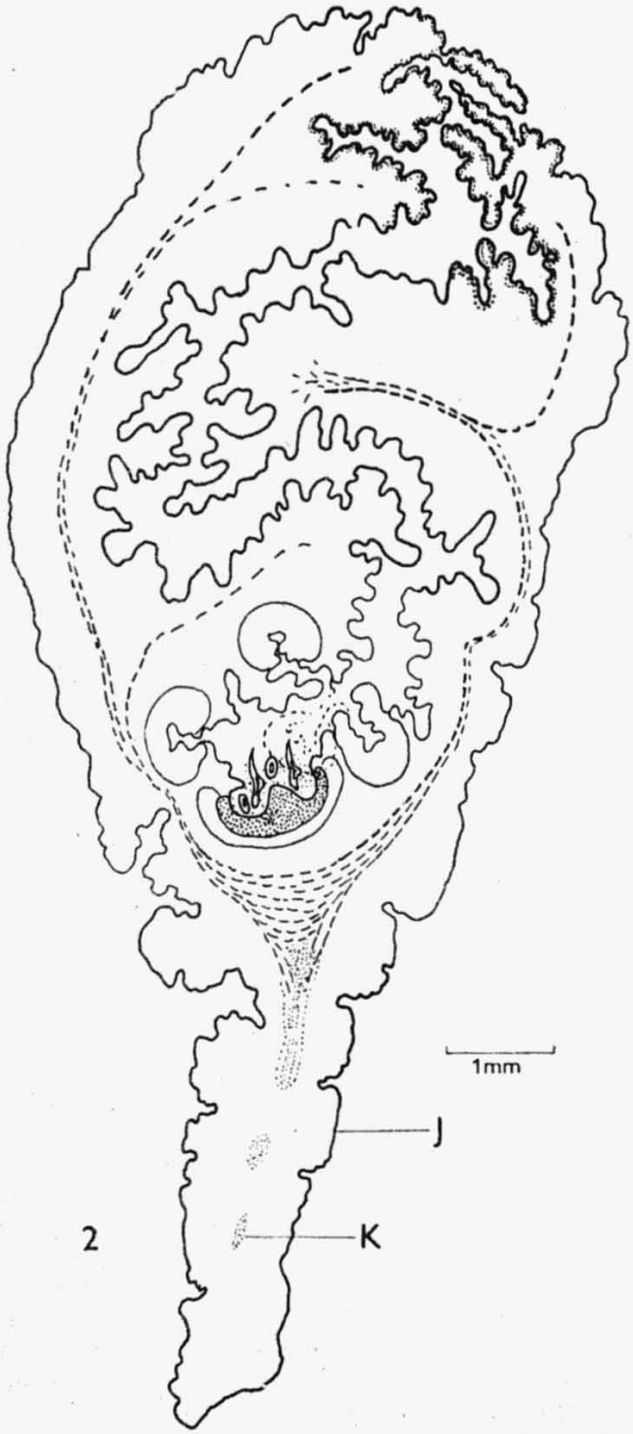

Fig. 2. Reconstruction made from a series of sections through a larval *T. polyacantha*. It shows a larva with advanced changes in the caudal part. The original bladder cavity is filled with connective tissue and therefore no longer visible.

A — opening of the spiral canal
B — spiral canal
C — remnant of the bladder cavity
D — connective tissue fibrils
E — bladder reduced to a stalk
F — receptaculum
G — suckers
H — hooks
I — rostellum
J — folded wall of elongate stalk
K — connective tissue centre of stalk containing a hyaline substance
L — dilated canal

(250 μm on the average). The rostellum was armed with two rows of hooks (50—54). The length of the larger hooks was 180—200 μm, that of the smaller hooks 126—130 μm.

Most of these larvae showed certain signs of regression in the form of dystrophic changes regarded as a sign of aging after a protracted stay in the intermediate host. The first of theses signs was a reduction of the bladder evidencing itself in a hyalinization of the parenchymal connective tissue, and in a disappearance of the bladder cavity. The delimitation of the wall of the bladder part of the larva was emphasized by a layer of thick connective tissue communicating with the tissue of the large receptaculum of the scolex proper. This was responsible for the loss of the microscopic character of the bladder wall (Plate I, Fig. 1). Dilated excretory canals were seen in the connective tissue layer of this part. In some larvae there was still a remnant of the bladder cavity; it was surrounded by a fibrous layer and extended to the receptaculum. The remaining part of the cavity was occupied by a homogeneous substance.

A remarkable feature of the modified wall on the surface of the caudal part (modified bladder) was a folded tegument measuring 6—8 μm in thickness and bearing microtriches (length 5 μm). The impressive longitudinal circular musculature became arranged in muscle bundles traversing the fibrous layer. Transverse muscle fibres proceeded in parallel direction to the fibres of the connective tissue of the receptaculum. Numerous myoblasts were present among the fibres. Batches of subtegumental cells were enclosed in the folds of the modified wall. Several of the cells were bi-nucleate. The kidney--shaped rostellum was underlayed by muscle fibres of the rostellar pad; these were separated from the fibres of the receptaculum by a thick membrane (Plate I, Fig. 2).

A swelling and homogenization of the fibrillar layer of the modified bladder indicated dystrophic changes. We observed a central stripe of a hyaline appearance which started to occupy part of the original bladder cavity. Pycnotic nuclei were seen in the hyaline centre of the fibrous tissue elongating the receptaculum. The measurements of the scolex were increased by a thickening of the parenchyma in the wall of the spiral canal and there particularly at the site of its opening where its wall was heavily folded. Calcareous corpuscles were not seen in this transitory zone. The tegument covering the opening of the canal was 8—9 μm thick, the length of the microtriches was 6—7 μm.

As the scolex increased in size in direction of the opening of the canal, the folds of its wall started to disappear. The parenchyma of the scolex near the suckers was full of calcareous corpuscles of which some were affected by dystrophic changes. A homogeneous substance of a non-cellular character was found in the lumen of the gratly branching spiral canal. The thickness of its tegument was 10 μm. In the vicinity of the canal, some of the calcareous corpuscles disintegrated into lumps, others retained their eosinophilic centres. Excretory canals in the parenchyma of the scolex were partly dilated and filled with an amorphous substance. Small hollows in their vicinity were filled with a substance of a mucoid nature. Dilated excretory canals in the scolex area were filled with a granular-like substance (Plate 1, Fig. 3).

The tegument of the spiral canal consisted of an outer- and an inner homogeneous layer: the thickness of the first was 1 μm, that of the second 8—9 μm. The outer layer was PAS positive and resistant to the saliva test which indicated the presence of neutral mucosubstances (Plate II, Fig. 1). It gave a feebly positive reaction for tyrosine, tryptophane and SS groups of proteins, was AB negative and did not contain SH groups of proteins. The inner homogeneous layer was feebly AB positive, PAS positive and highly positive for tyrosine and tryptophane (Plate II, Fig. 2). It contained, in comparison with the outer layer, less cystine (SS groups) and more cysteine (SH groups of proteins).

The tegument on the surface of the scolex was less tryptophane - and tyrosine positive than that of the spiral canal. It was feebly positive for SH and SS groups of

proteins, and AB negative. The tegument of the connecting piece (reduced bladder) was highly positive for PFAAB, and for AB pH 0.2. It contained SS groups of proteins and tyrosine, and was feebly positive for tryptophane. It did not contain acid mucosubstances.

The subtegumental cells were feebly AB positive, strongly PAS positive, and contained tyrosine, tryptophane and both SH and SS groups of proteins. Close to them, in the wall of the connecting piece, there was a larger quantity of glycogen. Numerous hollows in the thickened connective tissue of the receptaculum and the connective piece were occupied by a substance of a proteinaceous character (Plate II, Fig. 3), positive for tyrosine, tryptophane and SS groups of proteins. A similar substance positive also for acid mucosubstances was present in the lumen of the spiral canal. A granular substance was found in the excretory system mainly in the dilated canals of the connecting piece (reduced bladder). With Goldner's blue trichrome we disclosed in it small, blue-staining and PAS positive granules in addition to large, red-staining feebly AB positive granules. According to Šlais (1970), the presence of a similar substance in the canals of the excretory system is always a sign of decay of the affected part of the tissue. Completely developed hooks were found only in the basal part and on the surface of the tegument positive for tyrosine (Plate II, Fig. 4).

DISCUSSION

Abuladze (1964) distinguished 7 groups of larval cestodes of the family Taeniidae Ludwig, 1866, i.e., the cysticercus, coenurus, strobilocercus, echinococcus, alveococcus, cladothyridium and armatetrathyridium. He placed in the last type the larvae of *T. polyacantha* and of *Taenia* sp. However, a number of cestode larvae developing in the thoracic or abdominal cavity of mammals such as *Taenia martis* (Shakhmatova 1964, Prokopič 1970), *T. talicei* (Dollfus 1960) are of a similar shape to that of the armatetrathyridium - type of larva. Another feature of similarity are the outer scoleces of polycephalic larvae of *T. twicheli*, *Multiceps endothoracicus* (Hulínská 1975) and others.

Originally, Baer (1925) regarded *T. polyacantha* as a synonym of *T. crassiceps*, but revoked his concept later by giving a detailed differential description of larvae of *T. crassiceps* and *T. polyacantha* (Baer 1932). Rausch (1959) analyzed these differences and gave his measurements for *T. polyacantha:* diameter of suckers 450 μm, number of hooks 44—50, length of large hooks 210—214 μm, length of small hooks 142—157 μm.

Having regard to the fact that *T. polyacantha* parasitizes practically all canines of the Holarctic region and utilizes in its life cycle most of the rodent species of this region, its variability is apt to be wide (Table 1). Šlais (1973) stated that differences mainly in the length of larval *T. polyacantha* were due also to their aging. Basing on his photographical documentation, we regarded our larvae as stages of the medium type. The process of aging of a larval *T. polyacantha* differs from that of a larval *M. endothoracicus* in that the bladder of the latter larva reduces until it disappears completely, and releases its scoleces at the same time (Hulínská and Šlais 1977). In a larval *T. polyacantha*, the caudal part of the reduced bladder retains its structure. In an aging larva of *T. martis*, the caudal part of the bladder increases in size at a simultaneous elongation of the larval body (Šlais 1973).

Table 1. Measurements of larval *T. polyacantha* given by various authors from different intermediate hosts.

Author	Baer 1925	Kirshenblat 1940	Nazarova 1958	Panin 1956	Murai 1974	Abuladze 1964	Schiller 1953	Rausch 1959	Voronina 1971	Our data
Place of finding	Switzerland	Georgia	Tatarian ASSR	Kazakhstan	Hungary	from various countries	Alaska	Alaska	USSR (Komi)	Sweden
Intermediate host		*Mesocricetus brandti*	*Microtus arvalis*	*Meriones meridianus, M. tamariscinus, Apodemus sylvaticus*	*Clethrionomys glareolus*		*Microtus oeconomus aperarius*		*Lemmus obensis, Microtus gregalis major, Dicrostonyx torquatus*	*Clethrionomys rufocanus*
Larval length	8—10 mm	16.2 to 18.8mm				12 mm	8—12 mm		7.0 to 12.0 mm	5.3 to 5.8 mm
Larval width	2 mm	2.3 to 2.7 mm				3 mm	3—4 mm		2.8 to 3.5 mm	3 to 3.5 mm
Scolex ⌀							700 μm	1.2 μm	750 to 910 μm	650 to 680 μm
Sucker ⌀	185 μm		250 μm				250 μm	450 μm	222 to 248 μm	245 to 255 μm
No. of hooks	60	56	64	60—62	64	60	44—48	44—50	46—48	50—54
Length of large hooks	200 μm	200 μm	208 to 216 μm	207 μm	208 to 216 μm	200 to 220 μm	210 μm	210 to 214 μm	200 to 212 μm	180 to 200 μm
Length of small hooks	118 μm	118 μm	120 to 124 μm	127 μm	120 to 124 μm	120 to 130 μm	140 to 150 μm	142 to 157 μm	175 to 182 μm	126 to 130 μm

МОРФОЛОГИЧЕСКОЕ СТРОЕНИЕ ЛИЧИНОЧНОЙ СТАДИИ ЦЕСТОДЫ *TAENIA POLYACANTHA* LEUCKART, 1856

Я. Прокопич и Д. Гулинска

Резюме. Морфологическое строение личиночной стадии (armatetrathyridiun) цестоды *Taenia polyacantha* Leuckart, 1856 изучено с помощью гистологических и гистохимических методов. Длина личинок 5,3—5,8 мм. Инвагинированный сколекс в расширенной передней части тела личинки покрыт сильной стеной с тонкоскладчатым тегументом. Ширина остальной пузырковидной части 2,3—2,5 мм, поверхность ее сильно складчатая, напоминающая на сегментацию. Этот вид является результатом регрессивных изменений, описанных в работе.

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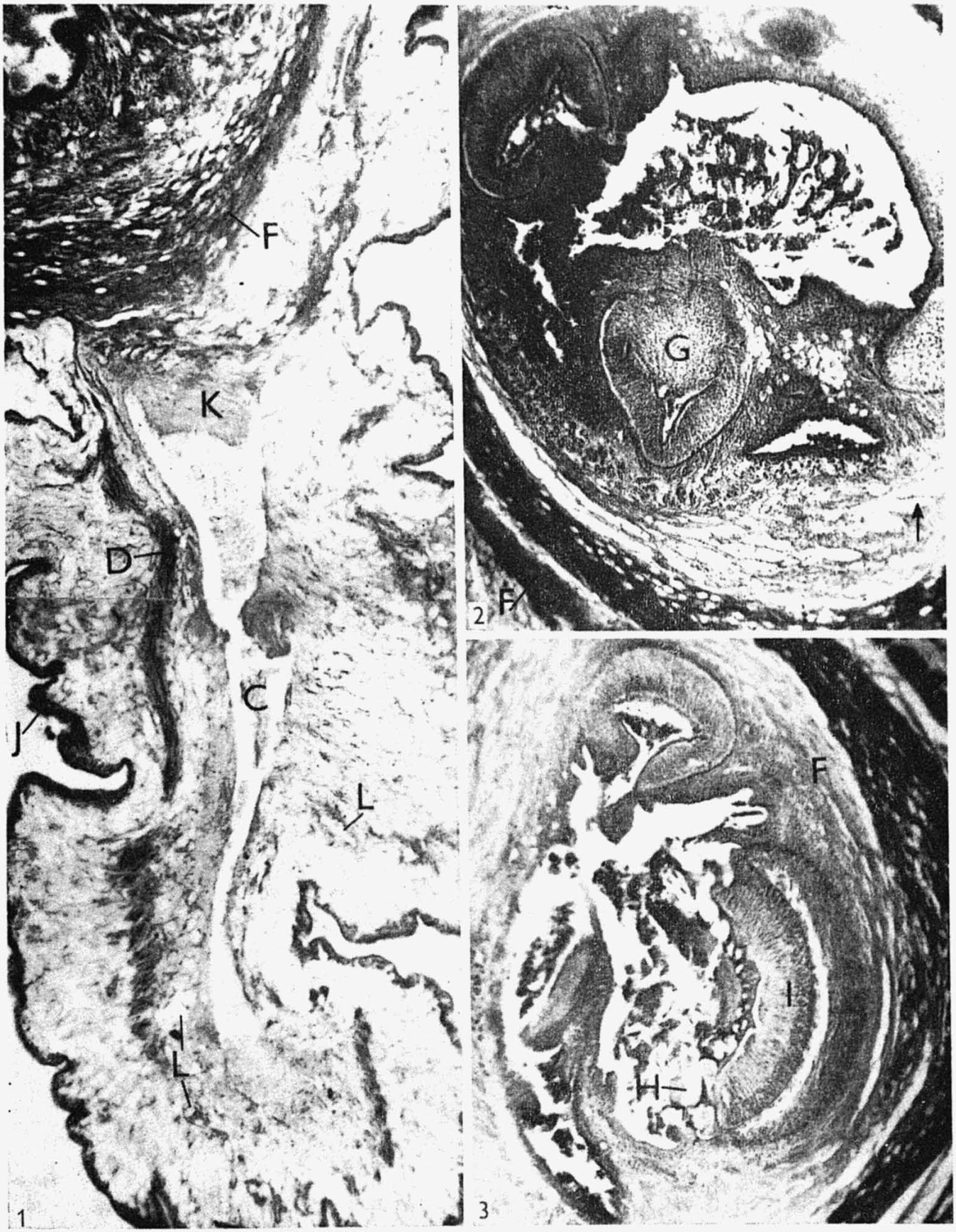

Fig. 1. Tangential section through the basal part of the scolex separated by the receptacrulum from the modified pedunculate part (reduced bladder). A substance of proteinaceous chara cte is occupying the remaining bladder cavity (×160, blue trichrome).

Fig. 2. The modified caudal part and its cavity are lined with fibrous tissue. The parenchyma of the wall contains transverse muscles, dystrophic calca-reous corpuscles and dilated hollows (×160, blue trichrome).

Fig. 3. Cross section through the cavity of the basal part of the spiral canal. The kidney-shaped rostellar cone with the hook organ protrudes in this cavity. The substance occupying the lumen of the canal, and the fibrous tissue of the receptaculum, are highly positive (DDD reaction, ×120).

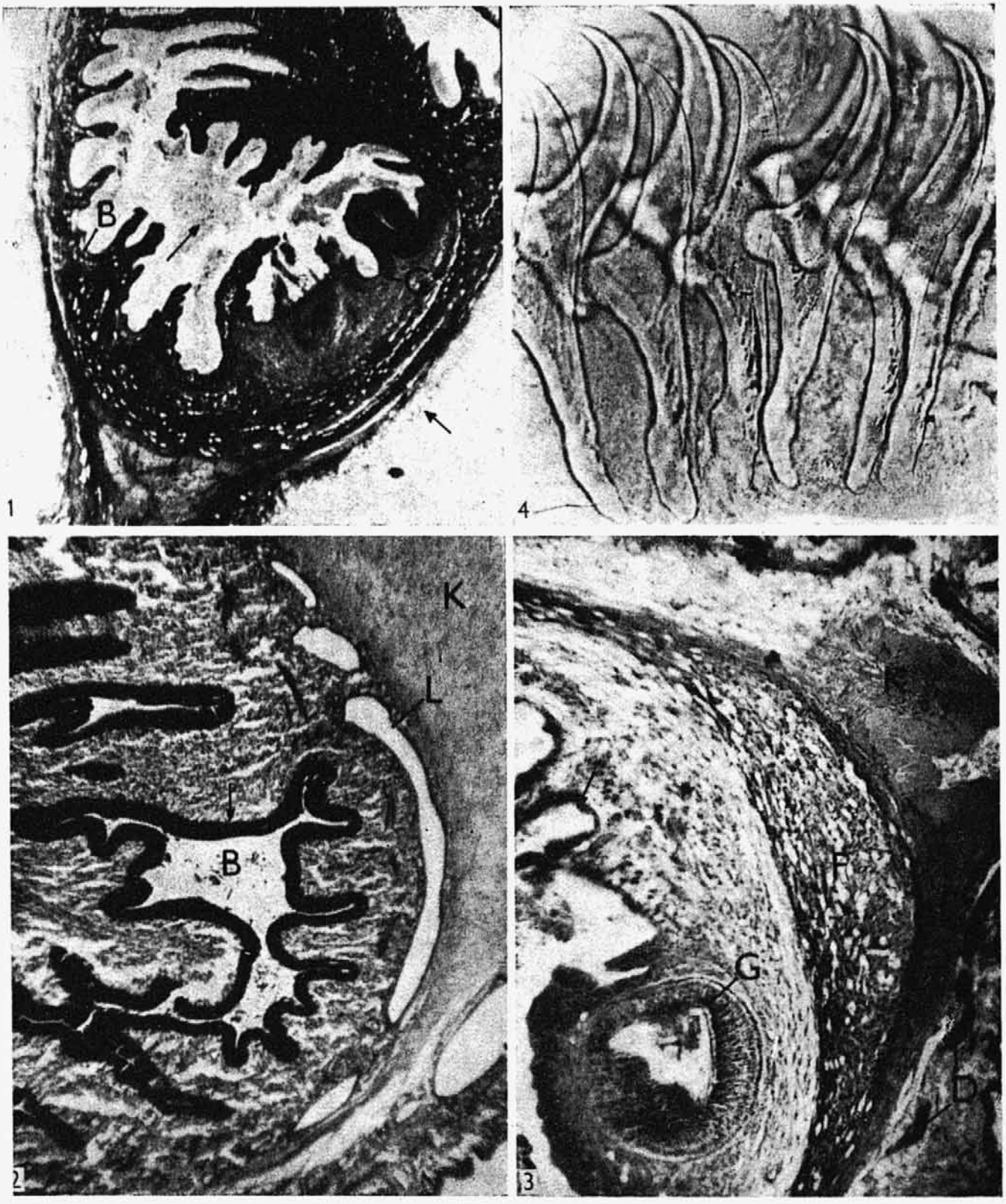

Fig. 1. Scolex part of a larval *T. polyacantha* with a branching spiral canal. The wall of the canal contains neutral mucosubstances and dystrophic calcareous corpuscles. The lumen of the canal is filled with a necrotic substance containing acid mucosubstances (AB + PAS, ×55).
Fig 2. Dilated excretory canals in the wall of the spiral canal. Its tegument is positive for tyrosine and tryptophane (TK, ×190).
Fig. 3. A hyaline substance underlying the receptaculum of the scolex proper and bordered by transverse muscles contains pycnotic nuclei (Mallory's PTAH, ×150).
Fig. 4. Large and small hooks of *T. polyacantha* (TK, ×300).