Transmission and scanning electron microscopic observations on the body wall surface of Taenia hydatigena and its metacestode, Cysticercus tenuicollis (Cestoda: Cyclophyllidea)

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ABSTRACT. The tegumental surface of Taenia hydatigena and its metacestode, Cysticercus tenuicollis was studied by scanning and transmission electron microscopy. The outer part of the bladder wall and parts of the strobila of the taenia were studied with special attention to some differences in the density, form and structure of the microthriches and, as a result, in the relief of the surface in general. These specificities are connected with certain adaptations to the living conditions and reflect the growth and development of the taenia. The changes in the type of the free tegumental surface are related to the digestive functions of the teguments and to changes in the environment of the larval and the adult forms of Taenia hydatigena.

KEY WORDS: Cysticercus tenuicollis, Taenia hydatigena, tegument, microthriches, scanning and transmission electron microscopy.

The covering tissue (the tegument) of cestodes is a protective and metabolically active surface where the main host-parasite interactions take place. The lack of digestive system in the representatives of the class Cestoda strongly attracts the attention of scientists to the problem of studying the body wall.

The present work is part of a series of morpho-functional studies of the tegument of Taenia hydatigena and its larval form, Cysticercus tenuicollis. Our aim was to study the topography and ultrastructure of the tegument surface of the larval and the adult forms.

MATERIAL AND METHODS

The larval form (C. tenuicollis) was acquired from naturally infected sheep, from peritoneal membranes, the liver peritoneum or the mesenterium. Our studies were confined to the bladder wall.
The adult form (T. hydatigena) was obtained from experimentally infected dogs by dehelminthization with 1% arecoline solution. With the aim of tracing possible changes of the surface structure in the course of proglottid development, samples from the neck region and from sexually mature proglottids were fixed and processed separately.

For scanning electron microscopy (SEM) small tissue samples were fixed in 6% glutaraldehyde and postfixed in 5% OsO₄. The material was further processed by the method of acetone dehydration and air drying of BARBER and BOYDE (1968).

For the transmission electron microscopic study the samples were fixed in 4% glutaraldehyde, then in 1% OsO₄, and embedded in Durcupan according to the standard method.

The observations were carried out with a JEM 100 B scanning and transmission electron microscope.

RESULTS

Larval form (c. tenuicollis)

The bladder wall consists of two main layers. Scanning electron microscopy showed that the outer surface of the bladder is a rough surface consisting of numerous sparsely situated microthriches with no apparent pattern of distribution. They are long and fine as a result of which they are intertwined, forming something like a network among which closed areas, lagoons, are formed (Fig. 1). The thin elongated microthriches are in most cases connected with each other by transverse connections.

The transmission electron microscopic study gives a more precise idea about the form and structure of the microthriches (Fig. 2). They are long, cylindrical structures situated at large distances from each other at their bases, and intertwined at their apical parts. The microthriches consist of two parts: a wide base and a long, fine apical part. The surface of the microthriches is covered with a plasma membrane (Figs 3a, 3b). The heart of the cylin-

Legend to the figures

Fig. 1 Scanning electron microscopy of the bladder wall, x 30 000
Fig. 2 Microthriches from the wall of c. tenuicollis, x 23 000
Fig. 3 Longitudinal and transversal sections of microthriches from c. tenuicollis, x23 000
Fig. 3a Detail of Fig. 3
Fig. 3b Detail of Fig. 3
Fig. 4 Scanning electron microscopy of the tegument of the neck region of T. hydatigena, x 3 000
Fig. 5 Longitudinal and transversal sections of microthriches of the neck region, x 26 500
Fig. 5a Detail of Fig. 5
Fig. 6 Scanning electron microscopy of the tegument of a mature proglottid of T. hydatigena, x 20 000
Fig. 7 Microthriches of the tegument of a mature proglottid, x 26 500
Fig. 7a Detail of Fig. 7
Fig. 8 Longitudinal and transversal section of microthriches of a mature proglottid of T. hydatigena, x 20 000
Fig. 8a Detail of Fig. 8
drical base has a striated structure due to the microfilaments running parallelly. Microtriches cut transversally have an oval or round form (Fig. 3). No surface coat (glycocalyx) is visible.

**Adult form (T. hydatigena)**

The structure of the covering tissue of the neck region and of mature parts of the strobila will be described.

The neck region observed under a scanning electron microscope possesses a thick system of microtriches (Fig. 4). The individual microtriches consist of a thin base and rounded tips resembling a "bud" or a "bulb". In some places transversal connections are observed between the microtriches. By transmission electron microscopy the microtriches show a similar, mushroom-like appearance with a "trunk", the base of the microtriches and a "cap", their apical part (Fig. 5a). In transversal sections rectangular, triangular or irregular trapezoid forms are observed, depending on the slant of the section (Fig. 5). The outermost surface is covered by a membrane which is not continuous but has small pores which lend it a riddle-like appearance. The outer plasma membrane covers not only the microtriches but also the areas between them. Immediately under it lies the inner membrane which is rough and of higher electron density. This membrane gets thicker in the area of the cap of the microtriches and is clearly seen in longitudinal sections. The substance filling the heart of the microtriches is comparatively light in colour. In transversal sections its structure is rough, and in longitudinal sections it is stratified due to numerous substructures running parallelly.

The relief of the mature parts of the strobila differs from the one described for the neck part. The brush border consists of densely situated, slanted microtriches oriented towards the back parts of the strobila (Fig. 6). The microtriches resemble arch-like projections with a wider base and gradually thinning at the end, forming claws.

By transmission electron microscopy the microtriches are cylindrical, gradually getting finer at their apical end, their form resembling a spine-like or beak-like ending (Fig. 7). In transversal sections microtriches are of oval or round shape (Fig. 8). The outer plasmal membrane preserves its porous character, and the inner strongly osmiophile one reaches the spine-like ending of the microtriches (Fig. 8a). Although the spines are the most electron-dense parts of the microtriches, tubular or lamellar substructures can be observed in them. The heart of the microtrich bodies is electron-microscopically lighter but also stratified (Fig. 7a). A three-layered membrane was observed between the spine-like cap and body separating the two parts of the microtriches.

The microtriches from all parts of the strobila are covered by a thin veil or coat which is a loose, net-like structure: glycocalyx (Figs 8, 8a). The morphological picture of this filamental cover is uniform along the surface of the whole strobila which varies in thickness (from 0.5 to 1 um).

**DISCUSSION**

The present study reveals some specificities in the structure of the tegumental surface of the larval and adult forms of *T. hydatigena*. The changes observed in the density and form of the microtriches and consequently in the relief of the surface in general reflect a tendency in their development parallel to the ontogenetic development of the helminth.
The density of microthriches increases gradually from the larval form through the neck region and the mature parts of the strobila. Such a trend was also described for Diphyllobothrium latum (BRATEN 1968a, b). In Hymenolepis fraterna, on the other hand, STOTTSOVA (1983) found a constant number of microthriches but an increase in their length starting from the neck region up to the mature proglottids of the adult worm.

There is a great variety in the form and structure of the microthriches. They are thin, filament-like at the bladder wall, shorter, mushroom-like in the neck region and reveal a form typical of most cestoda in the mature region i.e. cylindrical projections with sharpened apical end.

These specificities in the form of the microthriches are most probably related to certain adaptations to the precise living conditions. Thus, the microthriches in the bladder wall are markedly elongated and finer which could be explained by the necessity of intensified absorption of nutritive substances of vital importance for the growth and development of the helminth.

The presence of shorter microthriches with rounded tips over the neck region tegument might be an adaptation to the closer contact of this part of the strobila with the host tissue. While the scolex and the neck are deeply sunk in the host's intestinal microvilli, the rest of the strobila is somewhat more free-floating in the intestinal lumen. The elongation of the microthriches and the sharpening of their spines in the mature parts of the strobila are suitable to support the long, ribbon-like body of the worm near the host's intestinal epithelium as well as to overcome intestinal peristalsis and the flow of the intestinal contents. The spine-like structure of the microthriches aids the adhesion of the taenia to the intestinal microvilli. Elongation of the microthriches, on the other hand, increases the absorptive surface, thus facilitating the access of nutrients to the tegument.

We consider the presence of transversal connections between the microthriches in the bladder wall and the mature proglottids of the taenia to be necessary for the microthriches to remain parallel to each other. Such connections were not observed between the microthriches in the neck region of the strobila. There the microthriches are shorter and have more stable bases. The transversal connections were also described by FEATHERSTON (1972). He considered these connections to be identical with the branched microthriches described by UBE-LAKER et al. (1970) and HAYUNGA and MACKIEWICZ (1975).

In conclusion, we can point out that along with the growth and development of the taenia considerable changes in the number, form and structure of the microthriches also take place. These changes depend on the tegument's digestive functions and on changes in the environment where the larval and the adult forms of the helminth are found, and once again prove the strongly manifested adapting abilities of the parasites.

MIZINSKA-BOEVSKA Y., POLJAKOVA-KRUSTEVA O. és FOK É.: Transzmissziós- és pásztázó-elektronmikroszkópos megfigyelések Taenia hydatigena és borsókája, cisticercus tenuicollis, kültakaróján (Cestoda: Cyclophyllidea)

Taenia hydatigena adult példányok és borsókák (metacestoda stádiumuk) köztakarójának elektronmikroszkópos vizsgálata során a szerzők a strobila és a borsóka tegumentének és különösen a mikrobolyhok morfológiájára összpontosították figyelmüket. Megállapították, hogy a mikrobolyhok formája és struktúrája állandó (1-3. és 6-8. kép), de specifikusan adaptálódik a fegy egyedi fejlődéséhez jellegzetes, az adult férreg nyaki szakaszán, az erőteljesen osztódó zónában a mikrobolyhok rétege legördülését mutatja meg.
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