The Functional Histology of the Bladder Wall of Some Cysticerci

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Abstract. The histological structure of the bladder wall of *Cysticercus cellulosae* (from the musculature of the swine, the brain of man on racemous brain cysts), of *C. bovis* and *Coenurus cerebralis* was studied on histological sections and on preparations of the whole bladder after JASVOIN. In *C. cellulosae* we proved small groups of special muscles placed close beneath the cuticle responsible for the wart-like surface of the bladder wall, typical for this species. In *C. bovis* and *Coenurus cerebralis*, the protruberances of the entire surface of the wall are caused by the contraction of the subcuticular muscle layer. On the surface of the cuticle of various species the dimensions of the protruberances and of the hair-like processes vary. The wart-like formations and the protruberances on the surface of the bladder wall of the cysticercus are only functional, caused by the contraction of the muscle fibers. The histological picture of the bladder was described during its proliferation and growth, in aging and dystrophy, and during autolysis.

In studies on the morphology of the cysticercus, the parenchymatous part of the larval body has received considerable attention because of the fact that the scolex of the cestode is developing in it. The bladder is only a transitory embryonic organ ensuring conditions for the life of the larva in the intermediate host. The microscopical structure of the bladder wall is relatively simple consisting of a thin surface cuticle, an irregular subcuticular cell layer and the parenchyma with its system of ducts. The bladder wall functions principally for securing the metabolic contact between the larva and the tissues of its intermediate host; hence its great importance. The bladder is also one of the parts of the cysticercus capable of changing its form, growing and adapting itself to changed living conditions (ŠLAIS 1965). Findings of the remains of the bladder wall are often the only proof of a cysticercosis. A profound knowledge on the microscopical structure of the bladder and, especially of the differences in the various cysticercus species, seems of great diagnostic importance. The wall of a hydatid cyst can be easily recognized by the

In honour of Prof. Dr. D. Benešová on the occasion of her 60th birthsday presence of the hyaloidine membrane on its surface, which is one of its characteristic features. The object of this work was to analyse histologically the bladder walls of *Cysticercus cellulosae*, *C. bovis* and *Coenurus cerebralis*.

MATERIALS AND METHODS

The microscopical structure of the bladder wall of *C. cellulosae* was studied during all stages of the cysticercus from the young larvae to developed, eventually dead and necrotic larvae. The material of *C. cellulosae* was obtained from a brain cysticercosis of man (Šlais 1965) and a muscle cysticercosis of swine (Šlais 1966), of *C. bovis* from a muscle cysticercosis of cattle from the Prague abbatoir. The bladder of *Coenurus cerebralis* was studied on preparations from the collections of the Department of Parasitology, Faculty of Natural Sciences, Prague, from the collections of the VIGIS, Moscow and from material, kindly presented to the writer by prof. Shults of Alma-Ata. The material was fixed in 10% formol, in Schaffer's fluid, or kept in formol or alcohol. For staining of the histological sections, standard or specialized methods were used. Histochemical reactions to polysaccharids and proteins were carried out. "In toto" preparations were made of pieces of the bladder wall and stained either with ferric hematoxylin after Weigert or by using the method of Jasvoin; the preparations were also observed under the phase contrast microscope.

1. The histological structure of the bladder wall of the cysticercus

The structure of the bladder wall of the cysticercus varies according to whether the bladder is smoothed out or extended, collapsed or completely shrivelled. Also the age of the cysticercus affects greatly the histological structure of its wall in the same way as the necrobiosis and the following autolysis affects the histological structure of the bladder wall during the gradual dying of the parasite. The appearance of the wall may also be influenced substantially by inconvenient osmotic conditions during the fixation especially in instances when the cysticerci had been affected by the defence mechanisms of the host or, when the specimens were dead. However, the cuticle, the subcuticular layer and the parenchymatous part of the bladder wall are always recognizable (Pl. 1, Fig. 1).

The cuticle, a narrow homogenous zone, generally 0.5 μ thick, is sometimes just within the limits of visibility under the microscope. When thicker (occasionally exceeding even 1 μ), this zone becomes strikingly light-reflecting and sharply outlined; its lower margin reacts more noticeably to silver impregnation. Histochemically, the cuticle reacts as a mucopolysaccharid. On its surface it carries delicate hair-like processes of 1—6 μ in height depending on the cysticercus species. The layer of these processes is a structure of the type of an absorptive striated border. The cuticle can become easily damaged and when absent on the bladder, this should be considered a sign of a starting autolysis. Sometimes the cuticle in a dystrophic bladder wall is swollen and column-like divided which makes the hair-like processes look longer.

The layer beneath the cuticle is granular in appearence. By using impregnation methods it is possible to distinguish delicate fibrillae and muscle fibers, inserted into the cuticle at several places. The layer of subcuticular cells is also changing, sometimes it consists of several layers, sometimes it is disconnected. Mostly, only the nuclei are stainable while it is most difficult to stain the cell plasma. The fine small fibers project from the cuticle downwards through the cells and, beneath their layer, there are usually thicker muscle fibers responsible for the contraction of the bladder. The thickness of the subcuticular layer in a not extended bladder is about 15 μ.

The thickest layer of the bladder wall is its parenchymatous part. This varies greatly in accordance with the state of the bladder and the age of the cysticercus, the mean values ranging from 25—30 μ. This part is not bordered off from the bladder cavity. The internal surface of the wall consists of a thin network of fibers with elongated cells in the middle of the fibers. Often, the parenchymatous part of the bladder wall looks like a layer of connective tissue in which the section of two types of ducts can be distinguished (Pl. I, Fig. 1, Pl. III, Fig. 1). Close to the internal surface of the wall there are two narrow ducts with walls of good staining properties especially by the method after Goldner (red). According to their dilation their diameter is 2.5—6 μ, the thickness of their wall surmounts 1 μ. On tangential sections a reinforcement with annular supports at intervals of less than 1 μ can be seen in the wall. On the peripheral part of the wall a border staining as collagen can be distinguished especially in older cysticerci. Sometimes the ducts seem to be accompanied by fibers. From the thin ducts delicate tubes (0.5 μ) shoot sideways and branch round them.

The second type of bigger ducts have a lumen of about 15 μ and above. The wall appears only as a sharp outline and becomes almost invisible in ducts with a wider lumen. On the sections the ducts are oval, frequently of an irregular to lacunary shape. Mostly they are placed closer to the surface of the bladder wall between a layer of thin ducts and a layer of subcuticular cells. It seems quite evident that the parenchymatous part of the wall contains two systems of excretory ducts. On the sections of bladders with a dilated system of ducts (Pl. I, Fig. 1), the parenchymatous part of the wall has the appearence of a spongy system with a fine branching of the principal ducts interwoven with coarser and more delicate fibers of connective tissue, giving strength to the wall. The lumen of the ducts of both systems depends on the dilation of the wall.

A clearer picture of these two duct systems is obtained from the so-called "in toto" preparations, made of the whole bladder wall after Jasvoin. They show the branching of both systems which often has the character of lacunas of 30 μ and above in diameter at the crossing points of the branches of the upper system. It is also possible to observe that some of the branches of the lower network of thin ducts communicate directly with the upper network. Sometimes, especially in younger cysticerci, the two types of principal ducts are not distinguishable and only one network of narrow ducts (mean strength 6—7 μ) is visible. The main part of the parenchymatous wall is evidently formed by the branches of the upper lacunary network but the gradual transition into the finest slits cannot be traced for the thinness of their wall. Proof of their congruence is given by their dilation and by the fact that they are filled with the same cloddy pigment at the onset of dystrophy of the cysticercus.

We also confirmed on "in toto" preparations the dispersed distribution of calcareous corpuscles in the bladder wall, which are becoming more numerous near the opening of the invaginated part of the cysticercus, but their density is so negligeable that it is quite exceptional to find them on histological sections. The cells in the parenchymatous part of the wall are very loose and have a spherical nucleus. The cytoplasma is indistinct and not even stainable in the method after JASVOIN, the flame cells, however, stain remarkably well by this method.

2. The microscopical anatomy of the bladder wall of *C. cellulosae*

The most characteristic feature of the bladder wall is the wart-like surface of the cuticle which VIRCHOW (1860) compared to a tiled pavement. In his opinion this ruggedness cannot be elucidated by the presence of cell nuclei beneath the surface of the wall. LEUCKART (1879—1886) had a clear conception of these wart-like protruberances on the membrane of the cysticercus. Basing on the first description by STEINBUCH from 1801, he considered them correctly characteristic for *C. cellulosae* because of their form and size. Agreeing with the occurrence of these features in *C. bovis* he pointed to the fact that in the latter species they are less frequent and less high. ZENKER (1882) also used these protruberances as proof of the bladder wall of a cysticercus without considering them specific for *C. cellulosae*. Since then, in pathology, the findings of these protruberances were considered a significant diagnostic proof for the presence of a cysticercus. According to TRELLES et al. (1952) their remarkable height and slim form is typical for the racemous cyst of the brain cysticercus. We found that the wart-like surface of the cuticle on the bladder wall of the cysticercus depends on its functional state and is due to the presence of special groups of muscle fibers. In *C. cellulosae* their arrangement and occurrence is so typical that, in contraction, they cause the wart-like surface, always considered a typical feature of *C. cellulosae*.

In all specimens of *C. cellulosae* in a muscle cysticercosis, in a brain cysticercosis of man and also in its racemous form (Plate 1), the surface of the bladder wall can be either wart-like or smooth. On serial studies of the whole parasite we often observed that one part of the bladder was smooth, another wart-like and some parts were just between a wart-like and a smooth appearance. The height of the wart-like protruberances varied from 15—22 μ, their width at the basis was 27 to 38 μ, the index of height to width was 0.60. In some places with especially marked protruberances, their width was 15 to 27 μ with an index of 0.90. The height of the hair-like border ranged from less than 1 μ to 2.5 μ in *C. cellulosae*. The subcuticular cell layer of the formed protruberances is straight and the wart-like protruberances are formed only by the granular component of the subcuticular layer with its reticular branches and short muscle fibers, which are crossed in almost stellar fashion. In the extended wall these muscle groups are extended and look like very elongated lunate formations with a slightly raised middle, disturbing thus the regular coherence of the subcuticular cells. The length of these extended muscles was mostly about 60 μ (in average for the whole group). On preparations of the complete bladder wall (Pl. IV, Fig. 2) the picture of the subcuticular cell layer of a cuticle with a wart-like surface appears as a layer of evenly distributed nuclei. In the extended wall the nuclei seem to be pressed into stripes forming a network of empty, almost circular areas (60 μ in diameter) (Pl. IV, Fig. 3). Another evidence of the functional changes of the bladder wall is given by the changing numbers of subcuticular cells. On 0.06 mm of length of a wall with a wart-like surface there are eleven cells while, on the same length of wall with an extended surface there are only 6—7 cells. The finding of the extended subcuticular muscles groups is characteristic for *C. cellulosae* (Pl. III, Fig. 2) and we observed it in all cysticercoses even if it was not possible to detect the wart-like surface of the cuticle of the parasite's bladder. The wart-like appearance of the surface has nothing in common with the coarser folds of the bladder wall because these folds disturb completely the regular features of the wart-like protruberances. The staining character of the subcuticular fibers is very often the same as of the muscle fibers although sometimes, it is difficult to distinguish only by staining the connective tissue from the muscle tissue in the bladder wall. This seems to depend on the little progressed differentiation of the muscle fibers in the bladder wall of the cysticercus. It is remarkable that in larvae with a beginning autolysis these subcuticular muscle fibres become very swollen and are stainable as the musculature.

The picture of these subcuticular muscles is most characteristic in such instances where the muscles have become loose but the bladder wall is not yet extended. At that stage, when there are still signs of a protruberated surface of the cuticle or, when the surface is straight, the diameter of the individual muscle groups corresponds with the diameter of the basis of these protruberances or may be even slightly bigger (40 to 50 μ), but the fibers recede garland-like in arches (Pl. III, Fig. 1) from their cuticular insertions.

This picture of the fibers is most remarkable in bladders which have just started to grow. Relatively thick-walled folds originate on the bladder and in them especially the subcuticular cells start to reproduce, forming a proliferation zone of up to 15 μ in height, in which the basophilic plasma of the cells is very distinct. Many cells are multinucleated and their division occurs by amitosis, but we also observed a fragmentation of the nuclei. These cells resemble the proliferating subcuticular zone of growth in the head part of the parasite described in a previous paper (Šlais 1966a). In places of the just starting growth of the wall its height decreases and the cell layer splits into groups of 4—6 cells under the muscle insertion; the distance between them is 40—50 μ. In places of the strongest growth there are 5—6 cells on 0.06 mm of the wall length, which is less than in the extended wall. The same relations were also found in the bladder wall which started to grow at one end of the parenchymatous larva. At the margin of the growth folds of the bladder which encloses the scolex (Šlais 1966b) the growth is most pronounced. The wall is very attenuated, its structure becomes indistinct, the distance between the small groups is now 35—45 μ, at the very margin 70—80 μ.

The aging of the bladder wall of *C. cellulosae* was studied on developed brain forms. The wall is generally very thick, changing from 50—180 μ according to the location. The parenchymatous part has a typical hyaline appearence. The subcuticular muscle groups are very flattened but their lunar shape can be distinguished because these places are not impregnable with silver in the method after GOMORI. Silver impregnation after this method, however, is most effective when the reticular skeleton of the aging wall has started to increase. At that period even necrotic bladder walls can be determined. The onset of the necrotic and autolytic changes disturb often the structure of the wall, the contraction of the cuticle becomes more excessive, the starting autolysis causes the fusing into balls of the subcuticular muscles and also desintegrating changes in the ducts.

3. The comparison of the microscopical anatomy of the bladder wall of *C. cellulosae* with *C. bovis* and *Coenurus cerebralis*

The bladders of *C. bovis*, fixed with the surrounding tissue, were always smooth without any protruberances on their surface regardless to whether living or dead specimens were used. In living bladders fixed after removing them from the tissue, various grades of the protruberated surface of the wall are retained, which is well visible on living cysticerci. The shagreenous appearance of the surface is most characteristic and does not change in the stases of the bladder, which can be observed on it in the form of peristaltic waves. On the sections, the protruberances (Pl. II, Fig. 1) appear like a coarser formation of the cuticle and of subcuticular cell layers. The size of the protruberances is more irregular than in the wart-like formations of *C. cellulosae*. In *C. bovis* these are not protruberances of the cuticle and the fibrous layer beneath it, but formations directly from the surface of the bladder wall. The subcuticlar cells are packed in several layers in these folds forming its basis, but on the margin of the folds the cells lie in a single, often incomplete layer. In agreement with this finding the layer of subcuticular cells beneath the smooth wall of the bladder appears as an area with evenly distributed nuclei (Pl. IV, Fig. 6), as observed on a preparation of the whole bladder. In a protruberated wall surface the nuclei of these cells on the protruberances can be focussed in several levels (Pl. IV, Fig. 4, 5); on their margin we often noticed light stripes of contrasting fibers in which there were practically no subcuticular cells. This is in agreement with our findings on the sections, where the insertions of the muscle fibers in the cuticle appear as stripes of various length with the fibers mostly projecting through the cell layer and continuing under it. The protruberances on the bladder wall surface of *C. bovis* originate from the contraction of the network of muscle fibers of the whole wall causing an arching of the bladder surface in places where there are no main muscle fibers. The dimensions of these protruberances are less regular (especially after fixation) sometimes varying in height (23—24 μ), with several peaks and different bases (from 50—70 μ) but always substantially bigger than in *C. cellulosae*. The relation between their relative height and width (0.40) indicates rather flat formations. The size of the hair-like processes of the cuticle is larger than in *C. cellulosae* ranging from 3—6 μ.

In *Coenurus cerebralis* we observed the protruberated surface of the bladder wall only in parasites fixed after their removal from the brain (Pl. II, Fig. 2). In the attacked organ the wall of the coenurus is always smooth, mostly extremely distended which is connected with the morphology and the size of this parasite. The protruberances resemble those of *C. bovis* but are smaller in size. Their width at their basis is 28—46 μ, their height 15—22 μ. These dimensions resemble the wart-like formations of *C. cellulosae* but the index of relation of height and width (0.46) shows that the protruberances of the bladder wall surface resemble *C. bovis*.

There is one more difference in the bladder wall of *Coenurus cerebralis*, especially prominent in a bladder with a starting autolysis. Very often the surface layers are separated from the main parenchymatous part of the wall by large artifactitious slits caused by a well developed upper system of the wide ducts which lies close under the subcuticular layer (Pl. II, Fig. 2). The ducts attain a width of 40 μ; the lacunas in the places where the ducts cross each other measure up to 120 μ in diameter while the lumina of the thin ducts in the lower network are the same as in the other cysticerci. For these unusual dimensions of the upper network these ducts are still visible in a very distended bladder wall; under inconvenient osmotic conditions they readily increase in size, disturbing the congruence of the wall and separating the relatively integral parenchymatous part of the wall. Sometimes, it is possible to find an excessive extention of the ducts of the upper network in *C. cellulosae* and *C. bovis*; their localisation is responsible for the destruction of the parenchymatous part of the wall but does not lead to its separation from the cuticle and from the subcuticular layer as in *Coenurus cerebralis*.

The height of the hair-like processes on the surface of the cuticle of *Coenurus cerebralis* is approximately 1 μ, but never extending 2 μ. Calcareous corpuscles in the parenchyma of its wall were found only in the area into which the evaginated scolex opens.

ANALYSIS OF THE FINDINGS

LEUCKART (1879—1886) drew attention to the limited development of the muscle network under the cuticle of the bladder in relation to the development of the scolex part in *C. cellulosae*. In his opinion the most interesting feature is the fine branching of the muscle fibers which intermix with the basal fibrillous layer beneath the cuticle, merging with it at the same time. LEUCKART's opinion that the relation and connection of the branching of the muscle network with the cuticle may explain the wart-like surface of the cuticle of this cysticercus, has now been confirmed by our findings of special muscle fibers in this zone. The elucidation of this question in the other investigated cysticerci is blocked by the difficulty in staining the fine muscle fibers which, therefore, cannot be differentiated from the branching of fibrils of a reticular nature. This staining lability of the muscle fibers

has also been found in the characteristic subcuticular muscles of *C. cellulosae.* 200
For this reason TRELLES et al. (1952) used even ammoniacal silver impregnation after HORTEGA to demonstrate the expressive contracted groups in the racemous form of the brain cysticercus, considering them the terminal branching of the fibrils and ducts. These authors, however, failed to recognize the relation of these muscles to the wart-like surface of the cuticle although they noticed these not too distinct protruberances in the relatively smooth wall of the *C. cellulosae.*

Compared with the exact observations of LEUCKART, none of the more recent papers contributed essentially to the knowledge on the histological structure of the bladder wall of cysticerci developing in the tissues and organs. HOLZ et PETZENBURG (1957) studied mainly the cuticle of the bladder wall of C. bovis and considered the fibrillous structure beneath the cuticle the branching of the subcuticular cells. In their opinion this branching projects into the cuticle and continues as hair-like processes on its surface. The view of YOUNG (1908) that these cells participate in the structure of the body wall only by cellular processes projecting into the cuticle, seems more exact. The real nature of the protruberated surface of the cuticle can only be disclosed by electron microscopy. Although LARSH et al. (1965) demonstrated the electron optic picture of the protruberated surface of the cuticle of *Coenurus serialis* the problem still remains unclear because there was no description to it. SIDDIQUE (1963) recognized under the electron microscope three layers in the cysticercus' cuticle; in his opinion the top-and midlayer participate in the structure of the protruberated surface and the cuticle consists of the complete surface layer of the wall above the subcuticular cells. Histologically this conception is not correct because the layer, determined as bottom layers by SIDDIQUE, are subcuticular layers. In a histological study of *C. cellulosae* and *C. bovis* by VOGE (1963) this writer sees the difference in the bladder of *C. cellulosae* and *C. bovis* only in the length and form of the hair-like processes. VOGE, however, did not evaluate with finality the greater length of the bladder of *C. bovis* because of the impossibility to determine this feature in dependence on the age of the cysticercus and on the reaction of the surrounding tissue from the scanty material at her disposal.

Uncertain is also the character of the subcuticular layer. LOGACHEV (1958) determined the basal cells of the parenchyma of *C. cellulosae* as basophilic amebocytes and assumed the cell layer beneath the cuticle to derive from them. He drew attention to the close relation of the subcuticular cells to the muscle fibers and to the processes forming their cytoplasma, characterizing them as process-like desmoblasts. The fact that in the tissue of the cysticercus very similar cells produce even connecting fibers explains also the indistinct differentiation between both fiber species. LOGACHEV's conception (1959) about the nonexistence of a typical subcuticular cell layer in the cysticercus is not correct. During the active growth of the bladder the cells become typically spindle-shaped and form an epithelial layer, in which their division becomes clearly visible. The cell division is amitotic as observed by LOGACHEV (1962) who found that amitosis is the principal form of division of the nuclei of the parenchyma in *Fasciola hepatica.*

Unsolved remains the question of the two excretory systems in the parenchyma of the bladder wall, occurring only in the cysticercus. The explanation of this problem will greatly contribute to the elucidation of the function of the bladder and of the metabolism of the cysticercus. Our findings are in harmony with the results of the careful study by Pintner (1896) on the excretory system of *C. cellulosae* and *C. bovis*. In addition we succeeded to prove canals connecting both systems of ducts which Pintner, not having found them could not explain. The vertical connecting ducts in the upper lacunary network, which Pintner described as sometimes projecting even into the subcuticular layer, were also observed by us but considered an artifact. Braun (1894–1900) maintained that he found openings of similar formations on the surface of the cuticle of *C. crassiceps*. Logachev (1958) assumed that the system of ducts in the bladder wall, filled with tissue fluid, reinforces the wall mechanically by its turgor.

Data on the structure of the bladder wall of the coenurus are very scanty as mentioned by Kunsemüller (1903) who was principally concerned with the origin of the scolex. Careful studies of his drawings made it possible to observe the conspicuous size of the upper duct system beneath the cuticle. Logachev (1962) found this system of the ducts of *Coenurus cerebralis* most complicated when viewed under the luminescent microscope. The lumen of these ducts, however, was everywhere the same. In a later paper (1964) Logachev, studying the microscopic anatomy of the bladder wall of *Coenurus cerebralis*, described only findings common also in other cysticerci. In this paper he already mentioned that the lumen of the ducts is different and that the ducts with the widest lumen pass trough the parenchymatous part of the wall. This finding is not in agreement with our observations. From the drawings of Larsh et al. (1965) on experimental work on *Coenurus serialis*, it is possible to notice the increase of the parenchyma in the wall of older cysticerci which we, according to our findings, consider a general sign of aging of the cysticercus. Brumpt (1949) considered the bigger size of the protruberances on its surface a differentiating feature between *C. cellulosae* and *Coenurus cerebralis*, determining these protruberances as papillae. He also assumed that the hair-like processes originate from a dissociation of the cuticle because of their considerably smaller size than in the larvae of *Taenia solium*. This fact could be also confirmed by us to a certain extent. Wainwright (1957) tried to differentiate histologically the typical *C. cellulosae*, the racemous cyst of the brain cysticercus and the coenurus. He ascertained, however, the changeability of the "papillary-like folds" and the hair-like processes in one and the same cyst and also drew attention to the possible variability of these signs in connection with the age and the tension of the cyst. In his opinion the origin of the racemous cyst is determinable only in such instances, where also scolices are found. According to our findings, a histological differentiating diagnosis of the mentioned cysticerci seems quite possible.

1. Under the cuticle of the bladder of *C. cellulosae* but above the layer of subcuticular cells there are muscle groups which, when contracted, cause the wart-like surface of the cuticle; this feature is most characteristic for this species. On histological sections these muscle groups, even if dilated, are characteristic for the bladder wall of *C. cellulosae* from the musculature of the swine, from a cysticercosis of the brain and from the racemous form of the brain cysticercus.
2. The protruberated surface of the bladder wall of *C. bovis* and *Coenurus cerebralis* is caused by the contraction of the main muscle layer of the wall, which can be proved on histological sections.
3. The wart-like protruberances and the protruberated surface of the bladder wall of the cysticercus are dependant on the contractions of the muscle fibers and therefore not one of its stable features.
4. The system of ducts in the wall of the cysticercus is formed by the upper lacunary network and the deep network of thinner ducts. In *Coenurus cerebralis* the upper network lies close beneath the layer of subcuticular cells and is remarkably conspicuous.
5. Table of dimensions of differentiating characters in the individual species.

	C. cellulosae	*C. bovis*	*Coenurus cerebralis*
Base of wart-like formations and protruberances	27 – 38 μ	50 – 70 μ	28 – 46 μ
Height of wart-like formations and protruberances	15 – 27 μ	23 – 34 μ	15 – 22 μ
Height of the border of hair-like processes on the cuticle surface	1 – 2,5 μ	3 – 6 μ	1 – 2 μ
Groups of muscle fibers beneath the cuticle	+	0	0

6. The bladder wall of the cysticercus shows a remarkable proliferation of the layer of subcuticular cells during its growth. In aging the parenchymatous part of the wall increases and changes regressively. The first signs of dystrophy to autolysis become manifested in the stagnation of the content and in the origine of deposites in the duct system of the bladder wall.

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EXPLANATIONS TO PLATES

Plate I

Fig. 1. Bladder wall of *C. cellulosae* from the musculature of the swine, showing the dilated branching of the system of ducts and the wart-like surface of the cuticle. On the base of the protruberances the contracted subcuticular muscle groups (a), beneath them the layer of subcuticular cells (b) and some fibers (f) of the main wall muscles. In the wall, sections of the ducts of the upper- (c) and the lower (b) network and connecting ducts (h) of both systems.

Fig. 2. Bladder wall of *C. cellulosae* (contracted) from the musculature of the swine. The stripes of the shrunken subcuticular muscle groups are well visible at the base of the wart-like formations.

Fig. 3. Wall of the racemous cyst of the brain cysticercus with a remarkable wart-like cuticle surface, taken from a not extended, but folded part of the wall of the cyst. In some parts the hair-like processes (e) of the cuticle are visible.
Hematoxylin-eosin (375 ×).

Plate II

Fig. 1. Protruberated wall surface of a collapsed bladder or *C. bovis*. Nuclei of the subcuticular cells accumulate at the base of the protruberances; beneath them stripes of fibers (f) of the main musculature of the bladder wall. Especially remarkable are the hair-like processes (e).

Fig. 2. Protruberated wall surface of the collapsed bladder of *Coenurus cerebralis*. Nuclei of subcuticular cells accumulated at the base of the protruberances. Hair-like processes (e) very low on the surface of the cuticle. Lacunas of the upper duct system greatly extended.
Weigert-van Gieson (375 ×).

Plate III

Fig. 1. Part of the wall from the proliferating fold of the bladder of *C. cellulosae* from the musculature of the swine. Most noticeable are the garlands of th loosened subcuticular muscles under the cuticle (a) and between them the compressed subcuticular cells (b). Between sections of the ducts of the upper (c) and lower (b) network a dilated, porous system of branching ducts. (Goldner 700 ×).

Fig. 2. a: part of the wall of a shrivelled bladder of the brain cysticercus; under its surface fibers of subcuticular muscles (a) b: surface of two proliferating buds of the racemous form of the brain cysticercus, between them granulated tissue (g). Fibers of the subcuticular muscles (a) are visible. Mallory's phosphowolfram hematoxylin (700 ×).

Plate IV

Fig. 1. Preparation of the whole bladder wall of *C. cellulosae* with the wart-like cuticle surface. The peaks of the wart-like formations are brought into focus. Weigert's ferric hematoxylin.

Fig. 2. Preparation from Fig. 1 with the layer of subcuticular cells brought into focus. The even distribution of the nuclei at the wart-like cuticle base are visible.

Fig. 3. Layer of subcuticular cells from a preparation of the smooth wall of *C. cellulosae*. Cell nuclei accumulate on the circumferences of the empty places, corresponding with the dilated subcuticular muscles groups which are not shown. Jasvoin.

Fig. 4. Preparation of the whole bladder wall of *C. bovis* with a protruberated surface. The peaks of the protruberances brought into focus. Weigert's ferric hematoxylin.

Fig. 5. The layer of subcuticular cells on a preparation of the complete bladder wall of *C. bovis* with the protruberated surface, brought into focus, shows the accumulation of cells at the base of the protruberances. Jasvoin.

Fig. 6. The even distribution of nuclei shown on preparation of the complete bladder wall of *C. bovis* with a smooth surface in focussing the subcuticular cell layer. Weigert's ferric hematoxylin. (Magnification of all figures 335 ×)

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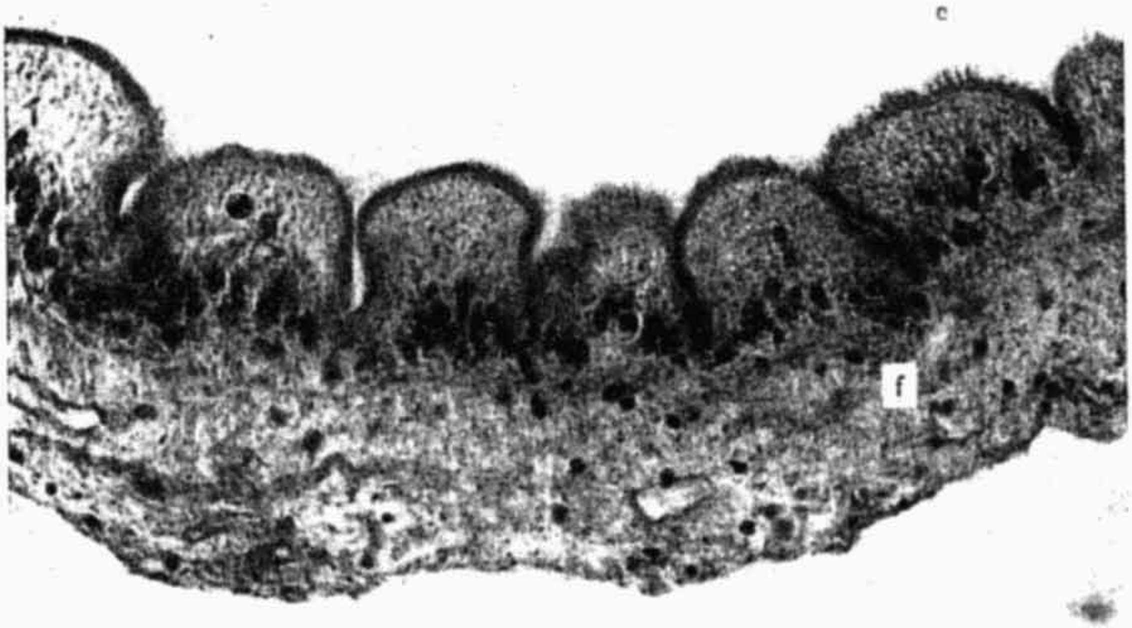

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