CONTRIBUTION TO THE PATHOLOGY OF STROBILOCERCOSIS (STROBILOCERCUS FASCIOBLARIS) IN THE LIVER OF MAN AND SOME ANIMALS

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Abstract. Tissue reactions with liver strobilocercosis were studied in man, pheasant and muskrat on the basis of histological examination. Microscopical changes in the liver induced by completely developed and still quite vital strobilocerci are very similar in all these hosts and in all cysts the parasite was enveloped by a fibrous capsule consisting of two layers. The development of regressive changes and the character of tissue reaction during the death of the parasite are discussed. *Strobilocercus fasciolaris* was found for the first time in man, in a solitary cyst in the liver. The possibility of massive infestation of man liver is pointed out.

In our previous paper (Štěrba and Baruš 1976) the morphology of strobilocercus found in a cyst from man liver was compared with that of *Strobilocercus fasciolaris*, the larval stage of *Hydatigera taeniaeformis*, recovered from pheasant (*Phasianus colchicus*) and muskrat (*Ondatra zibethica*). It was concluded that the strobilocercus from man liver was identical with *S. fasciolaris*.

The probability of infection of man with the larval stage of *H. taeniaeformis* is largely contingent on the incidence of this cestode in the definitive hosts and possibility of contact with the eggs. In Czechoslovakia, *H. taeniaeformis* has been recorded in five species of Carnivora listed in our foregoing paper (Štěrba and Baruš 1976). In view of a possible infection of man with the eggs of this cestode, the cat (*Felis silvestris lybica* f. *catus*) is of greatest importance, because as a domesticated animal it lives in the closest contact with man. Although the dog (*Canis familiaris*) has not been reported to serve as definitive host of *H. taeniaeformis* in Czechoslovakia, it should be noticed that this animal is susceptible to infection (Vogelsang 1925, Kozlov 1963) and may become a source of infection to man.

The pathological picture of strobilocercosis has been little studied in the literature. Occasional papers by various authors deal primarily with degenerative processes occurring during heavy experimental infections (Bullock and Curtis 1920, 1924, 1926; Bullock et al. 1934, Hutchison 1958, Gelazius 1962, Coleman and DeSalva 1963) and only some of them (Vahátka 1967, Marcial-Rojas 1971) briefly describe the histological picture in spontaneous infections. The present paper deals with pathological changes caused by strobilocercus in the liver of man, pheasant and muskrat. The strobilocercus has never been reported in man in the world literature and also the occurrence of this parasite in pheasant is quite exceptional.

MATERIAL AND METHODS

A spherical cyst from the liver of 77-year-old man obtained at post-mortem examination and an excision of a part of liver with strobilocerci from pheasant (Ryšavy 1973) and muskrat were used in our studies.

The material from all hosts was fixed in 10% formal. The strobilocercus from man liver was re-
moved from the cyst and determined on the basis of morphological and metrical characters. A whole mount was prepared from the scolex part of strobilocercus after a fine preparation. The incompletely segmented middle part and the bladder part of strobilocercus and the cyst with a remainder of liver parenchyma, as well as the cysts from pheasants and muskrat, were embedded in paraffin and partial series of histological sections were prepared. The sections were stained using conventional staining methods: haematoxylin-eosin, van Gieson's method, van Gieson-elastica, Gomori's method and trichrome staining after Goldner and Masson. The demonstration of calcium was carried out using the method of Kossa. PAS reaction was used for the detection of mast cells and regressive modification of Giesma's method for the determination of hooks of the parasite.

RESULTS

1. Man. Numerous serous cysts and one spherical cyst measuring 7 mm in diameter, remarkable in its whitish, relatively thick tissular wall (0.1—0.2 mm), were found in liver lobes of a 77-year-old man at autopsy in Sítk's Institute of Pathology and Anatomy, Faculty Hospital, Plzeň (No. of autopsy record 443/74, No. of histological examination II-2002). A macroscopic examination revealed that the cyst contained a strobilocercus. The cyst with a part of liver parenchyma was taken out for histological studies (Štěrba and Buroš 1976).

Microscopical observations indicate that the cyst wall consists of lamellar, distinctly undulated, sclerotic hyaline tissue. Occasional small centres of dystrophic calcification are visible in the connective tissue wall, which contains activated fibroblasts, histiocytes and reticular cells in the margin. A thin layer of newly formed collagenous and reticular fibres is adjacent to the wall from the outside. Lymphoplasmocytic infiltrates are present in some places. The liver cells around the cyst are very atrophic.

The cyst is filled with a coiled strobilocercus and finely granular content with the admixture of occasional cellular elements, histiocytes, fibroblasts and eosinophilic and neutrophilic leucocytes. The strobilocercus is characterized by a scolex with four suckers, rostellum with 30 hooks arranged in two circles (each consisting of 15 hooks) (Plate 1, Fig. 2). The long, incompletely segmented middle part terminates in a small bladder filled with a fluid. The segments are covered with a tegument (Rees 1971), the subtegmental zone contains subtegmental cells and muscular fibres, which are present in a large number in the parenchyma of the larva, together with calcareous bodies (Plate II, Fig. 1). Calcareous bodies are contained also in the wall of bladder (Plate IV, Figs. 2, 3) which is a determining character of strobilocercus.

Other serous cysts are formed by a hyaline layer, mostly without epithelium. They are linked with portal fields. There is a slight, diffuse fibrosis, little venostasis, sclerosis of branches of artery hepatica and infiltration of lymphocytes and plasmocytes in portal fields.

2. Pheasant. A section through three oval cysts with coiled strobilocoerci in strongly autolyzed liver parenchyma is shown in Plate III, Fig. 1. The cysts measure 7×4, 5×5 and 6×3 mm in diameter. Two of them lie close to one another and their wall consists of collagenous lamellar connective tissue. There is a remainder of atrophic liver parenchyma between their walls (Plate IV, Fig. 1). The connective tissue of one of the cysts is strongly folded, with minimum cellulation, without vessels and with considerable hyaline sclerotization (Plate IV, Fig. 2). Quite occasionally activated fibroblasts and histiocytes occur mostly on the inner surface of the connective tissue wall. Numerous, strongly swollen, mono- and multinuclear histiocytes, fibroblasts, reticular cells and neutrophilic or eosinophilic leucocytes are visible in the connective tissue wall of other two cysts. Mast cells are found only rarely. Activated and swollen
histiocytes penetrate through the connective tissue wall and on the inner side of the
cyst form a layer consisting sometimes of even five cells situated above one another.
Close to the connective tissue wall is a thin layer of collagenous connective tissue with
lymphocytes, reticular cells, occasional eosinophilic leucocytes, fibroblasts and newly
formed capillaries.

The cysts are filled with a finely granular content situated between the sections
through strobilocercus and cyst wall (Plate III, Fig. 2). In some places the tegument
of not fully segmented parts of strobilocercus adheres to tissue envelope and in places
where it comes into contact with the parasite there are regular imprints of parts of
strobilocercus segments in the connective tissue.

In the places where activated histiocytes are accumulated on the inner side of the
connective tissue wall, the cells are released into the cyst content and gradually dege-
nerate. The cells partly disintegrate, partly their vacuolation is changed and partly
they form homogeneous, cosinophilic balls without nuclei. Besides the histiocytes,
there are occasional, often degenerated erythrocytes and neutrophilic and especially
eosinophilic leucocytes in the nuclear content of cysts. Larger dystrophic calcifications
are visible in the wall of the bladder-like part of strobilocercus, in the connective cyst
wall and cyst content. The onset of calcification may be observed even in some areas
of strobila region. Calcareous salts are deposited in form of irregular, multiangular
formations or druses of various shape. Their periphery displays basophilic staining,
whereas the amorphous centres stain only slightly.

Sections through the scolex part of strobilocercus show the suckers and rostellum
with hooks (Plate V, Fig. 1). The scolex is adjacent to the connective tissue cyst wall
in which the hooks are immersed, as it was demonstrated by Giemsa’s regressive
staining (Plate V, Fig. 2). The connective tissue adjacent to hooks reaches up to the
connective tissue of the rostellar margin, running into the space between hooks in
form of lashes. The surface of the lashes is stucked together with a thin layer of con-
nective tissue on the surface of rostellum by means of a thin liquid exudate (Plate V,
Fig. 2). The cells of the connective tissue are pyenotic, the fibres of the inner layers are
disintegrated into fine granules and the structure of the connective tissue is quite
indistinct. Externally there is a thin layer consisting of 3—4 layers of lamellar colage-
nous fibres with numerous fibroblasts, the nuclei of which are strongly flattened and
elongated. A large vein compressed by the cyst adheres to this connective tissue layer.
In another vein compressed by the cyst and adjoining its wall there is a fresh, extensive
parietal thrombosis filling almost entire lumen of the vessel.

3. Muskrat. An oval parasitic cyst of spherical shape and measuring 7 mm in
diameter was found in the excision from liver of muskrat (Ondatra zibethica). The cyst
wall, 0.05—0.15 mm thick, is formed by a folded hyaline tissue with activated fibro-
blasts, histiocytes and occasional eosinophilic and neutrophilic leucocytes (Plate IV,
Fig. 1). Large number of swollen and proliferating histiocytes are located on the inner
surface of the cyst wall where they form a thin layer (Plate VI, Fig. 2). Sometimes they
are arranged in form of a palisade. A thin connective tissue layer, infiltrated with
macrophages, fibrocytes, reticular cells, plasmacyctes and lymphocytes adheres to the
connective tissue cyst wall. A large lymphoplasmodotic infiltration forms conspicuous
focus-like clusters. The atrophic liver parenchyma forms sometimes bands of rests
of liver cells, separated from the remaining parenchyma by the connective tissue
in the porta. The liver tissue proper is passively hyperemic and occasional infiltrates
of lymphocytes and plasmacyctes can be observed in portobiliary areas.

The sections through the cyst content show the middle, incompletely segmented
part of strobilocercus and the section through its bladder-like part. The cyst is filled
with finely granular content with larger admixture of cellular elements, mainly histo-
cytes, and neutrophilic and eosinophilic leucocytes. The vacuolation of some histiocytes changes and they gradually disintegrate, others change into marked homogeneous spherical structures. A characteristic finding are special focal dystrophic calcifications. They form irregular, multangular structures only partly calcified, showing conspicuous basophilic staining by haematoxylin-eosin only on its periphery, whereas the middle of these structures stains only slightly or not at all. These calcifications occur in the tegument, subtegumental zone and parenchyma, especially of the bladder, and are gradually released into the cyst content. However, the onset of calcification can be sometimes observed also in the tegument of incompletely segmented part of strobilocercus. These calcifications rarely occur also in the proper connective tissue wall of the cyst. Other parts of the strobilocercus are still well preserved.

**DISCUSSION**

*Strobilocercus fasciolaris* belongs to the larval stages of cestodes, the oncosphere of which penetrates into the liver of the intermediate host, where it locates itself and continues developing.

According to Marcial-Rojas (1971), the development to the infective stage lasts about 30 days. A whitish, spherical or ovoid cyst arises, measuring from some millimetres to several centimetres in diameter. The appearance of the cyst is not always the same. Hutchison (1958) observed that already during the first 14 days of infection of mice the cysts sometimes degenerate and are replaced by minute yellow scars. Usually the cyst wall is at first transparent and the presence of strobilocercus gives it a whitish colouring. Later, when the connective tissue of the cyst wall proliferates, the wall becomes markedly thickened and whitish, as it was observed in our cases. Reddish or, rarely, black cysts observed macroscopically by Hutchison (1958) and other authors are often encountered in heavy infections lasting more than 6 months. The unusual colouring of the cyst in these cases is due to the haemorrhage into the cyst content and its filling with blood. The strobilocerci in these changed cysts are mostly yellow, but of normal morphology and capable of infecting cats.

Most often there have been 1—5 cysts recorded. An exceptional finding was described by Tenora and Baruš (1955) who observed 315 cysts in the liver of muskrat. The liver tissue was completely atrophied and instead of liver arose a grape-like structure filling the entire abdominal cavity.

The pressure atrophy of liver parenchyma, which always accompanies the development of the cyst, does not cause any general changes with infection of 1—5 strobilocerci (Vaňatka 1967). In these cases the hosts do not show any symptoms. A marked symptomatology is caused only by heavy, massive infections accompanied by extensive destruction or disintegration of liver parenchyma. Schwabe (1955) and earlier also Bullock and Curtis (1920) found that in certain strains of rats the strobilocerci may provoke the formation of liver sarcoma during 12 to 15 months after infection.

While comparing the histological findings from man, muskrat and plesaunt we found that microscopic changes caused by the strobilocercus in the liver are very similar. In all cysts the parasite is enveloped by a fibrous capsule consisting of two layers. The internal layer is thicker and formed by hyaline connective tissue containing many types of cells. Besides fibroblasts, histiocytes and reticular cells there were also occasional neutrophilic and eosinophilic leucocytes. The external, thinner layer was formed by a network of colagenous and reticular fibres and contained occasional capillaries. Besides eosinophiles and fibroblasts there were also lymph cells and plasmo-
cytes forming marked infiltrates in some places. These were conspicuous especially in muskrat and pheasant, but were also present in the vicinity of the cyst from man liver. We did not observe, however, the marked presence of mast cells in the capsule of *S. fasciolaris*, which was reported by Coleman and De Salva (1963).

The calcifications observed in all our microscopical examinations are very typical of *S. fasciolaris*. They result from gradual degeneration and are located mostly in the bladder part or, to a smaller extent, also in the tegument or subtegmental zone of the strobilocercus. The calcifications occur usually also in the cyst wall or their conglomerates are contained in the liquid cyst content. Gelazius (1962) observed the impregnation of cysts or larvae with calcium salts at any stage of development of *H. laenaeiformis* larva. The same author, but also Bullock and Curtis (1926) recorded that the deposition of calcareous precipitates into the cyst wall and body of larva results from the close contact of blood circulation and developing larva in the liver and that the calcification of some parts of larva usually precedes its death.

The development of degenerative changes of strobilocercus inside the cyst, which was not observed in our study, leads to its death in the final phase. This is accompanied by an exudation especially of neutrophilic leucocytes into the cyst content. The marked exudation of leucocytes made Bullock and Curtis (1924) believe that the death of larvae inside the cyst is due to the presence of pyogenic microorganisms. However, the cultivation of these changed cysts revealed staphylococci only in two cases. Similarly Hutchinson (1958) found later plasmocorphic Gram-positive bacteria and *Corynebacterium muris* only in some of the cysts with exudation of leucocytes. These occasional findings show that the contamination of cysts with the bacteria is not the main reason of the death of strobilocercus as it was supposed before. The development of inflammation with marked leucoytic exudation is, in our opinion, a reaction to products of disintegration of the dead parasite.

Our finding is the first record of *Strobilocercus fasciolaris* in man. It was a solitary cyst in the liver which is usually found in rodents, though the cysts are sometimes numerous in these hosts (Holíková and Kočiš 1955, Tenora and Baruš 1955). The record of strobilocercosis in man suggests that under certain conditions a massive infection of liver might occur. Of importance is the insufficient hygiene of old people and their close contact with some pets, especially the cat. The conditions leading to massive infection of man are thus in principle similar as in the case of hepaticolysis (Štěrba and Šlais 1972, Šlais 1973, Šlais et al. 1973).

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**ПАТОЛОГИЯ СТРОБИЛОЦЕРКОЗА (STROBILOCERCUS FASCIOLARIS) ПЕЧЕНИ ЧЕЛОВЕКА И НЕКОТОРЫХ ЖИВОТНЫХ**

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**Резюме.** На основе гистологического исследования была изучена тканевая реакция при стробилюбекеркозе печени человека, пчазы и оленята. Было обнаружено, что у совершенно развитых и еще совсем витальных стробилокерков микроскопические изменения, вызванные стробилюбекеркоза в печени этих хозяев, очень подобны и что во всех плявах паразит окружает белья капсулой, состоящей из двух слоев. В работе обсуждается развитие регрессивных изменений и характер тканевой реакции при отмирании паразита. *Strobilocercus fasciolaris* был найден в первый раз у человека в солитарной цисте печени. Предупреждается о возможности массового поражения печени человека.
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Fig. 1. *Strobilocercus fasciolaris* from man liver; general view of scolex with rostellar part and hooks in two circles. Native preparation. (×77)

Fig. 2. Detail of the blade and shape of hooks from Fig. 1. Native preparation. (×134)
Fig. 1. Histological section through incompletely segmented middle part of strobilocercus from man liver. Haematoxylin-eosin. (×55).

Fig. 2A. Black calcareous bodies in the wall of bladder part of strobilocercus. Method of Kossa. (×71)

Fig. 2B. Histological section through bladder part of strobilocercus with calcareous bodies. Haematoxylin-eosin. (×57)
Fig. 1. Histological section through three cysts with coiled strobilocerci from pheasant liver. Close to the cyst is a vessel (C) partly deformed by the cyst and filled with blood precipitate. A section through scolex part (S) of strobilocercus is visible in one cyst. Stained by regressive Giemsa's method. (×5.5)

Fig. 2. A cyst filled with finely granular content (O) situated between section of strobilocercus and cyst wall (S). Stained by van Gieson-elastica. (×53).
Fig. 1. Histological section through two neighbouring cysts. Remnant of atrophic liver parenchyma (P) between the walls. Stained by van Gieson-elastica. (× 53)

Fig. 2. Detail from Fig. 1. Connective tissue (V) of one of the cysts is strongly folded. (P) — atrophic liver parenchyma. Stained by van Gieson-elastica. (× 177)
Fig. 1. Section through scolex part of strobilocercus from pheasant liver. (C) - vessel compressed by the cyst, (H) - hooks, (R) - rostellum, (P) - section through sucker. Stained by regressive Giemsa's method. (× 50)

Fig. 2. Detail of rostellar part with hooks from Fig. 1. Connective tissue (V) of the cyst wall penetrates into the areas between hooks (H) in shape of lashes (S), the surface of which is stucked together with a thin connective layer on the surface of rostellum (R) by a thin exudate. (C) - deformed vessel. Stained by regressive Giemsa's method. (× 348)
Fig. 1. Section through connective tissue cyst wall from muskrat liver. The wall consists of folded hyaline tissue. External, thinner connective layer with lymphoplasmocytic infiltrate (L). Haematoxylin-eosin. (×177)

Fig. 2. Swollen and proliferating histiocytes on internal surface of cyst wall. Liver parenchyma (P) around the cyst. Granular content (O) inside the cyst. Stained by regressive Giemsa's method. (×177)