TISSUE REACTION IN EXPERIMENTAL CYSTICERCOSIS OF SHEEP AND GOATS CAUSED BY INFECTION WITH TAENIA SAGINATA EGGS

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Abstract. In experimental infection of sheep with Taenia saginata eggs, the intensity of infection may be influenced by the age of the animal at the time of infection, the height of the infection dose, and the mode of infection (perorally in capsules or by means of an oesophagus tube). In inadequately intermediate hosts of T. saginata (sheep, goat), the cellular reaction around the young cysticercus is very strong, but it differs from the reaction known in bovine cysticercosis. Large macrophages, which migrate to the larva at the early phase of infection in cattle, are lacking in sheep and goats. Neither the formation of collagen in the granulation tissue was observed in those hosts, but the demarcation of the cysticercus was formed by a wide zone of connective tissue at the periphery. The development of the cysticerci was markedly retarded and already four weeks after infection a majority of cysticerci were dead. Nodular changes persisted until 48 days p.i., when the cysts are transparent in cattle. Neither cysticerci nor their remnants were found at that time. The results of indirect haemagglutination reaction are not constant in inadequate intermediate hosts (particularly in sheep) and only low titres of antibodies can be detected even in strong infections.

Cattle are natural intermediate hosts of T. saginata, but spontaneous infection with C. bovis was recorded also in zebra, camel, various species of gazelles and antelopes and some other ruminants (Grabar 1939, 1974). Cysticercosis in wild living animals, which are often hunted by local inhabitants and are not submitted to a veterinary inspection, may become the main source of human taeniasis in some parts of Africa. Grabar (1939) reported on two cases of spontaneous liver cysticercosis (C. bovis) in sheep and mentioned older records of C. bovis in giraffe. It is evident, however, that a spontaneous C. bovis infection in other animals than those of the family Bovidae occurs quite exceptionally. In spite of this, attempts are made to elucidate whether an experimental infection can be induced in adequate intermediate hosts and what is the course of this infection. The problem of a model experimental animal for the studies of bovine cysticercosis would be thus solved and a comparison of the changes in inadequate intermediate hosts with those in cattle might contribute to a deeper knowledge of basic laws of C. bovis infection and of questions of specie specificity of the parasite. These experiments showed that inadequate intermediate hosts can be infected, but only few cysticerci (0.06—0.12) develop from the eggs or oncospheres in both peroral and intravenous infections (Boczoń et al. 1974, Kozakiewicz 1977), whereas in calves, 4—13% of eggs develop (Kozakiewicz 1977, Chroustová 1981) and the cysticerci die very soon. It was reported that, e.g., in sheep a majority of cysticerci are dead already 6 weeks after infection (Geerts et al. 1981). Not all animals of the same experimental group can be infected (Boczoń et al. 1974). A different resistance may occur even in different races of the same species (Geerts et al. 1981). In non-natural (inadequate, atypical) hosts, as in sheep, the development of cysticercosis is characterized by a rapid "immune reaction" (Geerts et al. 1981). A strong cellular reaction around the dead cysticerci even foci of inflammatory cellulation without the parasite were observed
Dexamethazone was repeatedly applied in order to make the infection more successful and to facilitate the development of the cysticerus by suppressing the cellular reaction. This process may affect positively the result of infection, and the onset of dystrophic changes in the cysts and the death of the cysticerus are thus delayed (Geerts et al., 1981).

We have performed an experimental infection of sheep and goats to get some information on the character of the pathological process and its dynamics, because the data on the pathomorphology of cysticerosis in atypical intermediate hosts are incomplete.

**MATERIAL AND METHODS**

One dwarf goat at the age of 1 year, four sheep of the race valaiska at the age of 10 months and three 2-month-old meroic lambs were used in the experiment. The goat was infected perorally with 200 000 eggs of *T. saginata* and the sheep with 150 000 eggs in gelatin capsules. The lambs were infected with 400 000 eggs of *T. saginata* administered in water by an osophageus tube.

After the animals had been killed, blood samples were taken for serological tests and a detailed post-mortem examination was performed. The muscles were cut into 5-mm thick sections. The histological and electron microscopical studies were performed by conventional methods.

**RESULTS**

The dwarf goat infected perorally with 200 000 *T. saginata* eggs was killed four months after infection. On histological examination, small tuberculoid nodes, necrotic in the centre, at the periphery of which was a hyperplastic lymphoid tissue and deposition of hemosiderin, were found in lungs. Alveolitis with a desquamation of alveolar alveolar epithelium was observed around the nodes. The liver contained a single peribular nodules with a necrotic centre; the necrosis was surrounded by giant multinuclear cells and lymphocytes were accumulated at the periphery of the node. Clusters of macrophages with a brown pigment (lipofuscin) were found in the connective tissue with a slight inflammatory infiltration at the periphery of lobules. The serological examination (IHA) was positive and the antibody level increased during the infection and later (Table 1).

The group of four valaiska sheep at the aged of 10 months was infected perorally with 150 000 *T. saginata* eggs in gelatin capsules. Since the macroscopical examination of one of the sheep killed on day 14 p.i. was negative (Table 1), the remaining three sheep were reinoculated with 200 000 eggs on day 26 p.i. using the same method. The post-mortem examination of this sheep revealed an elongated, mostly calcified focus in liver parenchyma, but it was regarded as an older process of another etiology. The histological examination showed that it was a necrotic focus with shadow remnants of leucocytes, but no other structures were found. It was surrounded by several layers of connective tissue and with a fibroplastic granulation tissue in some places. The periphery consisted of lymphocytes, partly in nodular formations. In the vicinity of this focus, but also in other excisions from liver tissue, were dilated veins with markedly thickened wall, containing sometimes, in addition to erythrocytes, a stratified eosinophilic mass resembed a thrombus. Sometimes granulomas with giant multinuclear cells at their periphery were visible in the vicinity of the changed vein. At some sites, macrophages with lipofuscin were accumulated, and periferal fields were infiltrated with lymphocytes and eosinophiles. The general character of the changes indicated a thrombosis and granulatative inflammation with following fibroproduction in the vessels. The changes did not seem to be caused by micrococcides. A medium lympho-plasmocellular infiltration of the interstitium was also observed in the heart muscle.

The first of the reinoculated sheep was killed 15 days after reinfection, i.e. on day 41 after primary infection. The liver contained grey-white milt-like foci and single spherical foci of yellowish colour measuring up to 3 mm in diameter. The small foci had a histological character of nodes, the periphery of which consisted of lymphocytes accumulated in follicular formations. The middle of the nodes was formed mainly from eosinophilic granulocytes which sometimes penetrated through the incompletely closed barrier of lymphocytes, infiltrated the surrounding liver tissue and reached up to serosa. Outside the node the infiltration with eosinophilic was markedly perivascular, but even the intima of sublobular veins was infiltrated by them. Thy of a calcified eosinophilic nodes and sometimes contained thrombi. Not very deep in the liver tissue was a wedge-shaped focus of eosinophilic with a hypoplasia of lymphatic tissue at the periphery. A mostly thrombotic vessel with inflammatory changes in the wall led to this focus. In the vicinity of these changes, the liver parenchyma was preserved only in islets surrounded by a newly formed connective tissue, largely infiltrated with eosinophilic. The epithelium of the Ginseya's capsule above these foci was hyperplastic and viliform structures of a connective tissue were seen as a result of the proliferation of the connective tissue component. The larger yellowish nodes were encapsulated with connective tissue and calcified in the centre: at some sites the necrotic mass still contained distinct clusters of eosinophiles and even several so-called calcaresous corpuscles of a typical appearance. Giant multinuclear cells and lymphocytes, surrounded the calcified centre and lymphocytes in form of follicles were observed further to the periphery. A lympho-plasmocellular infiltration of interstitium was found in the heart muscle.

The remaining two sheep were slaughtered on day 77 after reinfection, i.e. on day 103 after primary infection. The post-mortem examination of one of them revealed white foci measuring about 1 mm in diameter in the liver, not sharply demarcated grey-white areas with a central cavity of the left ventricle near the left ventricle at the arterial end of the left ventricle. At the arterial end of the left ventricle, grey-white, elongated structures measuring about 3 ×1 mm and situated subepikardially in abdominal muscles. A yellow-white, hard, bean-shaped structure was found in musculus quadriceps femoris in one leg. The histological examination showed that the microscopical correlation of the not sharply demarcated foci under the epicardium is a very strong perivascular cellulillation of intersistium with lymphocytes with an admixture of plasmocytes and at some sites also lymphocytic infiltration of subepicardial fat tissue. The liver tissue contained clusters of lymphocytic cells and at the periphery of some lobules, proliferation of fibrous elements and accumulation of large macrophages with pigment granules was observed. The granules showed a light yellow fluorescence in UV light and the histochemical reaction of NiI blue, alcian blue demonstrated the presence of mucin in the foci. The foci in abdominal muscles, subepikardially visible already on macroscopical examination, contained clusters of eosinophilic, which together with the lymphocytes infiltrated also the interstitium among the fibres of the abdominal muscle. The histological examination of the calcified structure from musculus quadriceps femoris after decalcification showed that it was a cyst with a dead and completely calcified structure. The structure of the larvae was disintegrated, but shadow contours of the suckers could be detected.

The changes observed in the second sheep were the following. A canal-shaped yellow structure penetrating deep in form of a wedge was observed at two places in the liver near its visceral surface and several small green-white foci were found under the serosa of the diaphragmatic area of the liver. Histologically it was a set of granulomas appearing like branched vessels and dilated canals. Their centre consisted of a glioma type tissue. Their centre consisted of a glioma type tissue. Their centre consisted of an eosinophilic substance with remnants of dead cells of the exudate, around which the giant multinuclear cells were arranged. Inside them, there were phagcytized parts of the necrotic exudate, spherical eosinophilic substance or irregularly spherical, distinctly contoured structures of unclear provenance, with an indistinct, slightly basophilic content. The peripheral part of the granulomas consisted of clusters of lymphocytes
and scarce connective tissue infiltrated with eosinophils. At the sites where the granulomatosus changes were not so pronounced, the described changes were evidently thrombotic at the periphery of liver lobules (probably sublobular veins) at the stage of repairation of pathologic changes. The arteries in their vicinity possessed a thickened muscular layer of the wall, intima infiltrated with eosinophils and narrowed lumen. The eosinophilic infiltration, even in more distant vicinity of the changes, was markedly perivascular. Macrophages with lipofuscin were accumulated perivascularly (according to the nature of the vessels, probably at sites where the vessels disintegrated) and at the sites with inflammatory infiltration of connective tissue. This tissue completely isolated smaller groups of liver cells at some places.

The second experimental group of animals consisted of 3 merino lambs about 2 months old at the time of infection. They were infected with a suspension of 500,000 *T. saginata* eggs in water administered with an oesophageal tube.

On the post-mortem examination of the lamb slaughtered on day 15 p.i., grey-white, not sharply demarcated foci were found subepicardially in the left ventricle, right atrium and in the region of auricle; the liver contained several foci of about 1 mm in diameter; the lungs contained 10 small nodules (2-3 mm in diameter), some in macroscopically unchanged tissue, others in the lung tissue with inflammatory changes. In the kidneys, there was only one node (3 mm in diameter) in the outer cortex.

The histological examination of the heart revealed dilated vessels with clusters of lymphocytes around them; inflammatory infiltration of interstitium and of vicinity of Purkinjé fibres and focal destruction of muscle fibres (Plate IV, Fig. 1). At the sites where cysticercus was found on histological examination, there was a zone of necrosis bordered by a few 2-3 mm thick, residual tissue from histiocytes and eosinophils (Plate IV, Fig. 1); the endothelium of capillaries and small vessels was markedly swollen. The proliferation of these cells reached rather far from the site of cysticercus localization. The nodular formations in the heart were a similar structure as the foci in heart. In addition to them there occurred infiltration of interstitium by lymphocytes and to a smaller extent also by plasmocytes; activation of lung macrophages filling completely some of the alveoli but occurring also in bronchi (Plate II, Fig. 2); a slight inflammation of bronchi and marked inflammatory infiltration of the wall of pulmonary arteries and their venules.

A necrosis was found in the centre of the node in the masseter, whereas around it there was again a fresh granulation tissue consisting of histiocytes and at the periphery, accumulation of lymphoid cells was observed.

The day 27 p.i. another surprisingly high number of cysticerci was found. There were almost 200 (186) cysticerci, 70 of them in skeletal muscles (7 in masseter, 100 in both lungs, 7 in liver and 9 in heart. The lamb exhibited the signs of malnutrition, with light ascites and hydrothorax. A node of about 10 mm in diameter was found in subcutaneous muscles in thorax region and a similar one in abdominal muscles. The nodes were of almost uniform size. In muscles they measured 10.9 × 7.2 × 7.7 mm on the periphery (measured by a caliper), in lungs they were somewhat smaller, 8.2 × 5.4 × 5.2 mm on the average. The peripheral part of the node was solid, sometimes almost gristy, and 1.7-2 mm thick, whereas the centre of the node was changed into a pasty, yellow to yellow-green matter. Sometimes a dark blood flowed from the section. In this purulent matter lay usually a small larva measuring 0.8-2 mm (0.83 mm in lungs and 0.96 mm in muscles on the average). However, the liver, heart and partly also the subcutaneous small nodules and minute grey-white foci (about 1 mm) arising as a reaction to the presence of larvae dying often at an early stage of infection.

The histological structure of the nodular affection was uniform and differed only in negligible details in some nodes. Around the cysticercus was a necrosis with nuclear detritus and single eosinophils at the periphery and sometimes with calcification of the foci.
The lamb slaughtered on day 41 p. i. harboured a total of 47 nodes: 28 in liver, 18 in lungs and only one in muscles (in m. poeas). The nodes were localized both on the surface and inside the lungs and liver, they were of grey-whitish colour, sometimes slightly opalescent and always filled with a yellowish matter. Their size and appearance was almost the same as on day 27 p. i. In a section through the node it was evident that it consisted mainly of a yellow, inspissated and rather compact mass with a pit-shaped impression. The solid tissue was preserved only at the periphery of the node, but it was at most 1 mm thick.

The histological structure of these nodes was almost the same as on day 27 after infection: a wide necrosis with nuclear detritus or remnants of exudate in the centre, then gradually a zone of histiocytes and activated fibroblasts (Plate V, Fig. 1), zone of lymphocytes and plasmocytes and at the periphery a wide zone of mature connective tissue. Sometimes the necrotic mass contained deposits of calcium salts or clusters of giant multinuclear cells. If eosinophiles occurred, they were few in number and only accumulated in foci. Of interest was the finding of quite intact erythrocytes in the centre of some "migratory caulis". In the liver, fibrosis was around numerous necroses which formed a macroscopically visible nodular structure, foci of necrosis affecting even the walls of some gall ducts, and arteries with markedly thickened walls and swollen endothelia.

In this period (41 days p. i.), cysticercus was never found in the examined lesions, not on histological examination. Eosinophilic fragments of foreign structures were sometimes detected, but they could not be objectively identified as parts of a cysticercus (Plate I, Fig. 2).

**DISCUSSION**

Some general facts follow from the above experiments. First of all, it is probable that the intensity of infection can be influenced by the age of the experimental animals (in young sheep the infection was much stronger than in older ones) and by the mode of infection. If the eggs were administered in water by oesophageus (stomach) tube, then the infection was unusually strong. The liquid with eggs gets usually through sultus oesophageus directly into abomasum (in young animals) so that the loss of eggs in rumen etc. occurring in peroral infections with eggs in capsules is thus avoided. The cellular reaction in sheep and goats is strong, similar to that occurring in cattle in the initial stage of infection. However, a comparison of the organ reaction in a sheep and cattle reveals that the very characteristic activation of large macrophages which migrate to the young larva and surround it after some time during the early phase of infection in cattle, is missing (Plate VI, Fig. 2) (Blažek et al. 1981) and that the conspicuous, even excessive and very early new formation of collagen among the cells of the granuloma tissue around cysticercus is lacking in sheep. In cattle, the cellular reaction around the parasites already at a very early phase of development after the newly formed collagen disappears as well, whereas in sheep the granulomatosus inflammation still persists at that time. The lymphocytes accumulate at the periphery of nodules and the whole node is demarcated by mature connective tissue. The development of the cysticercus is evidently retarded in the atypical intermediate host (sheep, goat): the scolex was not developed on day 27 p. i., whereas in calves, the scolex and suckers are already formed at that time (Blažek et al. 1981). The retardation in the development of larvae might indicate that the cysticerci retarded in development will be exposed to the effect of humoral antibodies which have been formed in the meantime; however, even the formation of antibodies (e.g., haemagglutinins) seems to be irregular or retarded in the atypical intermediate hosts or the levels of their titres reach only the lower limit of positivity even in a relatively strong infection (Table 1).

From morphological findings we assume that the cysticercus localized in the organism of an atypical intermediate host does not stimulate sufficiently the foreign cells to the production of substances important for its nutrition and not even to the antibody response (Table 1). The absence of large macrophages around the cysticercus may indicate not only a certain nutritional deficiency, but necessarily a deficiency in transforming the antigenic impulses to antibody-forming cells. The development of the cysticercus, as mentioned above, is retarded and already on day 27 p. i. its surface is covered with a conspicuous layer of oesinoophilic matter probably of protein nature, which did not occur around cysticerci in cattle and which seems to be an indicator of the isolation of larvae from the surrounding healthy host tissue and its death. The retardation in development is also indicated by the fact that the characteristic form of cysticercus formed in cysticerci on day 27 p. i. and by the insufficient morphological differentiation of microtriches. The ultrastructure of the bladder wall indicates not only the functional insufficiency of subtegmental cells, but also the beginning of dystrophic changes and probably even damage of these cells resulting in the formation of autophagic vacuoles. From the morphological view, the cellular reaction around the cysticercus in sheep corresponds to an intensive inflammation and formation of foreign bodies. The fact that the inflammatory reaction persists in the same intensity even at the time when it is disappearing or has already disappeared in cattle, indicates that the cysticercus is a foreign body in the organism of the atypical intermediate host. At that time, the cysticercus in cattle is at the stage of advanced morphological differentiation and the almost complete absence of marked reactions indicates that it is adapted to the tissue of its host and does not irritate its organism. In the organism of an atypical intermediate host, however, the cysticercus (C. bovis) is probably unable to utilize the proteins of the foreign, unknown organism for biochemical reconstruction of its surface and adapt thus its own biochemical structure to the host organism. It is then deprived of all advantages provided by this mimicry in cattle hosts.

It is interesting that the nodules and granulomatous inflammation, sometimes with giant cells of foreign body type, persist for a very long time even without cysticercus and that the inflammatory changes are quite evidently bound to vessels and their vicinity. It is thus confirmed, even in these cases of abortive infection, that the cysticercus penetrates into the target organ through the hematogenous way, as it was detected particularly in the neonatal infection of calves (Blažek et al. 1982).

**РЕАКЦИЯ ТКАНИ ПРИ ЭКСПЕРИМЕНТАЛЬНОМ ЦИСТИЦЕРКОЗЕ ОВЕЦ И КОЗ, ЗАРАБОТНЫХ ИЯЦАМИ TAENIA SACRATA**

К. Блацек и И. Шпальцова

Реакция тканей при экспериментальном заражении овец яйцами Taenia saginata на интенсивность заражения оказывает влияние на возраст животного во время заражения, величину инфекционной дозы и способ заражения (через рот в кусках или при помощи зонда в заднее отверстие тела) (Blažek et al. 1981). У молодых животных, зараженных через рот в кусках, вокруг молодого цистицерка возникает сильная клеточная реакция, но она отличается от реакции известной при цистицировании крупного рогатого скота: отсутствуют больше макрофагов. Увеличение их числа в подвидах слизистых оболочек в ранней фазе развития скота, в гранулемной ткани отсутствует образование коллагена, а увлажнение покрытых слоев кожной соединительной ткани. Развитие цистицированного в лёгких через ингаляцию заражения через воздух более высоким, чем у крупного рогатого скота. И реакция на интенсивные изменения кожи в то время встречается уже прорезавшийся хвост. На цистицированных овцах на кожных покровах в области надхвостника на участках с очагами инфекции у перонконтактных проявлений может быть обнаружена лишь низкая титр антител даже, как и при случае инфекции.
<table>
<thead>
<tr>
<th>Experimental animal</th>
<th>Mode of infection, injection dose of T. saginata eggs</th>
<th>Time of slaughter after infection or reinfection (days)</th>
<th>Pathological-anatomical finding</th>
<th>Serological examination (IHA) Time p.i. (days)</th>
<th>Titre C T</th>
<th>Evaluation</th>
<th>Note</th>
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<tbody>
<tr>
<td>Dwarf goat 1 year ♀</td>
<td>200,000, per os in gelatine capsules</td>
<td>122</td>
<td>Heart ▼ Lung □ Liver □</td>
<td>9</td>
<td>neg</td>
<td>neg</td>
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<tr>
<td>Merino sheep 2 months ♀</td>
<td>500,000, per os by oesophagus tube</td>
<td>15</td>
<td>Heart ▼ Lung □ Liver □ Massevert □</td>
<td>15</td>
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<tr>
<td>Merino sheep 2 months ♀</td>
<td>500,000, per os by oesophagus tube</td>
<td>27</td>
<td>Heart ▼ Lung □ Liver □</td>
<td>27</td>
<td>neg</td>
<td>2</td>
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<tr>
<td>Merino sheep 2 months ♀</td>
<td>500,000, per os by oesophagus tube</td>
<td>41</td>
<td>Lung ▼ Liver □ Fossas □</td>
<td>41</td>
<td>4</td>
<td>8</td>
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<tr>
<td>Valashka sheep 9 months ♀</td>
<td>100,000, per os in gelatine capsules</td>
<td>14</td>
<td>Heart ▼ Liver □ □</td>
<td>14</td>
<td>2</td>
<td>8</td>
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<tr>
<td>Valashka sheep 9 months ♀</td>
<td>150,000, per os in gelatine capsules; reinfection after 26 days 200,000</td>
<td>41</td>
<td>Liver □ □ Muscle □ □</td>
<td>41</td>
<td>16 p.r.i.</td>
<td>8</td>
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<tr>
<td>Valashka sheep 9 months ♀</td>
<td>150,000, per os in gelatine capsules; reinfection after 26 days 200,000</td>
<td>103</td>
<td>Liver □ □</td>
<td>103</td>
<td>77 p.r.i.</td>
<td>2</td>
<td>16</td>
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Explanations:
- C antigen from C. bovis
- T antigen from T. saginata proglottids
- ▲ node
- □ periporal inflammatory changes or fibrosis
- □ myocarditis
- □ vessel changes (vasculitis, thrombosis)
- □ calcified node
- ◻ not sharply demarcated focal changes
- ♣ good nutrition
- ♦ bad nutrition

REFERENCES:
Fig. 1. *C. bovis* in sheep heart on day 15 p.i. Cysticercus (C) is surrounded by necrosis (N) and granulation tissue (GT). Cell debris of heart muscle are still preserved (arrows). HE. (× 155). Fig. 2. Remnants of *C. bovis* bladder (C) in node on day 41 p.i. HE. (× 700)

Fig. 1. *C. bovis* (C) in sheep bronchus (BR) on day 27 p.i. Exudate (EX) in bronchus lumen, the wall of bronchus is changed by inflammation (IX) or necrotic (N) (× 40) HE. Fig. 2. Detail of activated lung macrophages in bronchus lumen in sheep cysticercosis on day 15 p.i. HE. (× 700)
Fig. 1. Node with dead cysticercus in sheep liver on day 27 p.i. Cysticercus (C), necrosis (N), zone of giant multinuclear cells (GC), granulation tissue (GT) with lymphocytes (L) at the periphery, zone of mature connective tissue (CT). HE. (x40)  
Fig. 2. Dead cysticercus (detail from Fig. 1). Necrosis (N), slightly eosinophilic zone of tegument (NT). HE. (See also Plate VI, Fig. 3.) (x300)

Fig. 1. Inflammatory infiltration around Purkyně fibres (PF). Sheep, heart on day 15 p.i. (x300)
Fig. 2. Character of granulation tissue in the node with cysticercus. Central part (CT) and periphery (P) of the node. HE. (x300)
Fig. 1. Node after death of cysticercus on day 41 p.i. Eosinophilic in the centre, giant cells, histiocytes and fibrinoid around it (arrow). HE. (×125).

Fig. 2. Gelatinous changes in the residual node on day 27 p.i. Star-like cells (arrows), numerous newly formed capillaries (CP). HE. (×125).

Fig. 1. Section through the node wall around cysticercus in sheep liver on day 27 p.i. Partly degenerated macrophages in the centre of node (CT), intermediate part with histiocytes, lymphocytes and single plasmaocytes (IM), periphery consisting of connective tissue (P), hepatocytes (H). Ultrathin section, toluidine blue, HE. (×200).

Fig. 2. Macrophages in node centre in early stage of bovine cysticercosis on day 21 p.i. Ultrathin section, toluidine blue (×270).

Fig. 3. Electron-dense mass with remnants of cysticercus tegument in sheep on day 27 p.i. Remnants of microvilli (arrows). (See also Fig. 4 and 5).