ON THE RELATIONSHIP BETWEEN THE STRUCTURE AND THE GROWTH OF THE SCALES OF FASCIOLA HEPATICA

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Abstract. Series of histological sections of the integument of Fasciola hepatica, silver-stained with Gomori’s method for the detection of reticular fibres, revealed the relationship between the striation of this layer and the structure and growth of the scales. These integumentary sclerites are shaped like scales and not like spines. In the cytoplasm of the integument a scleroprotein is formed round these rays of striation, which by some authors on the grounds of their electron microscopic studies were identified as mitochondrial rows. This scleroprotein merges with the anterior side of the gradually growing scale. Sometimes the remnants of this radiated structure remain enclosed in the proper scale substance like foreign configurations.

The sclerotized integumentary formations of Fasciola hepatica are generally identified as spines. In view of their shape they should, in fact, be regarded as scales, being flattened in their apical part and moderately convex; in addition, a distinct dimorphism of these superficial formations is found in some trematodes, for example in representatives of the family Echinostomidae, between the collar spines and the minute scales on the other superficial parts of the body. In an earlier paper (ŠLAIS, ŽDÁRSKÁ 1967) evidence has been presented on the difference in the microscopical structure and in the histochemistry of both formations in Echinostoma revolutum. BURTON (1964) described the ultrastructure of the integumentary spines of Haematoloechus medioplexus as a crystalline configuration arranged in a lattice, hence resembling the spines of Schistosoma mansoni. SENFT et al. (1961), however, described their ultrastructure as a complex of lamellae, but the formations described by BURTON were completely different from the scales of Fasciola hepatica, because their lamellar structure could be conceived even on standard histological sections.

MATERIAL AND METHODS

Adult Fasciola hepatica Linné, 1758 in the liver of fallow deer were fixed in 10% neutralized formol. The material was cut into series of histological slides, which were stained with standard and special methods. Our observations were made mainly on slides stained with the Gomori’s method for the detection of reticular fibres.
RESULTS

The scales of the adult trematodes are integumentary formations, only lifting but not penetrating the surface membrane of this layer. The base of these scales is submerged into the complex of the so-called subcuticular layer. They mostly run parallely to the longitudinal axis of the body and slope backwards, thus being aligned at sharp angles to the body surface. Because they are functionally connected with the muscular layer they can be erected.

The transverse section through the base of the scale (Fig. 1) appears to be widely oval, gradually flattening towards the top of the scale. Sections through the upper half the scale are sickleshaped with an obtuse edge, anteriad concave. The apical end resembles the edge of a spoon. However, on a central longitudinal section the scale seems to become continuously attenuated until ending in a point. This apparently has been the reason for which these integumentary configurations have been considered to be spines.

Fig. 1. Shape of transverse sections through the scale of a liverfluke from the base (a) to the top (e). A — anterior side; R — reverse side of scale.

The well-known vertical striation of the integument of Fasciola hepatica, seen on histological sections, often continues in the anterior side of the scale. The border line between the scales and the integumentary substance is not always very clear as illustrated by Björkman and Thorsell (1964, Fig. 1). The transverse striation of the integument of this trematode is caused by the arrangement of mitochondria in rows perpendicular to the surface as shown in the electron microscopic studies by the mentioned authors and by Threadgold (1963). Although this latter study contains evidence of the radiated structures of the same electron density as the substance of the integument, which were located in the highly electron dense substance of the scales, they have neither been described nor explained. In the histological literature these structures have sometimes been described as caniculi. Their staining with acid stains and with certain silver methods was described in an earlier paper (Šlab, Žbárská 1967).

During our studies of the slides stained with Gomori’s method and viewed under the optical immersion system we observed a striking resemblance both in shape and size between the rays in the scleroprotein substance of the scales and the rays of striation in the environmental integumentary substance. Some of these striation rays passed directly into the surface layer covering the reverse side of these scales (Plate Π, Figs. 5, 6) which was found to be of a different nature and also exhibited different staining properties (dark-brown colouring of this layer, no colouring of the main substance). The surface of this layer being
smooth seemed to be of a stable structure; it did not change on the scales, functioning as a bond between the scales and the integumentary substance. Contrary to that the surface of the anterior concave side was most uneven (Plate II, Fig. 1), forming steplike protrusions, which could not be viewed on the oblique lateral section through the scale. The rays of striation inside the integument adhering to the anterior side of the scale, often appeared as if emerged into the scale substance. Enclosed in the basal portion of the scales we observed many of these radiated structures (Plate I, Fig. 2, Plate II, Figs. 2, 3, 4).

DISCUSSION AND CONCLUSIONS

On the grounds of our histological findings we concluded that the zone of growth of the scales of Fasciola hepatica is located in the anterior side and in the apical comb. The newly formed scleroproteid originating round the mitochondria, joins the original scale substance. In this process the striation mostly disappears after becoming imbibed by the scleroproteid; it merges later with the scale substance. The findings by Björkman and Thorsell (1964) that elongated amorphous bodies with an electron density slightly greater than that of the environment similar to the matrix of the scales was observed parallel to the rows of mitochondria, seems to support our opinion. These relatively big bodies are responsible at large for the striated appearance of the integument seen on standard histological sections. In some parts, however, namely in the basal part of the scales where the contact with the proper integumentary substance is not so close, the process of the scleroproteid formation is less perfect. The remnants of these radiated structures remain enclosed in the scale substance as if they were some foreign configurations.
The findings that these rays in the scale substance are remnants of cytoplastic structures around which the substance is deposited, are in harmony with the findings by Morseth (1965) on a granulation in the outer layer of the embryophore of the egg present in cyclophylidean cestodes. This granulation exhibits similar optical properties in standard histological sections representing the remnants of cytoplastic corpuscles, around which the electron dense granules accumulate, forming the scleroproteid columns of the embryophore. This scleroproteid being very similar to keratin, differs slightly from the scale substance of the liver-fluke as proved by our histochemical analysis published in 1967 (Šlais, Žďárská). The persistence of these radiated structures in the scales seems to be connected with their larger size, because they have not been found in smaller scales. However, there may be, in fact, other ways of growth of these integumentary formations in trematodes. This applies mainly to the true spines related in a different way to the integument; for example, according to Burton (1964), the spines of Haematoloechus medioplexus originate from the secretory electron dense bodies.

REFERENCES


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EXPLANATIONS TO THE PLATE II

Fig. 1. Oblique transverse section through the scale at its apical end. The cytoplasm with the rays of striation adjoining the anterior uneven concave side. Some rays in the scale substance orientated in the same direction.

Fig. 2. The same section of the scale slightly lower through the substance of the integument, showing numerous rays in the scale.

Fig. 3. The same section, at the level of the border line between the integument and the basal muscular layer, in which the interstitial substance was demonstrated by silver staining. An accumulation of striation at the anterior side of the section through the scale, on the reverse side the dark section through its surface layer.

Fig. 4. Oblique section through the base of the scale submerged into the muscular layer; rays in the scale substance.

Figs. 5, 6. Oblique tangential section through the site in which the integumentary substance and reverse side of scale are joining. A continuation of some rays in the surface layer of this side conceivable. Gomori (x 1,300).
Fig. 1. Longitudinal section through the unerected scale of the liverfluke in its axis — Gomori (× 800).

Fig. 2. Oblique longitudinal section through the more erected scale showing the uneven surface of the anterior side and the radiated structures in its substance. Gomori (× 800).