ON THE MORPHOLOGY AND FINE STRUCTURE OF C. ANATIS, A TYPE SPECIES OF THE GENUS CAPILLARIA ZEDER, 1800

V. BARUŠ, F. TENORA, R. WIGER and T. P. SERGEEVA

Institute of Vertebrate Zoology, Czechoslovak Academy of Sciences, Brno, University of Agriculture, Brno, The Veterinary College of Norway, Oslo, and Helminthological Laboratory, Academy of Sciences of the USSR, Moscow

Abstract. The fine structure of outer characters of C. anatis (Schrank, 1790) from Anas acuta L. was studied for the first time by scanning electron microscopy (SEM). According to the rules of the International Code of Zoological Nomenclature, C. anatis is a type species of the genus Capillaria Zeder, 1800. The knowledge of its morphology and fine structure enabled to complement the diagnosis of the nominal genus of the subfamily Capillariinae. The fine structure of the head end, particularly the topography of cephalic papillae, lips and stylet, surface of body cuticle, male pseudobursa including spicule sheath armed with spines and spicule proper is described and documented.

The taxonomic division of the subfamily Capillariinae Railliet, 1915, particularly the system and number of genera, has been discussed very much since the establishment of the nominal genus Capillaria Zeder, 1800 till the present time. In principle there are two opinions on this problem. Some of the authors include the numerous species of this subfamily to a single genus Capillaria (recently, e.g., Roman 1960, 1965, Gallego and Mas-Coma 1975), others assume, in our opinion quite correctly, that the species of Capillariinae should be assigned to several genera (see Skryabin et al. 1957). At the present time, there are 19 genera of this subfamily, but some of them have already been synonymized.

In our opinion, the complicated systematic relations inside the subfamily Capillariinae should be elucidated by evaluating the morphology and revising the position of the type species (C. anatis) of the nominal genus Capillaria Zeder, 1800. In order to instigate the desirable revision of the system of genera belonging to Capillariinae we made the first step on this complicated way and studied in detail the morphology and ultrastructure of C. anatis (Schrank, 1790).

MATERIAL AND METHODS

The nematodes (C. anatis) were recovered from naturally infected definitive hosts Anas acuta (L., 1758) and Aythya marila (L., 1761) from the Ob River Delta region (USSR). The material was collected during All-Union helminthological expeditions of the USSR Academy of Sciences in the years 1974—1975.

All specimens were localized in the caecum of the definitive hosts. A total of 196 females and 145 males were examined by an optical microscope and 10 males and 10 females of C. anatis from A. acuta were then used for the SEM studies. The material was processed using the method published by Wiger et al. (1978). Observations and photographs were made with a Jeol JSM-35C scanning electron microscope.
RESULTS

Description of *C. anatis* from *A. acuta*

The male body is 6.70—13.14 mm long and 0.035—0.058 mm wide at level of oesophagus end. The total length of oesophagus is 4.23—5.29 mm. The head portion is rounded and 0.005—0.006 mm wide in diameter. It is distinctly separated from the remaining portion of body by a transverse incision. The surface of cephalic plate is covered with a smooth cuticle, whereas the other parts of body are irregularly transversely striated (Plate I, Fig. 1). Due to a contraction, the transverse striation is markedly dense in some specimens, in others it forms rings with irregular longitudinal undulation which may be caused also by the fixation of the material (Plate I, Fig. 2). The mouth opening is situated terminally. It is a narrow, 0.0025—0.0032 mm long slit oriented dorso-ventrally. The mouth is surrounded by lip-like elevations (in our opinion true lips situated laterally) connected in angles of mouth opening. The upper margin of lips is rounded, the margins correspond to one another in their shape. In the median line the lips are supported from the inner side by a massive epithelium forming two lobes on each lip. The maximum height of lips does not reach 0.001 mm. The bases of both lips pass to a slightly concave triangular area measuring 0.002 mm in maximum width and 0.001 mm in length. The mouth opening is surrounded by 12 cephalic papillae (sessile or buried), six of them are in the inner circle and six in the outer one (Plate I, Fig. 3).

A conspicuous organ is the stylet protruding from the middle portion of the mouth cavity (Plate I, Fig. 4). It is finger-shaped (with markedly rounded tip) and runs from a special sheath surrounding its middle part and base proper. It is probable that the upper margin of the stylet sheath is slightly thickened. The length of the evaginated portion of stylet is 0.0007 mm and its maximum width is 0.00027 mm. The distal end of stylet sheath is 0.0005 mm wide.

The posterior end of male body forms a characteristic pseudobursa of a relatively massive structure (Plate II, Fig. 1). The base is formed by two markedly developed lateral processes, rounded at their whole periphery and separated from one another by a shallow and wide incision. The system of these supporting and attaching organs includes also a pair of small papillae on the pseudobursa, which are situated near the upper margin of cloaca (one on each side). The bases of these small papillae are attached to the massive lateral papillae (or processes). A thin and short process runs ventrally from the small papillae. The whole pseudobursa is tightly covered by a smooth cuticle not forming any alae, cuticular ridges or commissures between the processes or papillae of the pseudobursa. The opening of cloaca is rounded and situated ventrally.

The evaginated spicule sheath is tubular and of almost uniform width (0.009 to 0.010 mm). It is the so-called “armed type” or spicule sheath, which is covered on its whole surface with sclerotized spines. The spines are massive, with a wide base, and their tips are oriented towards cloaca. In the proximal part of spicule sheath the spines are sparse (Plate II, Fig. 2), whereas in the middle and distal part they are more densely distributed (Plate II, Fig. 3). The spines are more or less regularly arranged in 11—12 longitudinal rows (from one side of spicule sheath). In lateral position the base of spines is 0.0013 mm wide and their height is 0.0018 mm. The spicule is 1.06—1.86 mm long. In three fourths of its length from proximal end it is triangular in section, the distal end is rounded (Plate II, Fig. 1).

The female body measures 8.11—18.34 mm in length and 0.044—0.060 mm in maximum width at level of vulva. The total length of oesophagus is 4.23—6.70 mm. The vulva is situated a short distance behind the end of oesophagus. It has a shape of a transverse slit with rounded margin. The vulvar appendage is absent. The eggs measure 0.055—0.062×0.022—0.024 mm and the surface of their shell is irregularly wrinkled.
DISCUSSION

In addition to classical morphological characters of *C. anatis* given in recent redescriptions (Madsen 1945, Skryabin et al. 1957, Czaplinski 1962 and others), our studies revealed a conspicuous stylet protruding from the mouth cavity in this species. In spite of the fact that this organ is supposed to be present in all or most of the Trichuroidea, its existence in adult specimens of the subfamily Capillariinae has not always been demonstrated. Of importance is particularly the detailed description by Wright (1974) who demonstrated the stylet in *C. hepatica* (Bancroft, 1893) situated in the dorsal angle of mouth opening and in buccal capsule. In contrast to this author, we consider the stylet to be a functional organ also in adult specimens of *C. anatis*, as in most of the specimens studied by us it was distinctly evaginated from a specialized organ (termed stylet sheath). In *C. anatis*, the stylet is localized in the middle of mouth opening.

Relatively little attention has been paid to the number and distribution of cephalic papillae in species of the family Capillariidae. This character in *C. anatis* can be compared only with that of *C. contorta* (Creplin, 1839) which was studied by SEM by Baruš et al. (1981). Both *C. contorta* and *C. anatis* possess 12 cephalic papillae (6 in outer and 6 in inner circle) and in both cases the papillae are sessile or buried.

Interesting and significant for a further development of the systematics and taxonomy of Capillariidae is the historical analysis of taxonomic position of *C. anatis*. Very detailed data were published by Madsen (1945), López-Neyra (1947) and Skryabin et al. (1957) and we are therefore mentioning only the basic views.

As it follows from the analysis published in the monograph by Skryabin et al. (1957) and in papers of many other authors, since the establishment of the genus *Capillaria* Zeder, 1800, *C. anatis* has always been considered a type species of this genus. Only Gagarin (1951) ex Skryabin et al. (1957), who first demonstrated the presence of spines on the spicule sheath of males, transferred *C. anatis* to the genus *Thominx* Dujardin, 1845. This transfer of *C. anatis*, typus generis of *Capillaria*, was evidently wrong, as it does not correspond to the rules of I.C.Z.N. It was therefore unnecessary for Skryabin et al. (1954) to determine a new typus generis, in this case *Capillaria columbcae* Rudolphi, 1819.

In our opinion, and in agreement with Moravec (1981), *C. anatis* remains typus generis for the genus *Capillaria* Zeder, 1800, which corresponds to the rules of I.C.Z.N. It is only necessary to amend the diagnosis of this genus considering the morphological characters of the taxon. On the basis of our detailed studies of the morphology and ultrastructure of *C. anatis* we propose the following diagnosis:

**Genus Capillaria** Zeder, 1800 emend.

Capillariinae with rounded cephalic plate and slit-like mouth opening surrounded by 12 or more cephalic papillae arranged in two circles. Stylet present in adults. Body cuticle transversely striated, bacillary bands present. Male: Cloaca situated ventrally, one spicule present, spicule sheath covered with spines. Pseudobursa consisting of two basic lateral processes separated from one another by a shallow, narrow or wide medial incision. One or more small papillae situated near the upper margin of cloaca or lateral processes. These papillae may be absent. Pseudobursa tightly enveloped by cuticle not forming lateral wide alae or cuticular ridges. Cuticular commissure connecting lateral processes of pseudobursa and papillae in median line or from dorsal side may be formed. Female: Vulva situated a small distance behind oesophagus end, vulval appendage present or absent. Eggs with lids on both poles, usually with ornamentation on shell surface.

As to the problems of the systematics and division of the subfamily Capillariinae, we agree with the opinions of numerous authors who stress the significance of morphological characters of individual species (as well as their localization, parasite-host relation and biology) for the division of the subfamily into several genera (see also Skryabin et al. 1957). We assume that of particular importance for the differentiation of genera is the form and structure of male pseudobursa, including other copulatory organs (spicule and spicule sheath). These characters have not been fully appraised in the system of Capillariinae. The studies of the morphology and fine structure of Capillariidae by means of scanning electron microscopy enable to obtain results applicable in a comparison of morphological characters at a higher level which can be used in the revision of the system of Capillariinae. Consequently, on the basis of our studies of C. anatis, typus generis of nominal genus Capillaria Zeder, 1800, we emended the generic diagnosis in such a way that it can be used for a comparison with others, still undetermined generic categories of this subfamily. This might be very useful for the determination of the validity of younger systematical categories of generic level in the subfamily Capillariinae.

О МОРФОЛОГИИ И ТОНКОЙ СТРУКТУРЕ C. ANATIS,
ТИПОВОГО ВИДА РОДА CAPILLARIA ZEDER, 1800

В. Баруш, Ф. Тенора, Р. Вигер и Т. П. Сергеева

Резюме. Методом сканирующей электронной микроскопии в первый раз изучена тонкая структура наружных признаков вида C. anatis (Schrank, 1790) от Anas acuta L. В смысле Международного кодекса зоологической номенклатуры этот вид является типовым видом рода Capillaria Zeder, 1800. Знания его морфологии и тонкой структуры позволили дополнить и уточнить диагноз номинального рода подсемейства Capillariinae. Описана и документирована тонкая структура головного конца C. anatis, особенно топография головных сосочков, губ и систела, поверхность кутиса тела и псевдобурса самца, включая вооруженное спикулярное влагалище и настоящую спикулу.

REFERENCES


—, Super-famille des Trichuroides (Trichuroid-
Three decades after its first appearance (1951) Busvine’s book has reached its revised third edition. The chapter on chemical control measures is completely re-written, keys and new figures are included in the appendix, and the bibliography and subject index are expanded. In order to meet the requirements of the publishers and to avoid the excessive scope of the book he omitted from this new edition three chapters (namely the chapters dealing with the morphology and classification, anatomy and physiology, and with ecology of insects).

The new edition is divided into 13 chapters. Chapter 1, representing an introduction, bears the same title as the whole book and is intended to inform the reader about the rich abundance of insect forms and about the significance of different groups of parasitic insects in the transmission of pathogenic agents and in the hygiene in general. Chapter 2 deals with the problems of preventive measures and pest control especially as regards Britain and the USA and some European countries, grouped as West-European (Denmark, France, the Federal Republic of Germany, Italy and the Netherlands) and East-European (Bulgaria, Poland, Yugoslavia) countries. The information on these problems was obtained by means of correspondence with various experts and as far as the countries and the contents are concerned the data are very fragmentary (e.g. only three lines are devoted to France, including the statement that “little further information has been obtained”) and their value is thus considerably disputable.

Chapter 3 is concerned with mechanical, physical and biological control measures, while Chapter 4 deals with chemical control. In chapters 5 and 6 different pest groups are discussed: bloodsucking Diptera (Culicidae, Ceratopogonidae, Simulidae, Phlebotomidae, Tabanidae and Stomoxys), synanthropic flies (Muscidae, Calliphoridae), Drosophilidae, Phoridae and Piophilidae. Chapter 7 sums up all parasitic arthropods discussed and is subdivided into three parts — the first reporting on parasitic insects, the second on parasitic and harmful mites, and the third on allergies caused by these parasites. Chapters 8—12 cover pests of foodstuffs, insects living in refuse, clothes moths, hide beetles and other fabric pests, wood-boring insects and poisonous insects. The last chapter entitled “Nuisances” is concerned with pests occurring in damp rooms, gardens and open terrain. The book is concluded with two appendices: chemical appendix, listing insecticidal substances supplemented with some basic physical data, and biological appendix, including brief keys to the insect groups discussed.

The general concept of the book, as seen from the mentioned arrangement of chapters, requires a few comments. In formal respect, the scope of the pest coverage is wider than implied by the title of the book. Along with insects also mites, spiders, scorpions are covered, namely the whole spectrum of arthropods of medical importance. Disputable is the inclusion of the chapter on
Figs. 1—4. Scanning electron micrographs of *Capillaria anatis* (Schrank, 1790). Fig. 1. Head end of female body (apical view); note the form of cephalic plate and transverse striation of the cuticle (× 3 200; white scale = 0.001 mm). Fig. 2. Detail of surface structure of cuticle in middle part of body (× 6 400; white scale = 0.001 mm). Fig. 3. Detail of cephalic plate of female (apical view); note the form of mouth opening and distribution of cephalic papillae (arrows) (× 6 400; white scale = 0.001 mm). Fig. 4. Detail of mouth opening of female (apical view); note the situation and shape of stylet (a), stylet sheath at its base (b), shape of lips (c), lobes of inner epithelium of lips (d) and triangular base of lips (e) (× 9 600; white scale = 0.001 mm).
Figs. 1–3. Scanning electron micrographs of *Capillaria anatis* (Schrank, 1790). **Fig. 1.** Pseudobursa of male (latero-ventral view); note the massive lateral processes (a), small papillae with ventral process (b) (× 860; white scale = 0.010 mm). **Fig. 2.** Proximal part of evagination of spicule sheath (lateral view); note the distribution and form of spines and margin of lateral process of pseudobursa (a) (× 4950; white scale = 0.001 mm). **Fig. 3.** Middle part of evagination of spicule sheath (lateral view); note the distribution and form of spines (× 5100; white scale = 0.001 mm).