

MORPHOLOGICAL STUDIES ON THE LARVAL HINDGUT OF SOME ANISOPTERA SPECIES

KATALIN HALASY and MÁRIA CSOKNYA

Department of Zoology, Attila József University, Szeged

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Abstract

The respiratory organ of the larvae of Anisoptera is the so called rectal tracheal gill which can be found in the modified rectum. According to the form and arrangement of the gills the investigated species belong to the third group of Tillyard-division. The lamelliform gills are covered by respiratory epithel. The epithelial cells are poor in organelles, they are distributed by invaginations of basal membran. Tracheoles are visible among the invaginations. The chitin-spinules of the anal papilla remove the mechanical dirt from the respiratory water. The spinules are simple or bifurcated.

We investigated the next species: *Aeschna cyanea* (MÜLL.); *Aeschna affinis* (VANDERL.); *Libellula quadrimaculata* (L.); *Leucorrhinia pectoralis* (CHARP.).

Introduction

As it is well-known the digestive system of insects consists of 3 parts namely: foregut midgut and hindgut. Foregut and hindgut is generally covered by thin cuticle. The main function of the foregut is storage, that of the midgut is digestion and absorption and that of the hindgut is mainly the passing of indigestible materials and decomposed from the malpighian tubules substances (GRASSÉ et al., 1949; WESENBERG-LUND, 1943). In addition — especially in the last part of the hindgut — absorptive processes take place as well. So the hindgut is an important place of excretory and osmoregulatory functions too (BERRIDGE, 1969; GRASSÉ et al., 1949; JUDD, 1948; KOVOOR, 1971; WESENBERG-LUND, 1943).

In case of some Insecta species the parts of the digestive system can remarkably modify, and they can fulfill other functions beside the above mentioned. So the hindgut of the larvae of Anisoptera (Odonata) takes part in the respiration as well.

Our aim was to study the respiratory chamber, respectively the rectal tracheal gills of some Anisoptera larvae.

Materials and Methods

We investigated into the larvae of the next Anisoptera species:

<i>Aeschna cyanea</i> (MÜLL.)	(Aeschnidae)
<i>Aeschna affinis</i> (VANDERL.)	(Aeschnidae)
<i>Libellula quadrimaculata</i> (L.)	(Libellulidae)
<i>Leucorrhinia pectoralis</i> (CHARP.)	(Libellulidae)

The determination was carried out by the taxonomic keys of STEINMANN (1964) and ÚJHELYI (1957). We used animals fixed in 10% formaldehyde as well as freshly collected animals. Paraffin sections (5–7 μ) were made from the materials fixed in Bouin and 10% formaldehyde that were stained with haematein-eosin, by van Gieson and Mallory (KISZELY et al., 1958).

Material fixed in 10% formaldehyde resp. 2.5% glutaraldehyde was used for the scanning electronmicroscopy. The secondary fixation was carried out in 2.5% KMnO_4 . The specimens were studied by EM-ASID-1 scanning apparatus of JEOL-100-B electronmicroscope.*

Results and discussion

The hindgut of Anisoptera-larvae — like that of other Insects — consists of 2 parts: ileum (or colon) and rectum. These 2 parts are different in their appearance as well. The ileum comes into sight next to the junction of malpighian tubules. This hollow is globular in the species *Aeschna* (Table 1, Fig. 1), oval in *Libellula*, and annular at *Leucorrhinia* (Table 1, Fig. 3).

Rectum is the most various anatomically as well as functionally. It has 3 parts. Its first part is the very short proper rectum with regular intestine structure. Its internal surface is gently plicate (Table 1, Fig. 3) (BERRIDGE, 1969). Its middle part expands and smaller tracheas are gathered from its wall into the dorsal and ventral visceral trunks of tracheas on the both side of the intestine (Table 1, Fig. 1). This part of the rectum is the so called respiratory chamber (MILL, 1970; MILL et al., 1972; WESENBERG-LUND, 1943). The gills can be found on its internal surface (Table 1, Fig. 2, 3, 4, Table 2, Fig. 1). The third that is last part is the so called atrium or vestibulare. There are no gills in it (Table 1, Fig. 2, 3, 4). Atrium is closed by the anal valve (SHARP, 1901; TILLYARD, 1917).

At the end of the abdomen there are 5 so called anal pyramids (STEINMANN, 1964; ÚJHELYI, 1957). A narrow canal is formed by the wider concave turned towards each other sides of pyramids in which the respiratory water can flow in and out. Chitinous spinules are visible on the sides of the pyramids, that are longer on the inner sides. They can be simple filiform (0,37 mm long), (Table 3, Fig. 1) or bifurcated (0,28 mm long) protuberances (Table 3, Fig. 2). Their role is presumably the mechanical cleaning of respiratory water.

The wall of the respiratory chamber is thin its musculature is slightly developed. This is explained by Mill and his colleagues (1970; 1971; 1972); they demonstrated experimentally that the circulation of respiratory water is carried out by certain muscles of the abdomen.

The protuberances of the inner wall of respiratory chamber are the gills which are lamelliform in the case of the investigated species. Differences are to be found only in the shape of the lamellae: the gills of *Aeschna*-species are roundish (Table 1, Fig. 3), that of *Leucorrhinia* are elongated leaf-like (Table 1, Fig. 4), and that of *Libellula* are ovale (Table 2, Fig. 1, 2). The lamellae are arranged in double lines like rooftiles

* We wish to thank Dr. NORBERT HALÁSZ for his help in the use of scanning electronmicroscope.

Table 1

Fig. 1. detail of the intestine of *Aeschna affinis* (VANDERL.) 40x

Fig. 2. opened respiratory chamber of *Aeschna affinis* (VANDERL.) 40x

Fig. 3. enlarged picture of rectal tracheal gills of *Aeschna affinis* (VANDERL.) 80x

Fig. 4. opened respiratory chamber of *Leucorrhinia pectoralis* (CHARP.) 40x

Table I



Fig. 1.

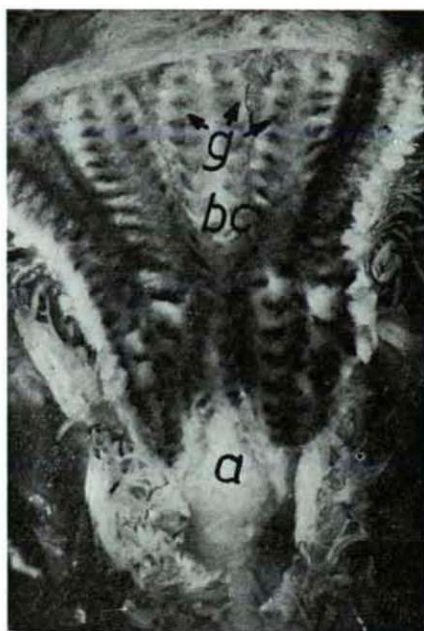


Fig. 2.



Fig. 3.

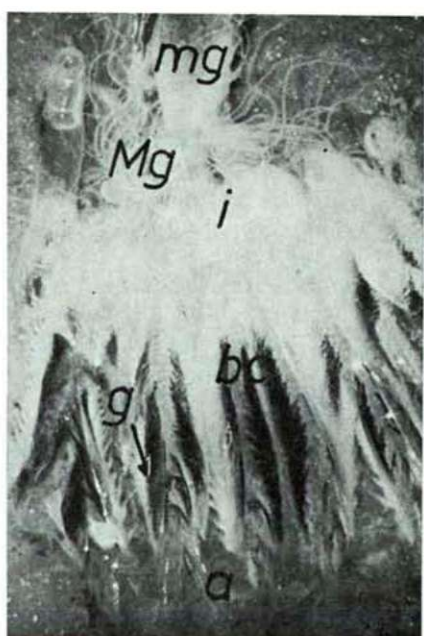


Fig. 4.

Table II

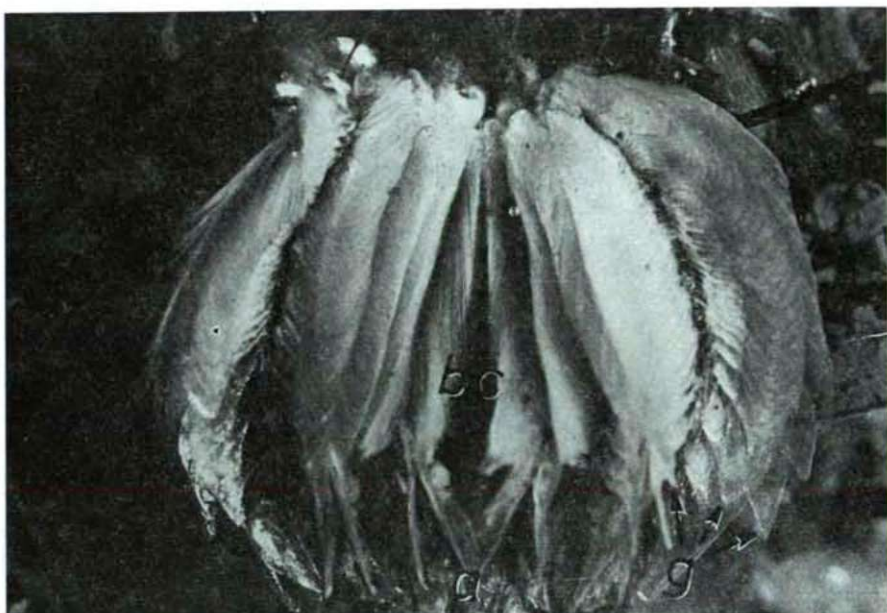


Fig. 1

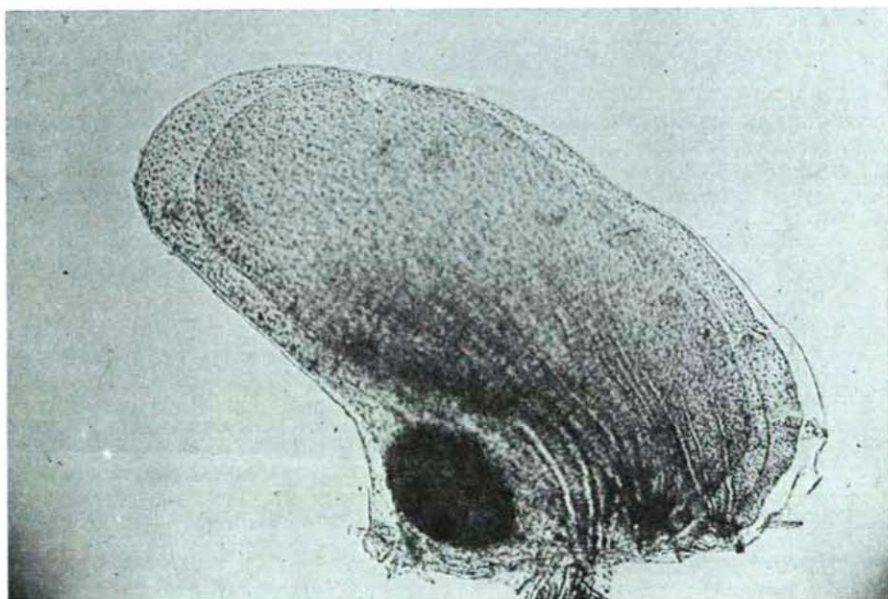


Fig. 2

Fig. 1. respiratory chamber of *Libellula quadrimaculata* (L.) 80x
Fig. 2. dissected gill-lamella of *Libellula quadrimaculata* (L.) 120x

Table III

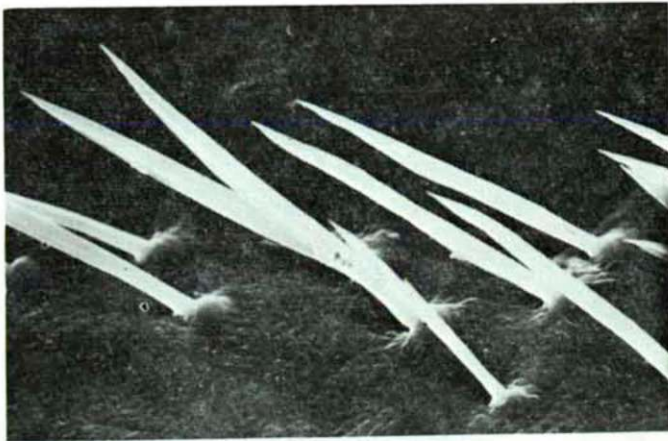


Fig. 1



Fig. 2



Fig. 3

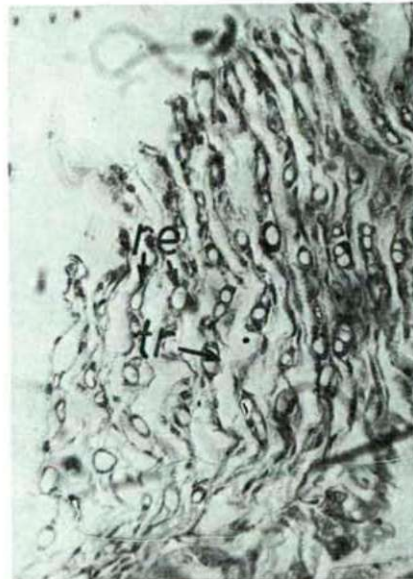


Fig. 4

Fig. 1. 2. scanning picture of anal pyramids of *Aeschna cyanea* (MÜLL.) 120x

Fig. 3. cross-section of respiratory chamber of *Libellula quadrimaculata* (L.) heamatein-eosin staining 400x

Fig. 4. cross-section of rectal tracheal gills of *Leucorrhinia pectoralis* (CHARP.) haematein-eosin staining 400x

a	=	atrium
bc	=	respiratory chamber
c	=	cuticle
g	=	gill
i	=	ileum
mg	=	midgut
Mp	=	malpighian tubules
re	=	respiratory epithel
tr	=	trachea-branches
vtr	=	visceral trachea-trunk

and they form 8 lines in the respiratory chamber. Their number is about 20 000—24 000 (SHARP, 1901). According to the form of lamellae and the junction of their trachea-branches into the visceral trunk the investigated species belong to the third group of TILLYARD (1917) — division of intestine gills. This type provides very large respiratory surface.

The specimens from the respiratory chamber unanimously confirm that only epithel of the intestine takes part in the formation of the lamellae. On the base of the lamellae the epithel cells are cylindric or cubic (Table 3, Fig. 3, 4) wich on the area of the lamellae suddenly flatten out. The basic cells stain deeply, in their cytoplasma basophil granules are visible.

The flat epithal cells of the lamellae are poor in organelles (WICHARD, 1979) and are covered by thin cuticle. Among the cells and among the basal invaginations of the cells tracheoles are visible. These tracheoles are of different diametres and their position is irregular. This arrangement ensures probably the most complete respiration.

In the epithel cells of rectal tracheal gills pigment granules can be seen as well. The quantity of these differs according to species so in *Libellula quadrimaculata* is very few in *Leucorrhinia pectoralis* little pigment granules can be found along the dorsal margin of the lamellae wich appears already at dissection like a dense stripe (Table 1, Fig. 4).

The rectal tracheal gills of the investigated larvae of Anisoptera are very similar structurally. Their position and supply with tracheas ensures the optimal respiration.

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Address of the authors:

Dr. KATALIN HALASY

Dr. MÁRIA CSOKNYA

Department of Zoology, A. J. University,
H-6701 Szeged, P. O. Box 428. Hungary