

**DATA ON THE EPITHELIAL CELLS OF THE TRACHEAL GILL  
EPHEMEROPTERA: PALINGENIA LANGICAUDA OLIV.**

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**Abstract**

The filamental epithelial cells of the gill plate of the larvae are poor in organelles, and a plate-system is to be found on their surface. The epithelial cells of the gill plate are richer in organelles, and produce cuticula and characteristic dense granules.

Investigation of the histological structure of the tracheal gill of *Palingenia longicauda* OLIV. led earlier to the description of some modified epithelial cells which are involved in the structure of the campaniform sensillae (CSOKNYA and HALÁSZ, 1972). If the gills of larvae in different states of development are examined, further modifications of the epithelial cells can be observed. The aim of the present paper is to describe these.

**Materials and Methods**

The studies were carried out on the tracheal gill of *Palingenia longicauda* OLIV. (Ephemeroptera). The gill plates were fixed in Palade osmium tetroxide (pH 7.4). For purposes of electronmicroscopic examinations, after dehydration with alcohol and embedding in araldite the sections were contrasted with REYNOLDS' (1963) lead citrate. Photographs were prepared with Tesla BS 242 D and JEM 100 B electronmicroscopes.

For purposes of light-microscopic observations, 5—7-micron sections were prepared from material fixed in 10% formalin, which were subjected to haematein-eosin and van Gieson and Best carmine staining.

**Results and discussion**

The entire surface of the gill plate is covered by cover and epithelial cells, closely interconnected into one layer. Cuticula of various thickness can be seen on these cells (EASTHAM, 1936; WICHARD and KOMNICK, 1971; CSOKNYA and HALÁSZ, 1973), which as regards appearance and structure is not uniform over the entire area of the gill. On the unstructured plated there are connected layers with strongly dense surfaces, which alternate dark and light in the deeper parts; at high magnification, fibrillary structures can be observed in these layers. Within a layer these fibrils are arranged parallel to one another, curved in the form of a parabola. This agrees with the cuticula structure of other Insecta, the similarity being particularly striking in the region of the common integument. In the case of ephemera larvae, besides the fibrils electron-dense granules sometimes 600—1000 Å in diameter can also be observed (Figs. 3, 5 and 6).

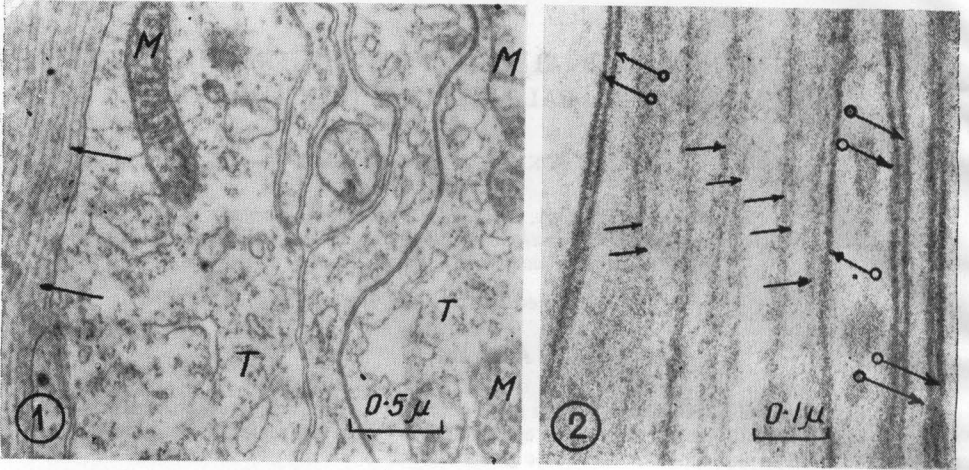


Fig. 1. Detail of epithelial cells of filament on electronmicroscopic photograph. There are many free ribosomes (T) in the cytoplasm. A multi-layered plate series (arrows) can be observed on the surface of the epithelial cell. M-mitochondrium.

Fig. 2. The structure of the plates (arrows) covering the surface of the filaments differs from the unit-membrane (arrows with circle) structure of the processes of the epithelial cells.

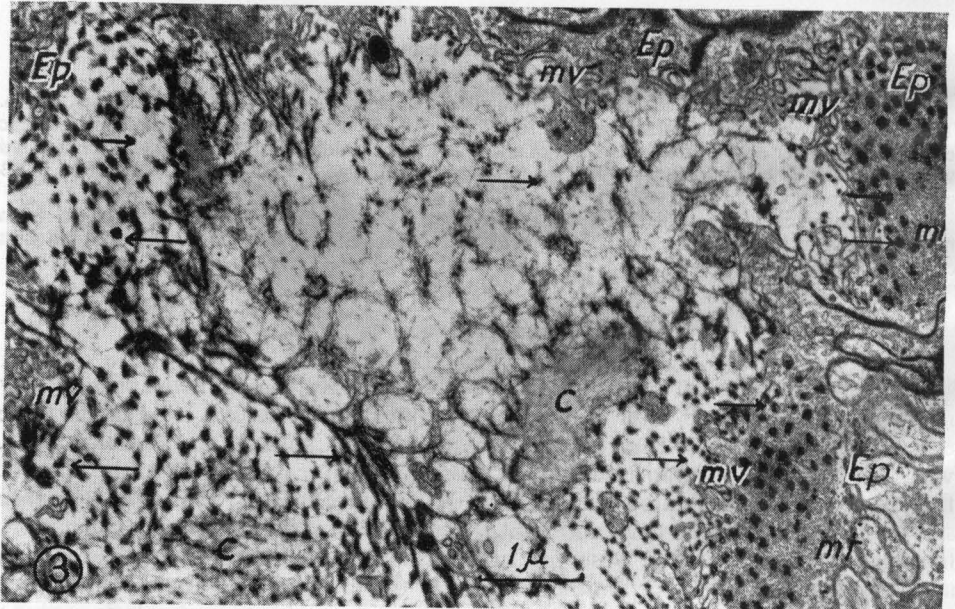


Fig. 3. Section parallel to the cuticula (c), with epithelial cells (Ep) of the unstructured section of the gill plate and with products. The surface of the cells is structured by microvilli (mv). The cells contain many microtubules (mt) and dense granules, which are incorporated into the cuticula (arrows).

On light-microscopic sections a thin, homogeneous border is visible on the surface of the epithelial cells of the filaments; this is the continuation of the previous cuticula, and gives the same staining as that. On electronmicroscopic photographs, however, it is clear that the structures of the two are different. Here it is a matter of a series of plates layered loosely on one another, which run parallel to the surface and thereby cover the epithelial cells. High-resolution photographs clearly reveal that the structure of the individual plates can not be identified with that of the well-known unit-membranes (Figs. 1 and 2). The thickness of the plates was found to be 40—50 Å, and their distance from each other about 50—350 Å. It is only very rarely possible to observe an (inner) plate adjacent to the surface of the cell, but at a greater distance from the epithelial cell; this may indicate that this system is more closely connected to the epithelial cells than is the cuticula. For instance, even in the periods between the moultings extensive interstices can frequently be observed between the cuticula and the underlying epithelial cells (Figs. 3 and 4). The surface of the epithelial cells too is different: below the plate series the epithelial cells have smooth surfaces (Fig. 1), whereas below the cuticula it is practically always possible to observe microvilli, which structure the cell surface (Figs. 3 and 5). It must be noted here that these plates can also be seen around the nerve bundles of the tracheal gill, as reported previously (CSOKNYA and HALÁSZ, 1972). The oxygen necessary for respiration presumably reaches the intercellular space and the haemolymph via the plate-system, with its different structure from that of the cuticula. On moulting the larvae lose this plate-system, similarly to the cuticula covering the body.

In spite of their considerable similarity, the epithelial cells of the gill plate, which give rise to the above-mentioned structures observed on their surface, also exhibit appreciable differences. This is due in part to the different abundances of organelles, and in part to their diversity. In addition to sporadic cisternae of the granulated endoplasmatic reticulum and some mitochondria, only free ribosomes occur in significant amount in the epithelial cells of the filaments. In contrast, the epithelial cells producing the cuticula contain large quantities of glycogen (Fig. 4) and many mitochondria in their deeper processes. Towards their surface, their microtubular substance increases strongly, among which vesicles 1000—1800 Å in diameter, possessing a dense content, appear close to the apical surface of the cell. As they approach the surface of the cell, their diameter increases, and then on the surface they open out to result in the very strong structuring of the surface (Figs. 3 and 4).

Moving away from the surface of the cell across the subcuticular interstice (Fig. 3), the dense material of the vesicles is deposited into the newly forming cuticula, and can be detected in it (Figs. 5 and 6). Study of many publications referring to the structure of the cuticula (SMITH, 1968; GNATZY and SCHMIDT, 1971; MORAN, 1971; MORAN, CHAPMAN and ELLIS, 1971; SCHMIDT and GNATZY, 1971) and of the high-resolution photographs presented in these, failed to reveal a similar phenomenon. Dense granules can be perceived in the cuticula in the photographs prepared by WICHARD, KOMNICK and ABEL (1972) on the chloride cells and cell-groups of the gill of certain Ephemeroptera larvae, but the authors make no mention at all as to the origin and function of these.

However, the surface cuticula in the region of the gill plate is produced not only by the above-mentioned cover cells, but also (in addition to their other functions) by the supporting cells of the campaniform sensillae, the trichogen and tormogen cells. It is assumed (SMITH, 1968; BLANEY, CHAPMAN and COOK, 1971; DALLAY,

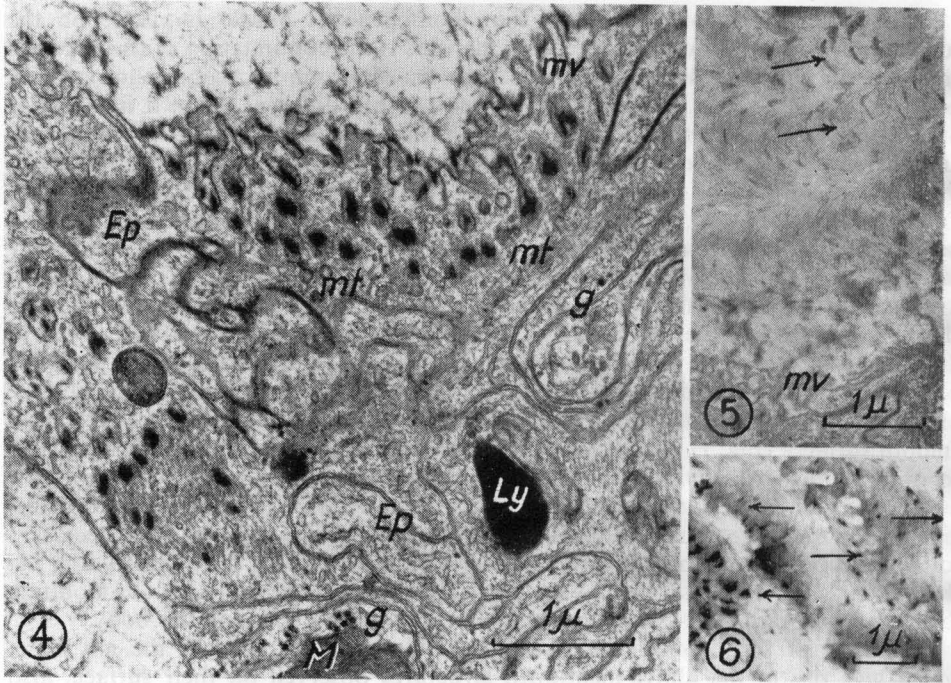


Fig. 4. Section (perpendicular to the surface) of processes of an epithelial cell (Ep) below the cuticula. The cell surface is made uneven by the microvilli (mv) around the discharging dense material. More deeply, glycogen (g) can be observed. M — mitochondrium; Ly — lysosome; mt — microtubule.

Figs. 5 and 6. The incorporated dense product (arrows) can be well seen between the regularly arranged cuticular ridges. mv — microvilli.

1971; GNATZY and SCHMIDT, 1971; SCHMIDT and GNATZY, 1971) that of these two types of cells it is the trichogen cells which produce cuticula more actively. These cells presumably take part in the formation of the microtubular bodies of the sensillae and of the exocuticular layer covering this, and in their reproduction after moulting (MORAN, 1971).

The cuticula production of the tormogen cells is less than that of the former cells; one should think here rather of the formation of the extracellular fluid, which collects in the extracellular cavity around the sensory process (SMITH, 1968; GNATZY and SCHMIDT, 1971; MORAN, CHAPMAN and ELLIS, 1971; SCHMIDT and GNATZY, 1971).

Comparison of the trichogen and tormogen cells of ephemera larvae does not reveal characteristics in their structures which might be used to explain the fundamental and essential functional differences.

The young Insectae are known to moult several times, as the old cuticula impedes their growth. This moulting is assisted by the moulting fluid (SMITH, 1968; BLANEY, CHAPMAN and COOK, 1971; GNATZY and SCHMIDT, 1971; MORAN, 1971; SCHMIDT and GNATZY 1971), which progressively raises the old cuticula, collecting in the space between the epithelial cells and the cuticula. In the case of the ephemera

larvae we were unable to distinguish characteristic cells or cell-groups which produce this moulting fluid, and thus we must assume that this too is a function of the epithelial cells.

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