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Zoology

On Water Transport from the Integument of *Archips podana* Sc. (Lepidoptera Tortricidae)

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(Presented by Academy Member I. Eliava)

ABSTRACT. Water transport from the integument of *Archips podana* Sc. by means of light and electron microscopy was investigated. The significance of study of water-transport is shown in order to choose necessary protective measures against caterpillars. It is found that the process of water-penetration through cuticle occurs irregularly in the front and back parts of the caterpillar's body. Water penetration into the caterpillar's body is connected with protein components, while ability of the cuticle's penetrability can be directed both into and out of the body and the rate of water penetration is not regular. *© 2009 Bull. Georg. Natl. Acad. Sci.*

Key words: *caterpillar, water-transport, lipids.*

Cuticle is an effective barrier for water molecules capable of penetrating in the direction from cuticle to epicuticle and vice versa [1, 2]. Cuticle possesses biological functional of asymmetry. It must be noted that penetration of water molecules from procuticle to epicuticle proves more difficult and, vice versa, the transport of water molecules is much easier in the opposite direction, i.e., from epicuticle to procuticle. The water is as if sucked through cuticle and in this way it is important for the development of epicuticle, when water can be absorbed directly from humid atmosphere.

The phenomenon of sucking water through cuticle is connected with the state of epicuticle and, in particular, with the behavior of lipid molecules in this layer. Water penetrance depends on the orientation of molecules of surface monomolecular layer. Contact angle of this layer and its size give the opportunity to the researchers to assume the orientation of the water molecules located on epicuticle.

The aim of the present work was to study the phenomena of water transport through cuticle by means of light and electron microscopy.

Material and methods of investigation

Material includes 40 caterpillars of *Archips podana* Sc. (Lepidoptera Tortricidae) from Tsalenjikha district. The material was fixed in alcohol, dehydrated and poured into paraffin. The blocks were cut on Reicher's microtom, thickness of the cuts was 7-10 mkm. Then the material was stained by Bemmer and looked through in light microscope of Opton-III Photomicroscope.

The material for electron microscopy was fixed in 1% osmium solution on buffer, poured into epon and cut on OmU2 ultratom. The cuts were contrasted according to Reinolds and looked through in Tesla BS-500 electron microscope, at accelerating voltage 80 kV.

In each individual case all the material was studied in different segments of caterpillar.

Results and Discussion

As the investigations show, water drops lie on epicuticle's surface inhomogeneously. They are mainly concentrated in oral (front) part of the caterpillar, while in anal (back) part the number of water drops is not

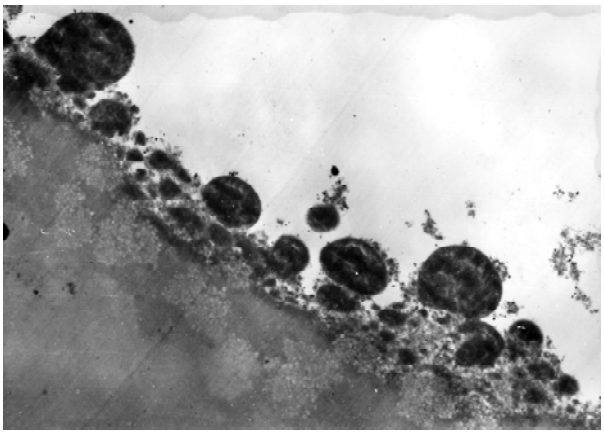

Fig. 1. Epicuticle of *Archips podana* Sc. Back part, drops of liquid on the epicuticles surface. Electron diffraction pattern 25.000x.

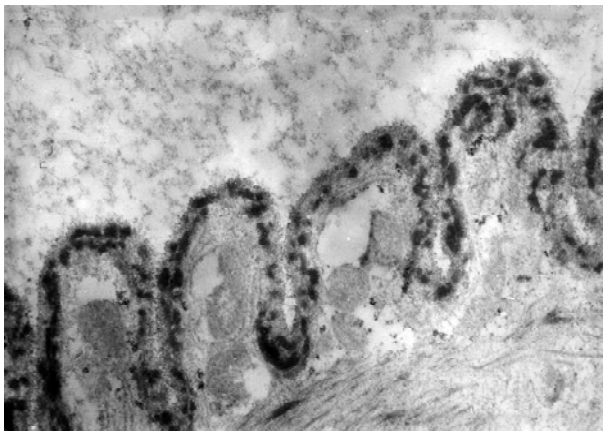

Fig. 2. Epythelium of *Archips podana* Sc., cartepillar. Back part. Electron diffraction pattern 35.000x.

large. It should be noted that water drops in front part are in most cases small, while in the back one - mostly big. On electronograms it is noted that the basis of all the drops is flat and the top of them is, vice versa, roundish which points to the active water supply inside the cuticle, i.e. active water absorption by cuticle (its exo- and endolayers) takes place.

Sucking of water by cuticle is connected, as noted in the literature [3, 4], with the fact that hydrophilic ends of lipid molecules begin to turn outside, forming a single monolayer. Density of the basis of water drops points to the growth of the area of sucking, which must be well presented in the oral part of the caterpillar. Inhomogeneous penetration of water drops into the endosystem of caterpillar must be presumably connected with various functional abilities of its branches. Thus the head part of caterpillar must be more active in both functional and metabolic relations than the anal one.

Water drops penetrate into the body of caterpillar not in a "free" form, but in the vicinity of lipid molecules. The picture of active water transport through caterpillar's cover appears.

As the authors [5, 6] assume, active transport of water is connected with lipid molecules, but it should be effected by proteins with the energy given to them. This energy is presented in the form of mitochondria and their functional activities, on the one hand, and level of direct hydration of each separate protein molecule, on the other. Thus adsorption of water by protein, i.e. the ability of protein to hydratation, contributes to the establishment of definite balance state, connected with isoelectric point in each private case.

Proceeding from Patton's statement [7], the change of isoelectric point may cause absorption of new portions of water by protein and vice versa. This fact is very important in the case of application insecticide dissolved in water.

At hydratation of protein water is sucked by cuticle, and at dehydratation protein releases water. This cycle is constantly changed, which should be taken into account when applying insecticides, most of which are contact poisons. Special interest is paid to those insecticides which may cause essential damage of the integument structure due to passive and active water transport through the caterpillar's structure. Caterpillars adopting insecticides (phosphor-organic poisons and compounds of pyrethrin groups) begin quickly losing water as a result of evaporation through porous canals and cuticle, and break down of water exchange causes their death.

ზოოლოგია

წყლის ტრანსპორტი მუხლუხის - *Archips podana* Sc. (Lepidoptera Tortricidae) ზედაპირიდან

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შესწავლილია წყლის ტრანსპორტი მუხლუხის ზედაპირზე სინათლის და ელექტრონული მიკროსკოპის საშუალებით. ნაჩვენებია მისი მნიშვნელობა კუტიკულის ფუნქციისათვის. წყლის შეღწევა მუხლუხის ზედაპირზე წინა და უკანა ნაწილში თანაბარი არ არის, რაც დაკავშირებულია ცილის კომპონენტებთან. წყლის შეღწევის ცვლას მუხლუხის ზედაპირზე ავტორები უკავშირებენ ინსექტიციდების უარყოფით მოქმედებას კუტიკულაზე.

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