Acta Biologica Szeged. 27 (1—4), pp. 155—158 (1981)

ADAPTATION OF MAYFLY LARVAE TO DIFFERENT SALINITIES

MÁRIA CSOKNYA

Department of Zoology, Attila József University, Szeged
(Received September 20, 1980)

Abstract

Chloride cells on the lamelliform gills of the larvae of *Cloeon dipterum* are of unequal dispersion. Their number depends on the external salinity. On the basis of their salt absorption they might take part in osmoregulation.

Introduction

Mayfly larvae have tracheal gills wich are lamelliform — or filiform ones, or these two forms can occure together (ÚJHELYI, 1959). Tracheal gills are known as respiratory organs, but a lot of data refer to the fact that they aren't the only places of respiration (SHARP, 1901; WESENBERG-Lund, 1943).

Gills especially lamelliform ones take part in other functions as well (EASTHAM, 1936; WICHARD, 1975) e.g. in osmoregulation that keeps the organism's salt and water balance independently of external salinity. Similar regulating structures are known both in Vertebrates (MUNSHI, 1964; SCHMIDT-NIELSEN and cow., 1964) and in Invertebrates (KAPOOR, 1978; WICHARD and cow., 1973).

We wanted to answer with our experiments wether larvae of *Cloeon dipterum* have this regulating system and what its efficiency is like? These are questions of interest because larvae are to be found in very different salinities (apart from extreme concentrations).

Materials and Methods

Our experiments were carried out on larvae of *Cloeon dipterum* (L.) (Ephemeroptera); these larvae were in last instar and approximately of the same size. We studied these larvae in water containing different quantity of sodium chloride. Larvae maintained in natural fresh water were taken as control. Diluted water was made by diluting natural fresh water with distilled water in the proportion of 1:1, 1:10, or 1:100; concentrated fresh water was obtained by adding various amounts of sodium chloride (16, 32 and 160 mM).

10 larvae were kept in the different solutions (10 larvae for each for 24 hours). The gills were removed; having fixed and stained by histochemical choride method (WICHARD and cows., 1973), they were processed for light microscope.

Results and discussion

2 pars of lamelliform gills are on each side of 1—7 abdominal segments. The members of the pairs are different only in size. Their tracheas form a rich network and join into the main visceral tracheal branch of the body.

Histological structure of the gills is similar to that of other mayfly larvae lamelliform gills, that is among their respiratory epithelial cells on their upper and lower surfaces there are chloride cells according to histochemical stain (WICHARD, 1975; WICHARD and cow., 1971, 1973).

Their distribution on the surfaces of the lamellae is unequal, most of them are on the middle and proximal part of the gills. Their number increases to 1—4 gill pair then suddenly decreases. The changing number of cells could be observed in the case of each applied concentration (Figs. 1, and 2). It this change is considered at increasing concentration of sodium chloride (Fig. 3) we can claim that the number of chloride cells per gill in diluted water is increasing but decreasing at gradually increasing concentration of sodium chloride.

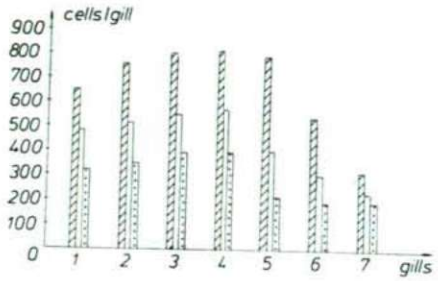

Fig. 1. Distribution of the chloride cells on the large gills of the larvae (clear column=in normal-striated column=in diluted-, dotted column=in concentrated water).

Table 1. Standard deviation of chloride cells per large gills

Number of gill	Diluted water	Normal water	Concentrated water
1.	n=10 652±1.054	n=10 482±3.80	n=10 320±2.44
2.	758±2.90	516±3.80 (n=9)	350±1.63
3.	805±4.29	558±4.85	390±3.74
4.	813±2.66	570±4.44	400±4.42
5.	795±4.83	402±3.62	219±2.26
6.	545±4.14 (n=8)	311±3.12	199±4.32
7.	323±4.41 (n=9)	231±1.88	200±2.35

The received data (Figs. 1, and 2). considering their standard deviation (Tables 1, and 2) indicate that sufficiently homogenous populations were used; and indicate an adaptive behaviour of the chloride cells too that is the larvae are able to tolerate a comparatively wide range of salinities. The increasing number of the cells may lead to the conclusion that these cells absorb salt from external presumably very hypo-osmotic environment and transfer to haemolymph. (We stress that even the external water at the control experiments can't be considered iso-osmotic in comparison with the haemolymph).

At the gradually increasing concentrations the decrease in the number of the cells can be correlated with the superfluous salt intake with food from external hyper-

Table 2. Standard deviation of the chloride cells per little gills

Number of gill	Diluted water	Normal water	Concentrated water
1.	n=10 135±3.80 (n=9)	n=10 80±2.74	n=10 25±2.21
2.	173±3.91	125±3.57	50±3.85
3.	183±3.68	116±4.30	50±3.07
4.	210±4.15 (n=8)	161±3.62	98±2.00
5.	176±2.05 (n=)	127±3.49	71±1.94
6.	195±0.816	64±2.36	30±1.63

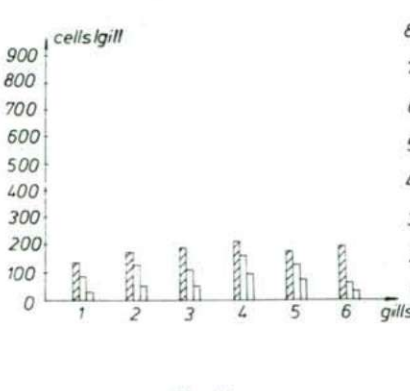

Fig. 2

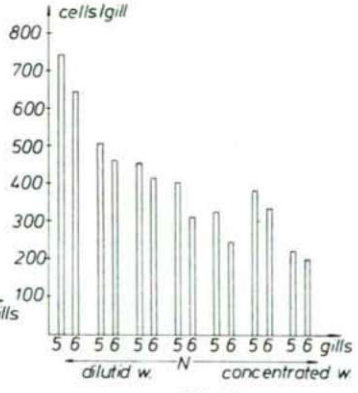

Fig. 3

Fig. 2. Distribution of the chloride cells on the small gills of the larvae (clear column=in normal-, striated column=in diluted-, dotted column=in concentrated water).

Fig. 3. Changing of the number of the chloride cells on 5. and 6. gills depending on the different salinities.

tonic environment. This time the salt-excretory activity is increasing in addition other cells and organs could also take part in salt secretion e.g. salt glands of marine birds or the chloride cells of marine fish (SCHMIDT-NIELSEN and cow., 1964).

Our light microscopic experiments can't prove these cells' ability of excreting salt.

Certain data doubt the excretory activity of these cells on the basis of experiments on other species with radioactive chloride.

Our experiments and results introduce the presence of the chloride cells and their changing number and indicate that they are members of a regulating mechanism. Further experiments are needed to clear what kind of changes happen in these cells.

References

EASTHAM, L. E. S. (1936): The sensillae and related structures on the gills of nymphs of the genus *Caenis* (Ephemeroptera). — Trans. R. Ent. Soc. Lond. *85*, 401—411.

KAPOOR, N. N. (1978): Effect of salinity on the osmoregulatory cells in the tracheal gills of the stonefly nymph *Paragnetina media* (Plecoptera: Perlidae). — Can. J. Zool. *56*, 2608—2613.

MUNSHI, D. J. S. (1964): Chloride cells in the gills of water teleosts. — Quart. J. micr. Sci. *105*, 79—89.

SCHMIDT-NIELSEN, K. and Y. T. (1964): The effect of salt intake on the size and function of the salt gland of ducks. — Auk. *81*, 160—172.

SHARP, D. M. A. (1909): The Cambridge Natural History. Insects II. Macmillan and Co., Limited st. Martin's street, London.

ÚJHELYI, S. (1959): Ephemeroptera. Fauna Hung. V.

WESENBERG-LUND, C. (1943): Biologie der Süsswasser-Insekten. — Nordisk Forlag, Kopenhagen und Verlag J. Springer Berlin, Wien.

WICHARD, W. (1975): Structure and function of the respiratory epithelium in the tracheal gills of mayfly larvae. — Proc. 2nd Int. Conf. on Ephemeroptera, Krakow.

WICHARD, W. and KOMNICK, H. (1971): Electron microscopical and histochemical evidence of chloride cells in tracheal gills of mayfly larvae. — Cytobiol. *3*, 215—228.

WICHARD, W. and KOMNICK, H. (1973): Fine structural and histochemical evidence of chloride cells in stonefly larvae. 1. The coniform chloride cells. Cytobiol. 7, 297—314.

WICHARD, W., TSUI, P. T. P. and KOMNICK, H. (1973): Effect of different salinities on the coniform chloride cells of mayfly larvae. — J. Insect Physiol. *19*, 1825—1835.

Address of the author:
DR. MÁRIA CSOKNYA
Department of Zoology, A. J. University,
H-6701 Szeged, Hungary