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The influence of *Bacillus thuringiensis* var. *israelensis* on the mosquito predator *Notonecta glauca*

Water bugs from the genus *Notonecta* belong to extremely efficacious predators of mosquito larvae in the entire holoarctic area (see e.g. Dubitskii in Laird M. and Miles J. W. (Eds.), 1985: Integrated mosquito control methotodologies. Acad. Press, Orlando, 444 pp. and others). On the basis of our field observations we were able to confirm that biotopes densely populated with the common water-boatmen (most often *Notonecta glauca* Linnae, 1758 under Czechoslovak conditions) are usually bare of mosquito larvae because here their populations are not very numerous.

Bacillus thuringiensis var. *israelensis* (*B. t. i.*) is at present given priority No. 1 in the programme Biological Mosquito Control (WHO — TDR/BCV/SWG — 7/84. 3). Results of tests against target organisms demonstrated intoxity for all predatory organisms investigated by Mulligan and Schaefer (1980: Proc. Pap. 48 th. Ann. Conf. Mosq. Contr. Assoc. 19—22), Garcia et al. (1980: ibid., 33—36), Miura et al. (1980: ibid., 45—48). However, mortality was relatively high, in case larvae Toxorynchytes were fed by infected larvae *Aedes aegypti* (Lacey L. A. and Dame D. A., 1982: J. Med. Entomol. 19: 593—596, and Lacey L. A., 1983: ibid. 20: 620—624).

In order to find out to what extent using *B. t. i.* against mosquito larvae can influence populations of the common water-boatmen and, if need be, to evaluate the relationship between common water-boatmen and mosquito larvae we arranged the following experiment:

Third and fourth instar larvae of *Notonecta glauca* collected in the field were by one placed into containers from transparent polystyrene with 2 dcl water and fed with larvae of *Culex pipiens*. Larvae of the common water-boatmen were divided into the following groups:

Nos. 1—10 Control, fed by mosquito larvae

Nos. 11—45 Common water-boatmen fed by mosquito larvae, 2.81×10^8 spores of *B. t. i.*/dcl added

Nos. 46—50 Common water-boatmen not fed, 2.81×10^9 spores of *B. t. i.*/dcl added

For controlling the effectiveness of the *B. t. i* spores, 50 larvae of *C. pipiens* not fed at all during the experiment were given to 3 containers marked K 1—3 and into 3 containers marked KB 1—3 we gave 50 larvae of *C. pipiens* + 2. 81×10^7 spores of *B. t. i.*/dcl. The water temperature in the containers fluctuated from 18—24 C. In the beginning of the experiment the respective amount of *B. t. i.* in a suspension was given to containers Nos. 11—45 and daily 50 live mosquito larvae were added. In view of the fact that the spore suspension in the microaquaria decreased in effectiveness, from the fifth day of the experiment a new dose of suspersion of initial concentration was added every third day to the samples treated with *B. t. i.* Controls were performed daily. The amount of mosquito larvae surviving from the prevoius day and changes in the state of the common water-boatmen (exuviation or dead larvae) were recorded.

While in controls K 1—K 3 all larvae without exception completed development to the pupal stage, mosquito larvae in samples KB 1—3 (with *B. t. i.*) were found dead after 24 hours.

In the control of the common water-boatmen (Nos. 1—10) the amount of mosquito larvae killed by one individual within 24 hours fluctuated considerably (from 5—55). Under experimental conditions the mean consumption was 21 larvae within 24 hours. One common water-boatmen larvae died during the experiment, the others completed development up to the imaginal stage.

In the group of 35 common water-boatmen fed by mosquito larvae which consumed *B. t. i.* (Nos. 11—45) four died during the experiment, the others completed development until imaga. After consumption of *B. t. i.* mosquito larvae for a certain period stayed motionless at water level. These already little mobile larvae were not attacked by the common water-boatmen.

The group of five common water-boatmen not fed at all but only kept in *B. t. i.* suspension (Nos. 46—50) completed development until the imaginal stage without exception.

Without doubt, experimental conditions in the laboratory microaquaria create to a certain extent stress situations for the observed organisms and may therefore distort the results of the observations. Even so, the experiment again proved *B. t. i.* to be non-toxic for *Notonecta glauca*, i.e. *B. t. i.* as a spore and as active beacterium, not even further pathogenic agents which the common water-boatmen consume together with the mosquito larvae are toxic. It is true that Prucell (1981: Mosq. News 41: 476—484) and Sebastien and Brust (1981: ibid. 41: 508—511) state that *Notonecta indica* and *Notonecta* sp. are the only non-target organisms influenced negatively by *B. t. i.*, but firstly: these authors worked with imagoes which posses a considerable tendency to migrate and are able to fly up from the experimental containers and secondly: Prucell worked in the field where the error of measuring is high at the reported low amount of common water-boatmen. Thirdly: the mortality in the second publication could have been due to cannibalism of common water-boatmen which attack even individuals of their own size when food is scarce. In this case there is no sign of a defect on the dead animal at first sight.

Considering that mosquito larvae shortly after consumption of *B. t. i.* become less attractive to the common water-boatmen, the combination bacillus — predator appears to be very advantageous because the predator may be of use in liquidating the rest of the mosquito population which for some reason survived the operation. Mosquito larvae are for the common water-boatmen equally attractive, whereas *B. t. i.* has no effect on them.

J. OLEJNIČEK and B. MARYŠKOVÁ
Parazitologický ústav ČSAV,
Branišovská 31
370 05 České Budějovice