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TWO TYPES OF HIBERNATION OF *CULEX PIPIENS* COMPLEX (DIPTERA: CULICIDAE) IN CROATIA

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An investigation of different ways in which the *Culex pipiens* complex hibernates has been carried out in cellar environments with two different ecological conditions. These two types of hibernation are as follows. The first type includes continuous exchange of generations in dark concrete basements with water, with 45 days for the development of a new generation. The second potential type of hibernation of adult mosquitoes is in dark and cold cellars where they lose 44.5 % of body weight and only 41.86 % of hibernating specimens survive.

***Culex pipiens* complex, hibernation, cellars,**

E. MERDIĆ[1], S. VUJIČIĆ-KARLO[2], Dva tipa prezimljavanja *Culex pipiens* kompleksa (Diptera: Culicidae) u Hrvatskoj, [1]Odjel za biologiju Sveučilišta Josipa Jurja Strossmayera u Osijeku, Trg Ljudevita Gaja 6, 31000 Osijek, enrich@ffos.hr, [2]Narodni muzej Zadar, Prirodoslovni odjel, Andrije Medulića 2, 23000 Zadar - Entomol. Croat. 2005, Vol. 9. Num.1-2: 71 - 76

U ovom radu predstavljeni su rezultati istraživanja različitih načina prezimljavanja *Culex pipiens* complex u podrumima u kojima vladaju različiti ekološki uvijeti. U odnosu na ekološke uvijete postoje dva načina prezimljavanja. Prvi tip uključuje kontinuiranu izmjenu generacija u mračnom betonskom relativno toplom podrumu s vodom, u kome razvoj generacije traje 45 dana. Drugi oblik prezimljavanja odraslih komarca je u tamnim i hladnim podrumima starih zgrada, gdje prezimljuju na račun rezervnih masti i gube 44,5% na težini, a prezimi samo 41% jedinki.

Introduction

The common house mosquito, *Culex pipiens* complex, presents a number of biological and morphological variants throughout its world-wide range (Mattingly, 1951). Since then, scientists have generally agreed that the complex is

composed of four forms: *Culex pipiens L., Culex quinquefasciatus Say, Culex molestus* Forsk., and *Culex pipiens* var. *pallens* Coq. (Vinogradova, 2000). In addition to the biological diversities of autogeny and stenogamy, anthropophilia or ornithophilia, it also presents certain types of survival mechanisms during inconvenient living conditions. In this particular case, the conditions are the cold winters of continental Croatia.

Homodynamy, as a biological characteristic of hibernating, shows the possibility of reproductive activity throughout the year. Heterodynamy, unlike homodynamy, requires an obligatory pause in the reproductive cycle (reproductive inactivity). A different population within the *Culex pipiens* complex exhibits both of these characteristics. Very often in the literature, systematic determination is discussed according to these characteristics, in which the homodynamic population is regarded as molestus, and the heterodynamic population is pipiens (Eldridge & Bailey, 1979; Spielman, 1964; Vinogradova, 2000).

Of the known characteristics distinguishing the biotypes of *Culex pipiens*, hibernation has attracted considerable attention. Only anautogenous biotypes hibernate (Spielman, 1964). However, depending on overwintering conditions, autogenous populations may also stop reproduction when bad conditions of temperature and relative humidity appear.

Yet, is it not possible that according to these differences in types of overwintering behavior, the *Culex pipiens* complex may or may not show these systematic differences? Within the *Culex pipiens* complex two types of populations regarding hibernation were determined. It is certain that in Zagreb new generations are produced as long as there are suitable ecological conditions, whereas in Osijek, there is population with reproductive inactivity. This paper presents some considerations and research on mosquito hibernation in basements in the urban areas of inland Croatia.

Material and methods

The investigation was carried out in two cities in Croatia. In the western part of the country, in the capital, Zagreb, 30 basements were investigated. In only five basements of new buildings (skyscrapers) where water was present were mosquitoes noted. In one of them we placed first and second instar of larvae into insectarium in the basement, and controlled development.

In Osijek, in the eastern part of the country, about 2000 cellars were checked (mostly in old buildings 100 or more years old). We noted the number of all mosquitoes in each cellar and the square meter with the highest density. This square meter was marked, and the number of mosquitoes was controlled every ten days during the winter period. We also controlled the reduction in the mass of the mosquitoes, and each time we took a sample of 20 mosquitoes (from a non-marked area), killed them, and weighed their total mass. We calculated the average mass of a mosquito. We measured both the wet and the dry conditions of the average mosquito.

Results

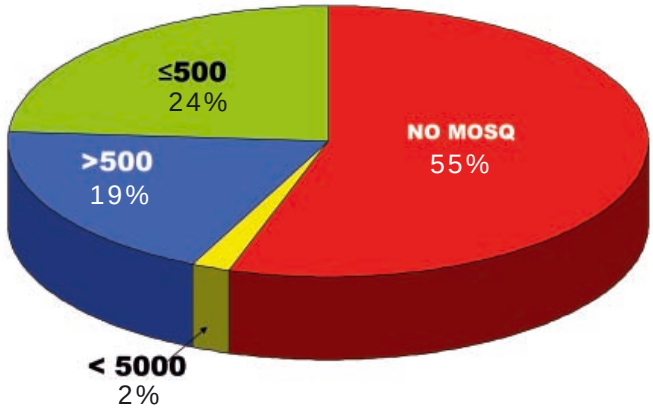

Figure 1. A total of 2002 cellars were investigated. These cellars are divided into 4 categories.

In Osijek, in Eastern Croatia, 2002 cellars were checked. In most of them there were no mosquitoes. In about 20% (405) of them, more than 500 mosquitoes hibernated in each cellar. In 30 of those cellars, between 5,000 and 30,000 specimens of the Culex pipiens complex hibernated (fig. 1). In addition to this species, *Anopheles messeae* and *Culiseta annulata* hibernate there in small numbers. The cellars with the greatest number of mosquitoes were of the same type (Merdić, 1990): deep (underground level), dark (with small windows without direct light), made of bricks, with a dirt floor, without water, and with the average temperature of 6°C. The survival percentage was determined during the whole

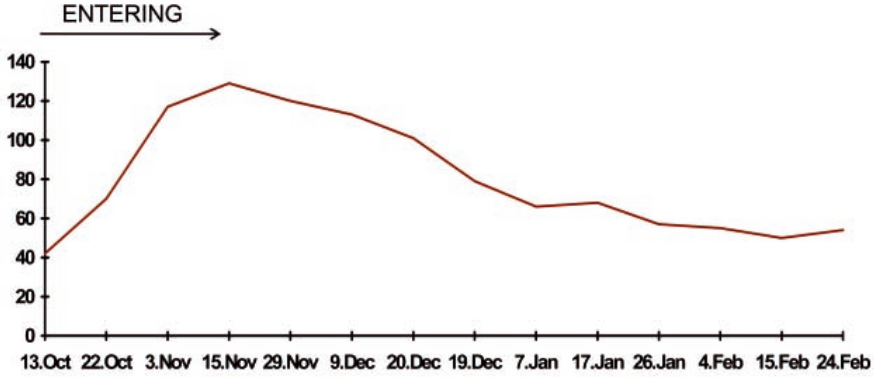

Figure 2. Decreasing of number of specimens hibernate in cellars in Osijek

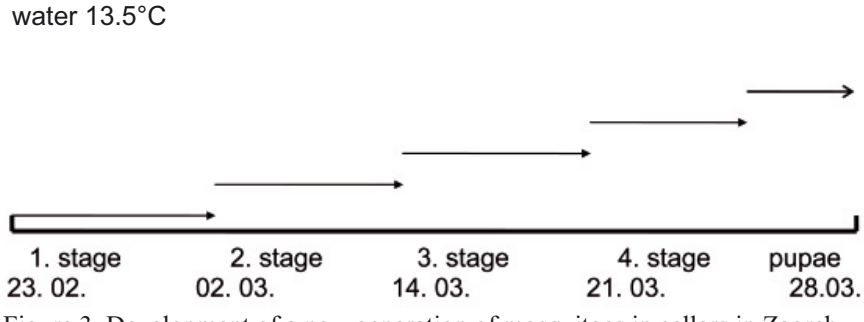

Figure 3. Development of a new generation of mosquitoes in cellars in Zagreb

winter period in the tested cellars. Under the optimal conditions for hibernation – T=6°C, Rh=90%, (Minar & Ryba 1971) – less than half of the mosquitoes (fig. 2) survived the winter. In this type of hibernation the loss of weight is normal, and related, first of all, to the loss of trophic fat (tab. 1). In this type of cellar, the weight loss is approximately 44.5%. The final survival is only 41%.

In the Western part of Croatia, in Zagreb, populations of *Culex pipiens* complex hibernating in a different way were found. The tested basement in Zagreb was made of concrete, approximately 2 m high, separated into rooms (5x10 m), in total darkness. There was a 5-10 cm deep layer of water at the bottom and the temperature of the water was always 13.5°C. The water dripped from a leak in a water pipe. The room temperature was also constant: 16°C. In the aforementio-

Table 1. Loss of weight of *Culex pipiens* complex specimens (average) hibernating in cellars in Osijek

DATE	MASS OF BODY	% OF LOSSOSE
13. October	3.03	
22. October	3.00	0.01
03. November	2.90	4.30
15. November	2.80	7.59
29. November	2.77	8.58
09. December	2.67	11.88
20. December	2.11	30.36
29. December	1.88	37.95
07. January	1.87	38.28
17. January	1.85	38.94
26. January	1.83	39.60
04. February	1.81	40.26
15. February	1.70	43.89
24. February	1.68	44.50

ned conditions, a great number of larvae, pupae, and adult mosquitoes, both male and female, were found. By following the developmental stages of the larvae, it was determined that the life cycle of one generation of *Culex pipiens* complex mosquitoes in the basement in the given conditions was about 45 days (fig. 3). This type of hibernation is completely different from the first one.

Discussion

For the population of mosquitoes overwintering in Zagreb, it can be said without qualification that it is an autogenous, homodynamic population that produces a new generation every one and half months in the above-mentioned conditions. That population can easily be determined as molestus, because this type of hibernation is characteristic of that category (excluding others).

The population of mosquitoes which hibernate in Osijek could be heterodynamic. Hibernating from reserve fat is noted (tab.1), and reproductive inactivity is evident. The mechanism of this hibernating could possibly be (1) excessive blood feeding in prehibernating females, or (2) pupae, which are photoperiodic

sensitive (Spielman & Wong 1973) directing females to enter ovarial diapause, or (3) all mosquitoes hide from the cold but only fertilized females survive. The ecological conditions in Osijek's cellars cause reproductive inactivity.

Eldridge & Bailey (1979) suggest that in prehibernation the females' follicular development is not actually suspended but greatly retarded. For the mechanism to be effective, it would only be necessary for the follicular development to be retarded enough to ensure that the resting stage is not reached until after the fall hibernation preparation period. If this is true, no environmental trigger is needed to terminate diapause, and female mosquitoes will leave the cellar as soon as spring temperatures become high enough to promote flight. Likewise, in our experiments, we found that when there was an unusually high increase in temperature in the winter, mosquitoes in the Osijek cellars moved or even left the cellar (unpublished data). However, when the temperature dropped again, they returned to their original location.

Based on our research in Osijek and on the literature, mosquito hibernation depends solely on reserve fat; the percentage of surviving mosquitoes is small; and in our observations the mosquitoes moved and returned when the temperature changed. Therefore, we can conclude that the mosquito population in Osijek is molestus. Finally, molestus can have two types of hibernation depending on ecological conditions: expressed or suppressed homodynamy.

References:

ELDRIDGE B. L. & BAILEY C. L., 1979. Experimental Hibernation Studies in *Culex pipiens* (Diptera, Culicidae): Reactivation of Ovarian Development and Blood - feeding in Prehibernating Females. J. Med. Entomol. 15, 5-6:462-467.

MATTINGLY P. F., 1951. The *Culex pipiens* Complex . Trans. R. Ent. Soc. Lond. 102. 7:331-342.

MERDIĆ E., 1990. Hibernation of mosquitoes (Dipt., Culicidae) in cellars in town Osijek, Croatia, Yugoslavia. Acta Ent. Jugosl. 23. 1-2:53-58

MINAR J. & RYBA J., 1971. Experimental Studies on Overwintering Conditions of Mosquitoes. Folia Parasitologica 18:255-259.

SPIELMAN A., 1964. Studies on Autogeny in *Culex pipiens* Populations in Nature. I Reproductive isolation between autogenous and anautogenous population. Am. J. Hyc. 80:175-183

SPIELMAN A. & WONG. J., 1973. Studies on Autogeny in Natural Populations of *Culex pipiens*. III Midsummer preparation for hibernation in anautogenous populations. J. Med. Ent. 10. 4: 319-324.

VINOGRADOVA E. B., 2000. The *Culex pipiens* pipiens Mosquitoes: taxonomy, distribution, ecology, physiology, genetics, applied importance and control. Pensoft, Sofia, pp. 4-44.