Acarina 10 (1): 91–94 

# DIFFERENT WAYS OF *IXODES PERSULCATUS* (ACARI, IXODIDAE) LARVAE AND NYMPHS PLACEMENT INTO THE FOREST LITTER AND THEIR INFLUENCE ON TICK DEVELOPMENT

# РАЗЛИЧНЫЕ СПОСОБЫ ЗАКЛАДКИ В ЛЕСНУЮ ПОДСТИЛКУ ЛИЧИНОК И НИМФ *IXODES PERSULCATUS* (ACARI, IXODIDAE) И ИХ ВЛИЯНИЕ НА РАЗВИТИЕ КЛЕЩЕЙ

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Key words: taiga tick, *Ixodes persulcatus*, development of larvae and nymphs, diapause
Ключевые слова: таежный клещ, *Ixodes persulcatus*, развитие личинок и нимф, диапауза

## ABSTRACT

The comparative analysis of the development of larvae and nymphs of the taiga tick placed into the coniferous-deciduous forest litter inside the glass containers, litter bags made out of the mesh, and bacteriological vials has been done. The data obtained demonstrate that the glass containers change the natural conditions of the larva and nymph development to a lesser extent and thus can be recommended to study the tick development in nature.

## РЕЗЮМЕ

Проведено сравнительное изучение развития личинок и нимф таежных клещей, заложенных в лесную подстилку смешанного леса в садках, мешочках из мельничного газа и бактериологических пробирках. Полученные данные демонстрируют, что стеклянные садки в меньшей степени изменяют естественные условия развития личинок и нимф и, соответственно, могут быть рекомендованы к использованию для проведения исследований развития иксодовых клещей в природных условиях.

The developmental aspects of the taiga tick biology in various parts of the species area have been extensively studied for quite an extended period of time [Gruzdeva, 1943; Pshenichnov, Khramushin, 1943; Serdyukova, 1948; Pomerantsev, 1950; Kheisin et al., 1955; Babenko, Rubina, 1961, 1968; Kachanko, 1978; Leonova et al., 1990, etc.]. Despite the numerous differences in climate, weather conditions etc. throughout the area, some general regularities of the *Ixodes persulcatus* development were revealed. The taiga tick larvae and nymphs engorged in spring or in the first part of the summer have their development without a diapause. Some of the ticks engorged in July demonstrate a diapause. Throughout the area almost all larvae and nymphs engorged in August develop with a diapause.

Some differences in the tick biology were also noted such as the time of a diapause, the ratio of molted, diapaused and dead individuals. The mortality in ticks was 7–87% in Irkutsk Province [Shikharbeev, 1965], 24–30% [Babenko, Rubina, 1968] and 5,1–10,8% [Korotkov, Kislenko, 1995] in Krasnoyarskiy Kray, and 10–58% in Primorye [Vavilova et al., 1965].

As a rule, to study the development of ticks in natural conditions year-round the bags made out of mesh or nylon [Methodical Recommendations.., 1987] and bacteriological vials [Katin et al., 1985; Yakina, 1984] were used. The data obtained by this method were compared with those obtained in nature. However, it is difficult to conclude how close these results are. The environmental conditions in the experimental sites were also not similar. For example, Korotkov and Kislenko [1991] mentioned that their data collected in Udmurtia were quite different from those obtained by Zhmaeva [1968] for Kirovskaya Province despite the same latitude and similar environmental conditions. The development of larvae and nymphs engorged in the first part of the spring-summer season in Udmurtia occured without a diapause. Vice versa, immature ticks from Kirovskaya Province engorged either earlier or later in the spring-summer season, have a diapause. Thus, the ratio of diapausing larvae and nymphs to engorgement time can be demostrated by S-curved line in Udmurtia, but by V-curved line in Kirovskaya Province. The transition to the de-

velopment of immatures without a diapause takes place only during a limited time in Udmurtia, comparing to Kirovskaya Province, where such a transition is not clear, inasmuch as the diapausing ticks can be found within individuals engorged either later in the season, or in its very beginning. The authors suggested that such a difference in the data obtained has resulted from different ways of placement of engorged larvae and nymphs into the soil litter within the experiment. The experimental larvae and nymphs were placed at the depth of 5–15 cm in Kirovskaya Prov. as the «hole-inhabiting» ticks, whereas they were placed inside the mesh-bags at the depth of 2–3 cm in Udmurtia. Fedorova [1983] placed ticks at the depth of 10 cm in Novgorodskaya Province. Thus the methods of the tick placement were different in the above-mentioned experiments, which may result in difficulties to interprete the field experiment data.

The goal of the present work was to compare different methods of study of vector's development in natural conditions.

## METHODS OF RESEARCH

The research was conducted in the coniferous-deciduous forest of the *Populus tremula — Betula pendula* forest subzone of Western Siberia during 1990–1993. The study plot was located 40 km to the north-west of Tyumen.

The development of engorged ticks was studied comparatively in glass containers, mesh-bags and bacteriological vials. The glass container was a cylinder volumed 250 ml with no bottom, which was placed into the soil and covered with a mesh. The mesh-bags sized 8×14 cm were placed in the soil litter and marked with a wooden label. The bacteriological vials were filled to one third with the wet sawdust and covered with a pith-cap. The vials were placed in soil under the angle of 15–20 degrees. The wetting of sawdust was done through the opening in the vial bottom by natural soil moisture.

The comparative study of the development of 3190 nymphs and 7250 larvae of *I.persulcatus* was conducted during the spring-summer season (May-August).

The peculiarities of the tick development were studied when the stable negative temperatures took place.

The following tick conditions were checked out for registration: 1) gone through the diapause — hungry and motile individuals; 2) being in the diapause — engorged and motile; 3) died during the diapause — immotile, engorged, with no changes in coloration; 4) died during the transformation and not molted before the cold period (expected mortality); 5) dead — died from drying out, overmoisturizing, fungal and bacterial diseases, or as a result of predation.

## RESULTS AND DISCUSSION

The analysis of the research results on the development of engorged larvae and nymphs placed in the forest litter by various methods, showed that the glass containers provide more favorable conditions for the tick development, comparing to the mesh-bags and bacteriological vials. During our research it was shown that the number of molted ticks in glass containers was the largest in spite of the weather conditions (Fig. 1). In these containers the molting level for May and June-fed individuals equaled about 100%. During all the period of our observations the average percentage of molted May and June-fed individuals varied in glass containers from 88% to 100% for larvae and from 61% to 95% for nymphs, in mesh-bags from 93% to 95% for larvae and from 15% to 75% for nymphs, and in bacteriological vials from 60% to 79%, and from 14,5% to 42%, respectively.

100% frequency of the tick molting per placement type was usual in glass containers (larvae in 9 cases, nymphs; 3 cases), but lower in mesh-bags (larvae in 3 cases), and in bacteriological vials (nymphs — only 1 case recorded).

The first diapausing individuals in all placement types were recorded among ticks of June feeding in cold and wet season of 1992. The early diapause of June-fed nymphs of this season can be explained by late frosts with the temperatures as low as $-1^{0}$C. As a result, all nymphskept in the glass containers, revealed a diapause, comparing to 42,5% nymphs in mesh-bags, and only 5% in bacteriological vials. All other ticks in two latter placements died. The frosts did not greatly affect the larvae. Only a few individuals had a diapause in mesh-bags (2%) and bacteriological vials (5%), while ticks kept in glass containers developed without a diapause. In the dry and hot season of 1991 the diapause in some June-fed nymphs was recorded in mesh-bags (9%). The first diapausing larvae were recorded in mesh-bags later, among July-fed individuals.

During the period of our observations the number of diapausing July-fed larvae in glass containers reached 12% and was significantly higher comparing that in mesh-bags and bacteriological vials ($P \leq 0{,}001$).

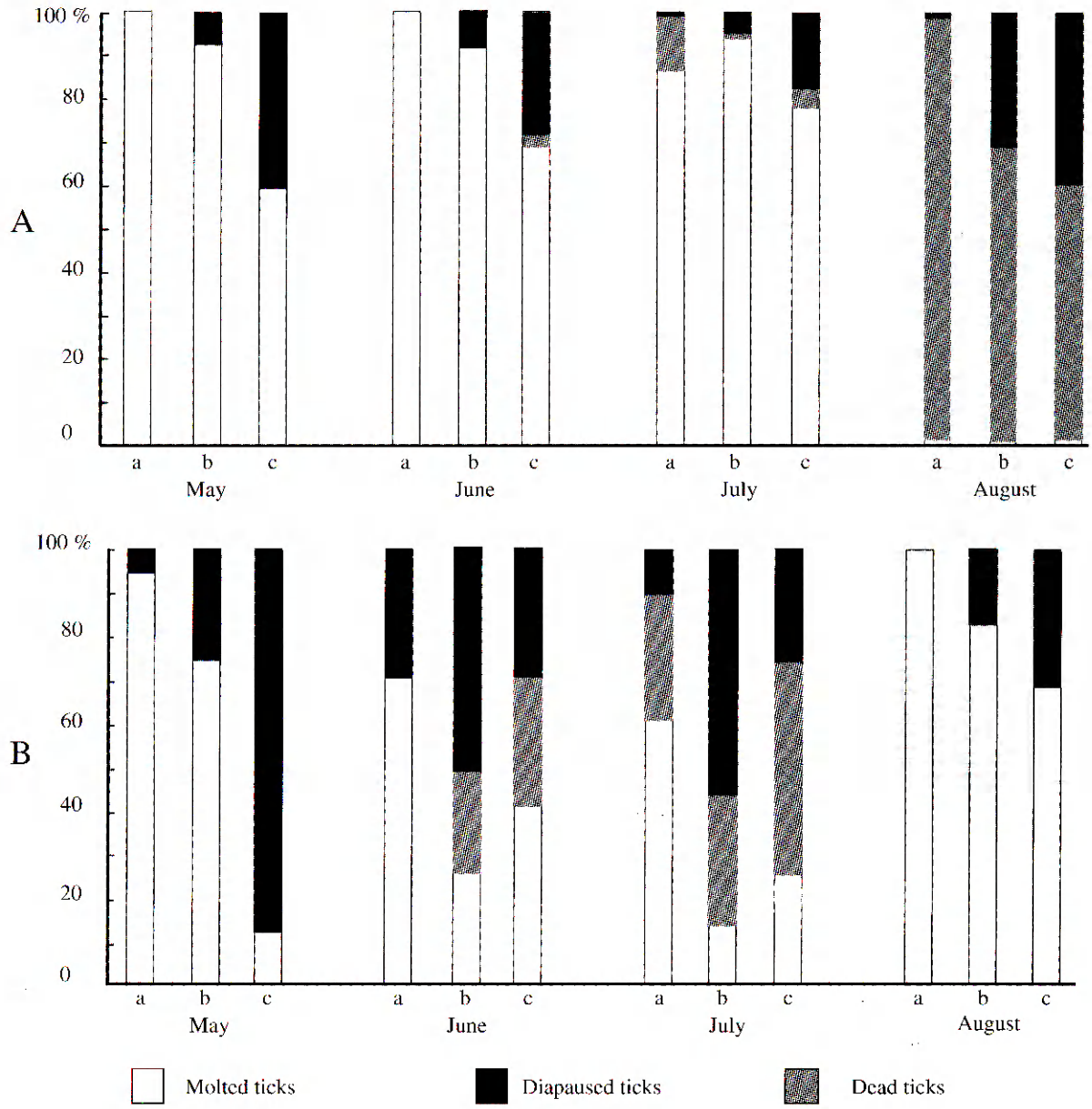


Fig.1. Peculiarities of the development of larvae (A) and nymphs (B) placed into the forest litter by different methods during 1990–1993. X — month of the tick placement and the type of placement (a — glass container, b — mesh-bag, c — bacteriological vial); Y — ratio of various tick individual states (in %).

In the natural conditions of Western Siberia all August-fed ticks had a diapause, as well as in other parts of *I.persulcatus* area. The August-fed ticks molted only after overwintering. However such scheme of the August-fed tick development was not always reported. The warm weather conditions during the season, 1991, favored the molting of some larval individuals in all types of placements. During the season 1993, the second half of the summer was warm resulting in molting of one larva in the glass container.

The cases of deaths of ticks in glass containers were only occasionally reported, and the number of larvae and nymphs died was significantly lower comparing to mesh-bags and bacteriological vials ($P<0,001$). he mortality from unknown reasons was recorded in glass containers only in one case for nymphs, and more often in mesh-bags (3 larvae and 6 nymphs) and bacteriological vials (6 larvae and nymphs, correspondingly). During our observations, the August-fed ticks died before the cold period: 1% of larvae in glass containers, 29,6% of larvae and 63% of nymphs in mesh-bags, and 35% of larvae and 55% of nymphs in bacteriological vials.

Thus, the analysis of data obtained shows that tick molting was more frequently recorded in glass containers comparing to mesh-bags. The lowest

number of molted ticks was reported for bacteriological vials. According to our observations, the ticks kept in glass containers were characterized by longer period of the development without a diapause, by larger number of molted individuals, and by low death rate. High mortality level in ticks was recorded in mesh-bags and bacteriological vials more often, than in glass containers.

The observed differences in the development of ticks can be explained by the conditions in placements of various types. The conditions most close to those in the natural environment can be retained in the glass containers (e.g. the longevity of the day-light, opportunities for movement and choosing the optimal conditions for the molting etc). Vice versa, after the continuous rainfalls the walls of mesh-bags get attached to each other, and the ticks get trapped inside water drops. Similarly, in bacteriological vials the extra moisture was accumulated, making unfavorable conditions for tick development. In opposite cases, when there were no rainfalls, the ticks were doomed to die of desiccation. Also the fungal growth inside the vials was often observed, as well as the condensed water accumulation on the vial walls.

Hence, the natural conditions of the tick development were less changed in the glass containers. The usage of this type of the tick placement makes it possible to get developmental data most close to those found in nature.

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