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## SEASONAL CHANGES IN ACTIVITY, SEX COMPOSITION AND AREAL OF THE TICK *IXODES RICINUS* (ACARI, IXODIDA) IN THE LANDSCAPE-GEOGRAPHICAL REGIONS OF UKRAINE

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**Seasonal Changes in Activity, Sex Composition and Areal of the Tick *Ixodes ricinus* (Acari, Ixodida) in the Landscape-Geographical Regions of Ukraine.** Akimov I. A., Nebogatkin I. V. — Data on seasonal activity of adults, nymphs and larvae of the sheep tick *Ixodes ricinus* Linnaeus are presented based on examination of our own collections for the period from 1977 to 2001 and archival materials for the period from 1953 to 2000, as well as data on changes in its natural habitat that now covers the whole territory of Ukraine. The period of activity in *I. ricinus* imagoes becomes longer from north to south and from west to east. In Ukrainian populations of *I. ricinus*, females slightly dominate (on average  $52.44 \pm 0.55\%$ ). The seasonal differences in the sex ratio are as follows: males are more abundant in springtime, females — in autumn. Significantly larger numbers of females (on average 52–60%) are registered on population peaks, and larger numbers of males — on their decrease.

Key words: ticks, areal, natural habitat, seasonal activity, Ukraine.

**Сезонные изменения активности, половой состав и границы ареала клеща *Ixodes ricinus* (Acari, Ixodida) в ландшафтно-географических зонах Украины.** Акимов И. А., Небогаткин И. В. — На основе анализа собственных сборов (1977–2001 гг.) и архивных материалов (1953–2000 гг.) приведены о сезонных изменениях активности взрослых, нимф и личинок европейского лесного клеща, а также изменение ареала вида, который распространяется на всю территорию Украины. Продолжительность активности половозрелых фаз *I. ricinus* увеличивается с севера на юг и с запада на восток. В популяциях европейского лесного клеща в Украине незначительно преобладают самки (в среднем  $52,44 \pm 0,55\%$ ). Обнаружены сезонные различия в соотношении полов: самцов больше в весеннее время, а самок — в осеннее. Достоверно большее количество самок (в среднем 52–60%) зарегистрировано на пиках численности, а самцов — на спадах.

Ключевые слова: иксодовые клещи, ареал, сезонная активность, Украина.

### Introduction

The period of activity and its seasonal characteristics for the sheep tick *Ixodes ricinus* Linnaeus, which is the main vector for the Lyme disease and tick-borne encephalitis in Europe (Fillipova, 1977; Alekseev, 1993) are important to know during prophylactic measures in the nidi of these diseases. No works summarize current information for Ukraine. The purpose of this article is to sum up data on seasonal changes in activity and sex composition of *I. ricinus* in landscape-geographical regions of Ukraine taking into account new information on expanded natural habitat of this tick southward.

### Material and methods

Hard ticks were collected by standard methods (Tularemia, 1954) on a flag, accounting person, by plugging burrows, during examination of nest substrate, examination of cattle and small cattle, horses, camels, domestic animals, pets, and combing of small mammals. Totally, for the period from 1977 to 2001, in 21 oblasts, 174 districts, cities and towns, during examination of more than 1,500 heads of cattle and small cattle, horses, camels, domestic animals, pets, and combing of 29 144 bagged small mammals, we have collected and examined 110,779 specimens of *I. ricinus*. Also, materials from short-range (half-year) forecasts and

**Table 1.** Amount of the ticks *Ixodes ricinus* from various in landscape-geographical regions and subregions of Ukraine**Таблица 1.** Количество собранных клещей *Ixodes ricinus* из различных ландшафтно-географических зон подзон Украины

| The number of ticks on the phases of development | Zone    |                       |               |         |                  |         |
|--|---------|-----------------------|---------------|---------|------------------|---------|
|  | Poles'e | Western Forest-Steppe | Forest-Steppe | Steppe  | Azovo-Chernomors | Crimea  |
| Adults   | 32 148  | 8 636                 | 34 691        | 6 430   | 2 859            | 15 464  |
| Nymphs   | 3 149   | 8 45                  | 3 397         | 629     | 280              | 1 526   |
| Larvae   | 222     | 59                    | 237           | 56      | 27               | 144     |
| Total (own charges)                              | 35 519  | 9 540                 | 38 325        | 7 115   | 3 166            | 17 134  |
| Adults   | 867 238 | 232 954               | 935 853       | 173 461 | 77 134           | 410 249 |
| Nymphs   | 14 135  | 3 796                 | 15 253        | 2 826   | 1 257            | 6 853   |
| Larvae   | 2 121   | 566                   | 2 271         | 531     | 258              | 1 392   |
| Total (archival data)                            | 883 494 | 237 316               | 953 377       | 176 818 | 78 649           | 418 494 |
| Total  | 919 013 | 246 856               | 991 702       | 183 933 | 81 815           | 435 628 |

reviews from sanitary-and-epidemiologic institutions of 25 oblasts, Alushta, Kyiv, Mariupol and Sevastopol cities, materials from personal archives of E. F. Litvinenko and E. M. Emchuk were used as well. In addition to our data, for the period from 1953 to 2001, totally 2,748, 148 specimens of sheep ticks were examined (table 1). To collect and process primary data, 'Epizootologic monitoring' database with Excel 2003 books and database control system Access 2003 were used. Primary data were analyzed by standard methods applied in biological statistics with Excel 2003, universal packages for statistical analysis SPSS v10.0.5 and Statistica v. 5.5A.

## Results

**Natural habitat (areal).** Today, according to the tendencies we noted earlier (Akimov, Nebogatkin, 1996), we can talk about expansion of sheep tick's natural habitat throughout the whole territory of Ukraine. In June, 2000, we found out 8 adults (5 females and 3 males) and 4 nymphs of *I. ricinus* on birds of 3 species, intensity 0.89; and 17 (8 females and 9 males) on a flag (3.4 tick per flag/km) on Tarkhankut peninsula in Crimea, in that way confirming findings of F. N. Vshivkov (1958) considered as accidental in steppe part of Crimea.

**Start of activity.** The first active ticks appear in Polissya and Forest-Steppe regions during 3rd ten days of March — the 1st ten days of April. The earliest date of arousal from winter diapause is March 03, 1986, and the latest — April, 25. In the Carpathians, ticks normally arouse from the diapause in April, in the Steppe — in March, and in Crimea — in February-March (fig. 1, 2).

**Period of activity for adult phases of *I. ricinus*** (number of days from the first arousal from hibernation to the last date of capture in nature was counted up) depends on habitat and landscape-geographical region and subregions, and its value clearly increased from north to south and from west to east. Thus, in Polissya, period of activity is  $145 \pm 7.15$  days (min. — 96 days, max. — 190 days); in the Western Forest-Steppe  $165 \pm 8.35$  (range 114–220); in the Forest-Steppe  $178 \pm 8.5$  (range 112–241); in the Steppe  $202 \pm 9.36$  (range 147–258); in steppe of Azov-Black sea area  $214 \pm 9.96$  (range 157–271); in Crimea  $249 \pm 10.71$  (range 194–297).

**Changes in seasonal activity.** During collection of sheep tick on a flag, curve for changes in the number of active individuals was observed to have two peaks. Such peaks in the number of attacking adult ticks are seen in spring — in May throughout all territory of Ukraine; in autumn — in Polissya, the Forest-Steppe and the

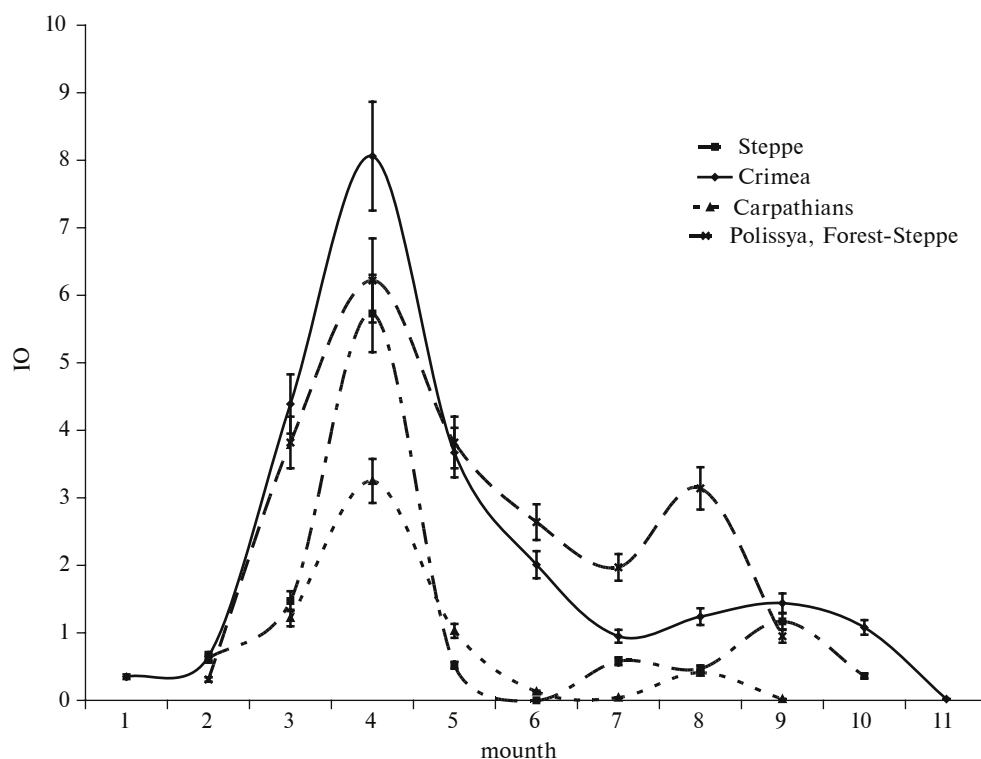


Fig. 1. Changes in seasonal activity of *Ixodes ricinus* in Polissya, Western Forest-Steppe, Forest-Steppe, the Carpathians, Steppe and Crimea (collection on a flag).

Рис. 1. Сезонные изменения активности *Ixodes ricinus* в Полесье, Западной Лесостепи, Лесостепи, Карпатах, Степи и Крыму (учеты на флаг).

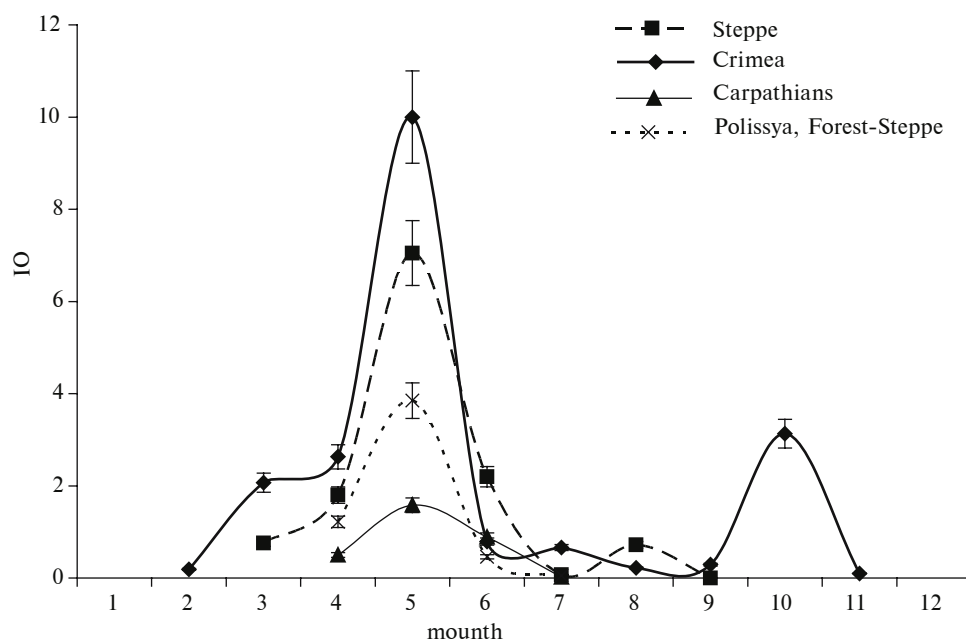


Fig. 2. Changes of seasonal activity of *I. ricinus* in Polissya, Western Forest-Steppe, Forest-Steppe, the Carpathians, Steppe and Crimea (collections from cattle).

Рис. 2. Сезонные изменения активности *I. ricinus* в Полесье, Западной Лесостепи, Лесостепи, Карпатах, Степи и Крыму (учеты на КРС).

**Table 2. Cattle of the females (%) *I. ricinus* on months in landscape-geographical regions and subregions of Ukraine**

**Таблица 2. Доля самок (%) *I. ricinus* по месяцам в ландшафтно-географических зонах и подзонах Украины**

| Month   | Zone         |                 |               |              |                      |              |              |
|---------|--------------|-----------------|---------------|--------------|----------------------|--------------|--------------|
|         | Poles'e      | Western Poles'e | Forest-Steppe | Steppe       | Azovo-Chernomorskaya | Crimea       | Average      |
| 3       | 36,07        | 38,49           | 40,48         | 43,21        | 37,33                | 45,10        | 40,11 ± 3,50 |
| 4       | 39,52        | 40,57           | 53,75         | 43,86        | 39,30                | 50,03        | 44,51 ± 6,06 |
| 5       | 39,70        | 41,80           | 56,41         | 44,53        | 40,42                | 52,72        | 45,93 ± 7,02 |
| 6       | 45,13        | 42,01           | 59,11         | 44,98        | 41,67                | 54,69        | 47,93 ± 7,30 |
| 7       | 55,37        | 53,70           | 59,49         | 52,19        | 48,34                | 58,95        | 54,67 ± 4,21 |
| 8       | 58,02        | 62,35           | 60,82         | 54,99        | 56,44                | 63,54        | 59,36 ± 3,83 |
| 9       | 61,89        | 65,10           | 63,33         | 57,00        | 56,44                | 63,61        | 63,08 ± 3,70 |
| 10      | 64,76        | 66,86           | 63,26         | 59,87        | 69,12                | 63,83        | 64,62 ± 3,12 |
| Average | 50,06 ± 0,55 | 51,36 ± 1,00    | 57,08 ± 0,99  | 50,08 ± 1,65 | 50,02 ± 1,09         | 56,56 ± 1,12 |              |

Carpathians — in September; and in the Steppe and Crimea — in October (fig. 1).

During collections on cattle, the curve has one or two peaks for changes in number of active ticks. One population peak for adult ticks attacking farm animals are in May in Polissya, the Forest-Steppe, the Carpathians and Steppe; and two peaks in Crimea: one well pronounced in May, another — in October (fig. 2).

During collections on a flag and accounting person, nymphal phase has no such significant changes in the number as compared to adult phase. The first spring peak of activity we can see in June; in summer time there are no abrupt decrease in their number; and after slight decline in July-August, the peak of activity is in September. In Crimea the first peak of activity is in May, and second — in August.

During collection of nymph of the sheep tick from mammals and birds in Polissya and the Forest-Steppe, the curve for changes in number of active ticks has one or two peaks and such curves look similar for males and females. The spring peak of number is in May, and autumn one — in September.

The period of nymph activity in Crimea has three raisings: in spring (April), in summer (June), and in autumn (September).

Being collected on a flag and accounting person, larvae were caught irregularly and for the whole period of observations less than 20 specimens were obtained and it does not allow for any conclusions.

At inventory on mammals and birds, larvae of the sheep tick in Polissya and the Forest-Steppe were found during the whole frost-free season with peak number of active individuals in August. The period of larval activity in Crimea has almost the same dynamics, however, insignificant decrease in larvae occurrence on host was noted in July.

**Sex composition.** In sheep tick populations in Ukraine, females prevail insignificantly (on average  $52.44 \pm 0.55\%$ ). Sex ratio depends on a landscape-geographical region or subregion and phase of population dynamics (table 2). We found out the seasonal differences in sex ratio: males are more abundant in springtime, females — in autumn.

## Discussion

The finding of both adult ticks and their nymphs in the Western Crimea allowed us to confirm the *I. ricinus* distribution throughout the whole territory of Ukraine, except for hard and salt steppe zone that became relict areas.

Colonization of the Azov-Black sea steppe area, as well as findings of the sheep tick in Askania-Nova reserve (Emchuk, 1972) may be likely considered as an example of expansion from small islands, the refugia, where this species persists from times of the vast forests and full-flowing rivers in historical time B. C. and ravine forests (Charleman, 1937). Ticks disappeared following the vanishing of characteristic biotopes needed for their life together with ungulate animals: tarpan (*Equus gmelini*) vanished in 1870th, saiga (*Saiga tatarica*) — even earlier (Sharleman, 1937). The new return happens both from north to south along the landed forest belts and from the extant relict forest areas.

The beginning of activity of *I. ricinus* after hibernation differs in different landscape-geographical regions and subregions and depends mainly on relief and weather conditions in particular year. This is rather long process, and the majority of ticks became active in 15–30 days. Duration of the period of their activity is clearly increased from north to south and from west to east.

In Ukraine, as well as on the greater part of the natural habitat, peak numbers of active ticks of all developmental stages may be pronounced or extended (Babenko, 1958; Arzamasov, 1961; Nikitchenko 1972; Balashov, 1998).

During collections of sheep tick on a flag, curve for changes in the number of active individuals has two peaks. Such peaks in the number of attacking adult ticks are seen in spring — in May throughout all territory of Ukraine; in autumn — in Polissya, the Forest-Steppe and the Carpathians — in September; and in the Steppe and Crimea — in October (fig. 1).

During collections on cattle, the curve has one or two peaks for changes in number of active ticks. One population peak for adult ticks attacking farm animals are in May in Polissya, the Forest-Steppe, the Carpathians and Steppe; and two peaks in Crimea: one well pronounced in May, another — in October (fig. 2).

During collections on a flag and accounting person, nymphal phase has no such significant changes in the number as compared to adult phase. The first spring peak of activity we can see in June; in summer time there are no abrupt decrease in their number; and after slight decline in July-August, the peak of activity is in September. In Crimea the first peak of activity is in May, and second — in August.

During collections of nymphs of the sheep tick from mammals and birds in Polissya and the Forest-Steppe, the curve for changes in number of active ticks has one or two peaks and such curves look similar for males and females. The spring peak of number is in May, and autumn one — in September.

The period of nymph activity in Crimea has three peaks: in spring, in summer, and in autumn. We think the first peak appears, and in the other parts of the natural habitat as well, due to overwintered individuals which molted in spring or in the beginning of summer of the previous year; autumn peak appears due to the nymphs of new generation, molted from satiated larvae in spring or in the beginning of summer of this year; and summer peak may be due to nymphs molted in autumn of the previous year and timed to the active dispersion of young small mammals of new generation.

It should be noted that in the period from 1968 to 1985, a curve of larval activity in Crimea has clearly one wave with a peak in August, and from the middle of 1980th till now we note three peaks of activity in April, June and August. We think that this phenomenon is related to switching on the two-year cycle of tick development, when irrespective of the fact which developmental stage winters in the first winter: hungry larvae, satiated larvae or hungry nymphs, satiated females lay eggs in the second year. Probably, it is related to the climate warming in the south regions, and this tendency may be extended to the North Black sea areas.

We found out seasonal differences in sex ratio: males are more abundant in spring-time, females — in autumn, and this pattern is characteristic for the whole territory of Ukraine. Significantly greater numbers of females (on average 52–60%) are registered on peaks, and greater number of males — on their decreases.

### Conclusions

1. Today, the areal of the sheep tick covers the whole territory of Ukraine, but earlier it has hiatus in steppe area and Crimea only.

2. Increased number of active adult ticks (collecting on a flag) becomes apparent twice — in spring (May) — in all areas, and in autumn (September) in Polissya, the Forest-Steppe, and the Carpathians), or in October (in the Steppe and Crimea). During collections from cattle, there is one peak in the number of attacking imaginal phases of ticks in Polissya, the Forest-Steppe, the Carpathians, Steppe in May, and two peaks in Crimea: the first is clearly shown in May, and the second in October.

3. The nymphs of ticks (collected on a flag and accounting person) have maximal activity in June; no sharp decrease in summer; slight decrease in July–August the peak of activity in September. In Crimea, the first peak of activity is in May, and the second — in August. During collections nymph of the sheep tick from mammals and birds in Polissya and the Forest-Steppe, the curve has two peaks: the spring peak in May, and the autumn peak — in September.

4. Since 1980s, active period of preimaginal phases of development of *I. ricinus* in Crimea has three peaks: for nymphs in spring (April), in summer (June) and in autumn (September), and for larvae — in April, June and August.

5. Duration of activity of imaginal phases of *I. ricinus* is increased from north to south and from west to east.

6. In Ukraine, in populations of *I. ricinus* females dominate a little (on average  $52.44 \pm 0.55\%$ ). Sex ratio depends on a landscape-geographical region or subregion and phase of population dynamics. Significantly larger numbers of females (on average 52–60%) are registered on population peaks, and larger numbers of males — on their decrease. The seasonal differences in the sex ratio are as follows: males are more abundant in springtime, and females in autumn.

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