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ABNORMALITIES IN *IXODES* TICKS (IXODOIDEA, IXODINAE)

УРОДСТВА У КЛЕЩЕЙ *IXODES* (IXODOIDEA, IXODINAE)

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КЛЮЧЕВЫЕ СЛОВА: клещ *Ixodes*, уродство, патология, щиток, кутикула, половое отверстие.

ABSTRACT

Ticks of the tick-borne encephalitis virus vector species, *Ixodes persulcatus*, from St.Petersburg, Samara, and Moscow regions were examined for the presence of abnormalities or monstrosities. The most common abnormalities were deformations of the female scutum dents, smoothed pattern of the chitinous «tiles», crumpled central and lateral parts of the scutum, and false duplication of the cervical grooves. In Samara Region we found an abnormality of the tibial part of the leg and a real monstrosity: an asymmetrical duplication of vulva and an abnormmality of the genital opening area without any other symptoms of pathology in the same specimen. Among the specimens collected in the Pskov Region, where only 17 partially fed *I.ricinus* females were collected, one was found with an abnormal crater-like distortion of the idiosome cuticle. The abnormality rate 1.3, 2.6, and 14 % in St.Petersburg, Samara, and Moscow regions, respectively, seems very high, which may be due to the heavy metal pollution level in the environment.

РЕЗЮМЕ

Исследованы на наличие уродств и патологических изменений клещи-переносчики клещевого энцефалита в Ленинградской, Московской и Самарской областях. Наиболее широко распространенными патологическими изменениями оказались деформация щитка самок: вмятины, сглаживание рисунка хитиновой черепицеобразной поверхности щитка, скручивание центральных и латеральных частей щитка, ложное удвоение цервикальных борозд. В Самарской области было обнаружено патологическое изменение голени четвертой конечности и истинное уродство - асимметричное удвоение полового отверстия, а также патологическое изменение области полового отверстия без других изменений тела. Среди 17 полунапитавшихся самок *Ixodes ricinus*, собранных в Псковской области, у одной было обнаружено кратерообразное вздутие кутикулы идиосомы. Отмечена высокая частота патологических изменений у клещей Ленинградской, Самарской и Московской популяций - 1.3, 2.6 и 14% соответственно, что, по предположению авторов, связано с уровнем загрязнения обследованных районов ионами тяжелых металлов.

INTRODUCTION

The first descriptions of abnormalities among Ixodoidea belong to Neumann [1899]; later on, a tick with two anuses and four stigmas was described by Brumpt [1934]. In the Russian literature the most complete data on monstrosities and abnormalities in Ixodoidea were collected by Academician Pavlovsky [1939], who was one of the first to try to systematize the types of tick teratology. More recently, this system was supplemented by Pervomaisky [1954] and then by Campana-Rouget [1959]. Most abnormalities in Ixodoidea have been observed in various genera

of Amblyomminae. They were caused (according to Pervomaisky and Campana-Rouget) either by interspecific cross-breeding (as the hynandromorphism) or by some abnormalities of the preimaginal period of development (due to traumatical, biochemical during the feeding period, or chemical actions). Much scarcer are the descriptions of monstrosities among Ixodinae.

Nuttall [1914] mentioned an *Ixodes caledonicus* specimen with abnormal form of the body and of the anal grooves. In the work of Brumpt [1934] there is a picture of an *I.hexagonus* female with two anuses. A bit more is known about the abnormalities in *I.ricinus* [Olenev, 1931, Brumpt, 1934]. This species was mentioned by Zapletal [1957] and Sixl [1972].

An *I.ricinus* female described by the latter author had only seven legs and a more massive coxa on the side with three legs. It is of interest that the lack of one leg was on the same side (the left one) as it was described by Olenev. It is not clear why this abnormality, the lack of one leg on the left side of the body, has been met more often among Ixodinae (3 to 1) than among Amblyomminae (9 to 11). We obtained these results from an analysis of the pictures published in the above-mentioned works.

We found only one description of an abnormality in *Ixodes persulcatus*, the main vector of tick-borne encephalitis virus. Its author [Koshkin, 1967] emphasized that the abnormality was a very rare one: he found one female without gnathosoma among 6,000 specimens. Having compared the rate of partial twinning in various families and genera of Ixodoidea, Robinson [1943] concluded that its «normal» rate was 1 per 2 or 4 thousand. Other monstrosities occur more frequently [Pervomaisky, 1950] but Pavlovsky [1939] described only 27 such cases upon examination of «dosens of thousands of ticks.»

The above gives grounds to conclude that abnormalities and monstrosities are a rare phenomenon among Ixodidae, especially in the genus *Ixodes*.

However, our own results proved that this conclusion is not correct at least nowadays and near big cities.

MATERIAL AND METHODS

Ixodes persulcatus ticks were collected during the season of 1991 with a white flag (the standard method) in the vicinity of St.Petersburg, Moscow, and Samara, and a small quantity of *I.ricinus* was sampled from cattle in the Pskov Region. All ticks were studied using the stereomicroscope; then specimens having various pathologies were fixed in 70 % ethanol. Every specimen was photographed and then examined using a scanning electron microscope. We investigated 563 females and 7 males of *I.persulcatus* and 17 females of *I.ricinus*.

RESULTS

As can be seen from the Table, we encountered 14 cases of the pathology in *I.persulcatus*, females constituting 2.48 %. No abnormal males were met, but our material is too scarce to make any conclusions about the rate of abnormalities among males of *I.persulcatus*. Among fed *I.ricinus* ticks we encountered only one with an abnormality of the cuticle of idiosoma.

It is clear from the table that most common abnormalities among *Ixodes* ticks are various deformations of the chitinous structures of scutum. Typical of the first type of scutum abnormality found in the St.Petersburg Region (comparison with the normal form is given in Fig. 1) are the smoothed cervical grooves and the asymmetrical dents on the scutum surface (Fig. 2). The structure of scutum dent (Fig. 3) is changed in comparison with the normal scutum (Fig. 4): the pattern of the chitinous «tiles» in the dent area is smoothed over and stretched. This stretching is best seen in the left part of the photograph (Fig. 3).

Scutum abnormalities typical of *I.persulcatus* females from the Samara Region mostly consist in the crumpling of the central part of the scutum and in the appearance of dents on its surface (Fig. 5, 6) or even in crumpling in not only the central part of the scutum, but almost

Table.
Abnormalities in *Ixodes persulcatus* females.

Type of abnormality	Samara			Moscow			St. Petersburg		
	Number of specimens collected	Number of specimens with abnormalities		Number of specimens collected	Number of specimens with abnormalities		Number of specimens collected	Number of specimens with abnormalities	
		abs	%		abs	%		abs	%
Deviations in the scutum		11	2.26		7	14		1	1.33
Doubled vulva		1	0.27		–	–		–	–
Abnormal leg		1	0.23		–	–		–	–
Total	487	13	2.76	50	7	14	75	1	1.33

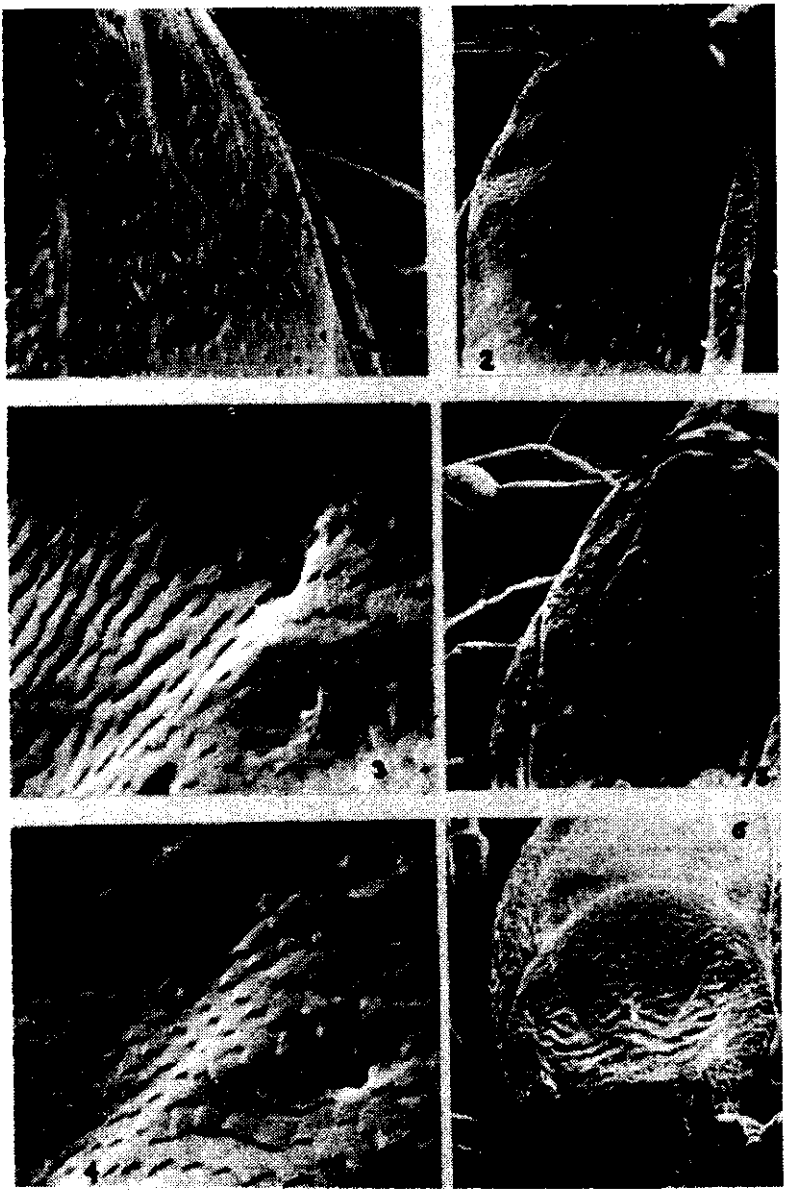

Fig. 1. Normal scutum of an *Ixodes persulcatus* female.
Рис. 1. Нормальный щиток самки *Ixodes persulcatus.*
Fig. 2. Two dents on the left side of the scutum of an *Ixodes persulcatus* female (St. Petersburg Region).
Рис. 2. Две вмятины на левой стороне щитка самки *Ixodes persulcatus* (Ленинградская обл.).
Fig. 3. Smoothed pattern of chitinous tiles of the dent area of an *Ixodes persulcatus* female.
Рис. 3. Смазанный рисунок хитинового покрытия в области вмятин самки *Ixodes persulcatus.*
Fig. 4. Normal pattern of the scutum of an *Ixodes persulcatus* female.
Рис. 4. Нормальное покрытие щитка самки *Ixodes persulcatus.*
Fig. 5. Dents and changed central part of the scutum of an *Ixodes persulcatus* female (Samara Region).
Рис. 5. Вмятины и измененная центральная часть щитка самки *Ixodes persulcatus* (Самарская обл.).
Fig. 6. Crumpled scutum, four cervical grooves of an *Ixodes persulcatus* female (Samara Region).
Рис. 6. Мятый щиток, четыре цервикальных борозды самки *Ixodes persulcatus* (Самарская обл.).

all of its surface (Fig. 8, 9, 10). In the latter case, instead of an elevation between the cervical grooves there is a depression and instead of two distinct cervical grooves there seem to be four (Fig. 6, 7).

Crumpled scuta and scuta with a changed pattern constitute one half of the cases of scutum abnormalities observed in the Samara Region.

In the Moscow Region, where the rate of abnormalities was higher (14 % of specimens examined), we recorded all the scutum abnormalities described above. However, three of the seven specimens with abnormalities had a typical crater-like deep dent near the end of the right cervical groove (Fig. 8). Intergroove space was also a bit crumpled, but much less so than in the specimens from the Samara Region. In the St. Petersburg and Moscow regions, we found only scutum abnormalities (8 cases of 125 investigated ones), whereas in the Samara Region such abnormalities were also recorded most often (84.6 per cent of cases), but two additional

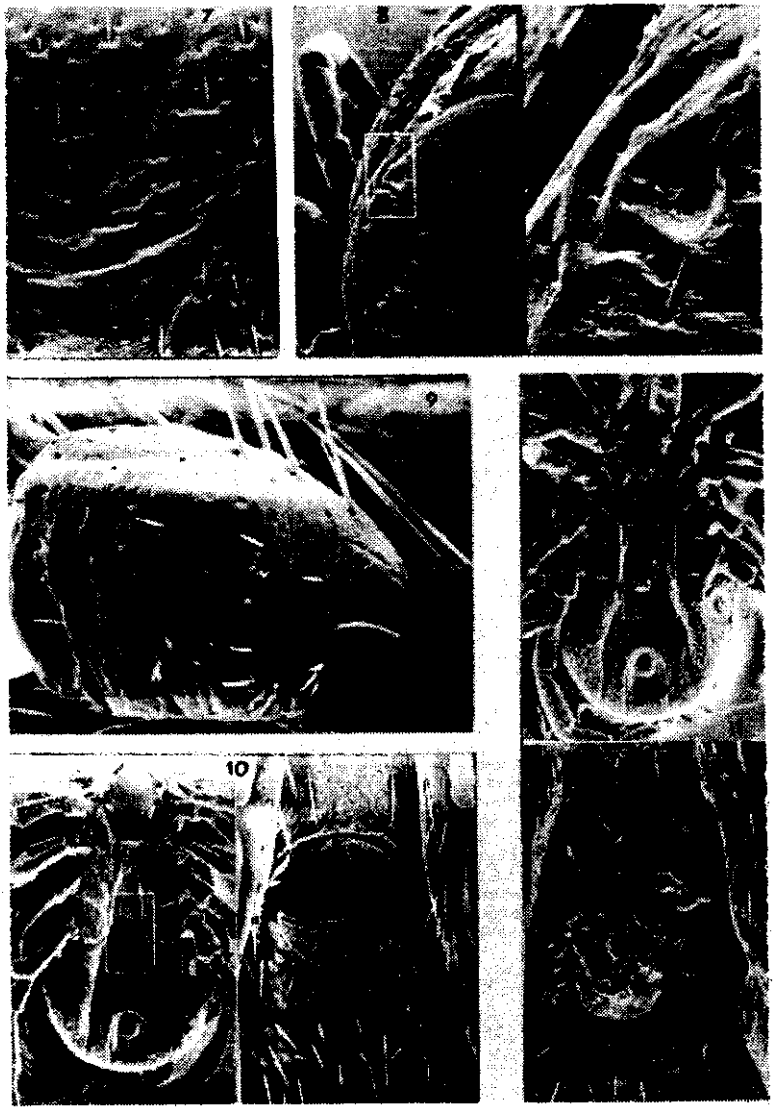
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Fig. 7. The part of the crumpled area of the scutum and doubled grooves of an *Ixodes persulcatus* female.
Рис. 7. Часть мятого щитка и сдвоенная бороздка самки *Ixodes persulcatus.*
Fig. 8. Crater-like asymmetric dent of the scutum of an *Ixodes persulcatus* female (Moscow Region).
Рис. 8. Кратероподобное асимметричное вдавление в щитке самки *Ixodes persulcatus* (Московская обл.).
Fig. 9. Deformation of the tibia, 4th leg of an *Ixodes persulcatus* female.
Рис. 9. Деформация голени четвертой конечности самки *Ixodes persulcatus.*
Fig. 10. Normal genital opening of an *Ixodes persulcatus* female.
Рис. 10. Нормальное половое отверстие самки *Ixodes persulcatus.*
Fig. 11. Double asymmetric vulva of an *Ixodes persulcatus* female. The remains of spermatophor in the left opening. The opening of the right vulva has a spiral form. Changes in the porosities and bristles of the genital platform.
Рис. 11. Двойное асимметричное половое отверстие самки *Ixodes persulcatus.* В левом отверстии - остатки сперматофора. Правое отверстие имеет спиральную форму. Изменения расположения пор и щетинок на генитальной пластинке.

types of monstrosities were present as well. The first type was abnormal tibia of the fourth left leg (Fig. 9). The abnormal tibia was much shorter but thicker than the normal one and its chitinous skeleton was crumpled. The dimensions and the arrangement of some tibia bristles were also abnormal.

Yet a real monstrosity, a specimen with double genital opening and distorted genital plate, has been recorded only one time in the Samara Region, maybe because more material has been investigated (487 females). Comparison between the normal (Fig. 10) and the abnormal (Fig. 11) specimens shows that the genital plate of the monster is enlarged, the arrangement of porosities and bristles is changed, and both plate openings are situated not in the center of the plate and asymmetrically towards each other. Still, in the lower opening one could see the remains of a spermathophor which it was not possible to remove, suggesting that this female had copulated and even had been inseminated. The second, upper, genital opening was heavily deformed and the orificium vaginae, if there was a real one, had a spiral-form opening (Fig. 11) instead of the normal transversal one (Fig. 10). This specimen showed no

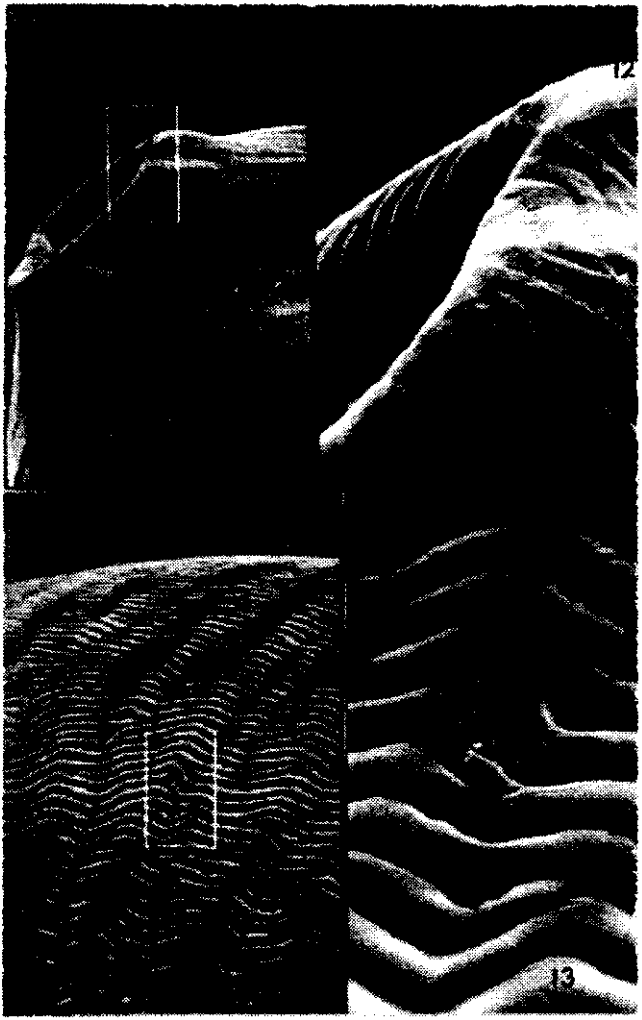

Fig. 12. Deformation of the body of a half-fed *Ixodes ricinus* female; crater-like deformation.

Рис. 12. Деформация тела полунапитавшейся самки *Ixodes ricinus*. Кратероподобная деформация.

Fig. 13. Minor deformation of the cuticle of the same female as in Fig. 12.

Рис. 13. Небольшая деформация кутикулы у той же самки, что и на рис. 12.

other forms of organ duplication. All other organs seemed to be normal.

Although the deformation of the chitinous covering in half-fed specimens is not exceptionally rare, it is noticeable that one deformed *Ixodes ricinus* female from the Pskov region was found among only 17 specimens collected. The deformation (Fig. 12) had a crater-like form and was not accidental for this specimen, because on the chitinous surface one could see other disturbances of the normal structure and pattern (Fig. 13).

DISCUSSION

The abnormalities of the chitinous cuticle among hard ticks have already been recorded earlier. For example, the left posterior portion of the body was underdeveloped in the *Ixodes caledonicus* specimen described by Nuttall [1914, Fig. 2]; the abnormal scutum in *Rhipicephalus sanguineus* was mentioned by Sharif [1930, Fig. 6], the abnormal structure of chitinous cuticle on the ventral side was described in a *Ornithodoros tartakovski* female by Pavlovsky [1939, Fig. 27], Reznik [1956, Fig. 5] notifies the asymmetric dent on the dorsal side of an *Ixodes ricinus* female. All the chitinous cuticle abnormalities mentioned were not connected with any form of hynandromorphism, of which the mosaic changes of the cuticle were typical. Thus the existance of scutum abnormalities is not so strange, though they have never been described in *Ixodes persulcatus*; the strangeness consists in their frequency.

1.3, 2.6, and even 14 % of cases in relatively small and randomly collected samples of ticks seem to be dependent on the degree of the pollution in the territories in question. We could not determine the kind of the pollution, but our experience with oribatid mites suggests that abnormalities of the chitinous cuticle are connected with the content of the heavy metal ions in the soil.

Most authors [e.g. Reznik, 1956; Campana-Rouget, 1959] linked abnormalities in the tick legs with various traumas during

the larval or nymphal phase of the development. It is quite possible that in our case (Fig. 9) the cause was the same, but the chitinous deformation of the tibia well-seen in the SEM photograph suggests that such type of chitin destruction may have been caused by chemical agents, or by the action of heavy ions.

The most strange monstrosity in *Ixodes persulcatus* ticks and even among all *Ixodes* species is the double vagina. Double anus and even twice doubled stigmas have already been described many times. Robinson [1944] published a picture of an *Ornithodoros moubata* female with doubled symmetric vulva, two anuses and four spiracles. But we have never come across with any descriptions of an otherwise normal specimen with two asymmetric genital openings. This female had no other signs of monstrosities, neither hynandromorphical nor traumatic. Thus, the cause of the abnormality described here is unclear.

The most important conclusion of our report consists in the statement of the fact that once a rare phenomenon, the abnormalities among the tick-borne encephalitis virus vectors *I.persulcatus* and *I.ricinus* [Pavlovsky, 1939; Koshkin, 1967], have become regular. The possible role of this phenomenon for virus transmission and vector capacity remains to be investigated.

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