

## NEW CASES OF THE CAPSULE DUPLICATION IN HALLER'S ORGAN OF IMMATURE *IXODES* TICKS (ACARI: IXODIDAE)

### НОВЫЕ СЛУЧАИ УДВОЕНИЯ КАПСУЛЫ В ОРГАНЕ ГАЛЛЕРА У НЕПОЛОВОЗРЕЛЫХ КЛЕЩЕЙ РОДА *IXODES* (ACARI: IXODIDAE)

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Ключевые слова: тератология, орган Галлера, *Ixodes persulcatus*

#### ABSTRACT

There are described new cases of capsule duplication in Haller's organ of prostriate ticks (*Ixodes persulcatus* larva and *I. ricinus* nymph from laboratory cultures), with a discussion of body parts duplication phenomenon in prostriate and metastriate ticks.

#### РЕЗЮМЕ

Описаны новые случаи дубликации капсулы органа Галлера у личинки *Ixodes persulcatus* и нимфы *I. ricinus* (из лабораторной культуры) с обсуждением феномена дубликации частей тела у простриатных и метастриатных иксодовых клещей.

#### INTRODUCTION

The teratology of ixodoid ticks is a subject of numerous special publications describing different forms of malformations and morphological anomalies in tick specimens collected in nature [Pavlovsky, 1939; Schulze, 1950; Pervomaisky, 1954; Campana-Rouget, 1959; Siuda, 1991; Alekseev, Dubinina, 1993; Buczek, 1994; Guglielmone et al., 1999]. Duplication of some body parts or limbs is quite interesting and more or less usual form of such malformations in these arthropods of extreme medical and veterinary importance. However, practically all numerous cases of duplication of limbs and body parts in ixodoid ticks were discovered in representatives of the family Argasidae (*Argas*, *Ornithodoros*), and in the group of Metastriata (*Amblyomma*, *Hyalomma*, *Haemaphysalis*, *Rhipicephalus*, *Dermacentor*, *Boophilus*) from the family Ixodidae, but only two cases of body parts duplication were described in Prostriata (*Ixodes*) collected in nature, namely in nymphs of *I. ricinus*

[Campana-Rouget, 1959; Siuda, 1991]. This seems to give an evidence of different subjection of these ticks to the mentioned morphological anomaly.

It is also essential that all the cases of capsule duplication in Haller's organ of ticks, collected in nature, are similarly shared by argasids and metastriate ixodids, namely by *Argas reflexus* [Buczek, 1994], *Rhipicephalus sanguineus* [Pavlovsky, 1939], *Aponomma lucasi*, and *Boophilus decoloratus* [Schulze, 1941], *Hyalomma steineri* [Schulze, 1950; Campana-Rouget, 1959]. All these cases are of unknown etiology. Only the case of capsule duplication in prostriate ticks (*Ixodes rubicundus* nymphs and adult ticks) was observed as a result of Haller's organ regeneration under experimental conditions [Belozarov et al., 1997].

This paper gives the description of new cases of capsule duplication in Haller's organ of prostriate ticks, which were discovered in *Ixodes persulcatus* larva and *I. ricinus* nymph from the laboratory culture, together with a discussion of duplication phenomenon in prostriate and metastriate ticks.

#### MATERIALS AND METHODS

The paper includes the results of additional study (using the scanning electron microscopy, SEM) of *I. persulcatus* larvae from Novgorod population, which revealed maternal photoperiodic effect in their size during our previous investigations [Belozarov, 1995]. Larvae were obtained from eggs laid by engorged adult females that were maintained under 18° and long-day (LD 20:04) or short-day (LD 12:12) photoperiods before feeding (during 11 months). Majority of eggs from "long-day" egg-clutches were normal in size (0.58×0.42 mm), while several dozens of eggs were of surplus

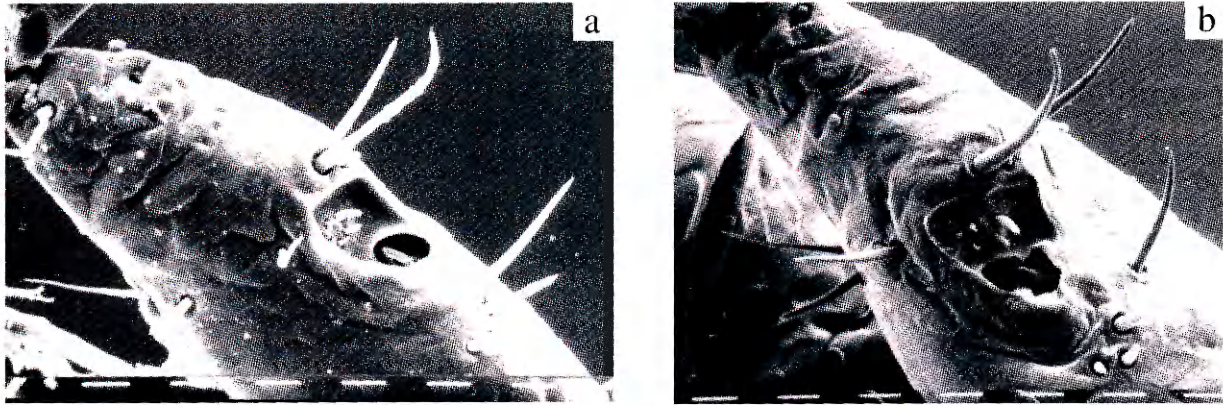


Fig.1. Haller's organs of normal shape (a) and with duplicated capsule (b) on left forelegs of *Ixodes persulcatus* larvae. Bars = 10 µm.

Рис.1. Орган Галлера на левой ноге у личинки *Ixodes persulcatus* в норме (a) и с удвоением капсулы (b). Масштаб = 10 µm.

size (0.78×0.52 mm), and larvae from these eggs were also 23–28% larger in length, than from normal eggs. “Short-day” egg-clutches contained only normal eggs (0.59×0.42 mm) and gave larvae of normal size. Both normal and giant larvae from “long-day” egg-clutches were fixed and served in 70% ethyl alcohol, being examined afterwards (specially in regard to their Haller's organ structure) with scanning microscope SEM 501B PHILIPS at the Laboratory of Electron Microscopy of the Faculty of Geology (St. Petersburg State University). Fifteen normal and 10 giant larvae were examined by means of SEM.

The paper also demonstrates two cases of capsule duplication in regenerated nymphal Haller's organs of prostriate ticks (*I. ricinus* and *I. rubicundus*). Examination of *I. ricinus* regenerates [affected by retinoic acid in experiments by Belozеров, 2002] was carried out recently with SEM 501B PHILIPS at the St. Petersburg University. Images of capsule duplication in regenerated Haller's organ of nymphal *I. rubicundus* ticks were received earlier during SEM examination of this tick by Belozеров, Kok and Fourie [1997] with a Jeol 6400 WINSEM microscope at the University of the Free State (UOVS), Bloemfontein, South Africa.

## RESULTS

Haller's organ, the main organ of distant reception in ixodoid ticks, is located on tarsus of both their forelegs. Its structure in *I. persulcatus* is characteristic of the genus [Balashov, Leonovich, 1978]. The organ consists of four compartments, differing both structurally (especially by number and topography of their sensory sensilla) and functionally: the capsule, the distal compartment (= distal knoll), the precapsular compartment (= ante-

rior pit), and the postcapsular area. All the examined larvae of both normal and sur-plus size (except one) had Haller's organs with normal sensillar sets (Fig. 1,a): two sensilla in the distal compartment (one long porous and one short smooth, with obligatory lateral location of the latter sensillum), five sensilla (one porous, one grooved, two thin and one conical) in the anterior pit of regular asymmetric form, five porous sensilla inside the capsule (one sensillum is usually well seen from roundish orifice of the capsule), and four sensilla in the postcapsular area (two central and two bordering).

However, Haller's organ of the left foreleg in one unique giant larva had specific deviations in its structure, mainly concerning the capsular compartment and, partly, the form of the anterior pit (Fig. 1,b). It is seen under larger magnification (Fig. 2), that the capsule is not single, as in normal Haller's organ, but duplicated, with larger orifice in the right capsule, and with smaller orifice in the left capsule. One porous sensillum (from their set) is well seen within each orifice. The anterior pit (but not the set of its sensilla) also demonstrates some traits of duplication.

It is of interest that the capsule duplication, discovered in larval Haller's organ of palearctic *I. persulcatus* tick, belonging to the subgenus *Ixodes* s.str., is very similar by its character to the malformation of the same type in Haller's organ regenerates of South African tick, *I. (Afrixodes) rubicundus* [Belozеров et al., 1997], especially in some of its nymphal regenerates (Fig. 3,a). We also observed definite similarity in another type of capsule duplication in nymphal Haller's organ regenerates of *I. rubicundus* and *I. ricinus*, when the regenerate in case of *I. ricinus* developed under the effect of retinoic acid (Fig. 4,a,b) in our recent experiments. The additional, more proximal cap-



Fig.2. Duplicated capsule and the anterior pit (under high magnification) from Haller's organ of *Ixodes persulcatus* larva, depicted in Fig. 1,b. Bar = 10  $\mu$ m.

Рис.2. Удвоенная капсула и предкапсулярный отдел органа Галлера (при большом увеличении) у личинки *Ixodes persulcatus*, изображенной на рис. 1,b. Масштаб = 10  $\mu$ m.

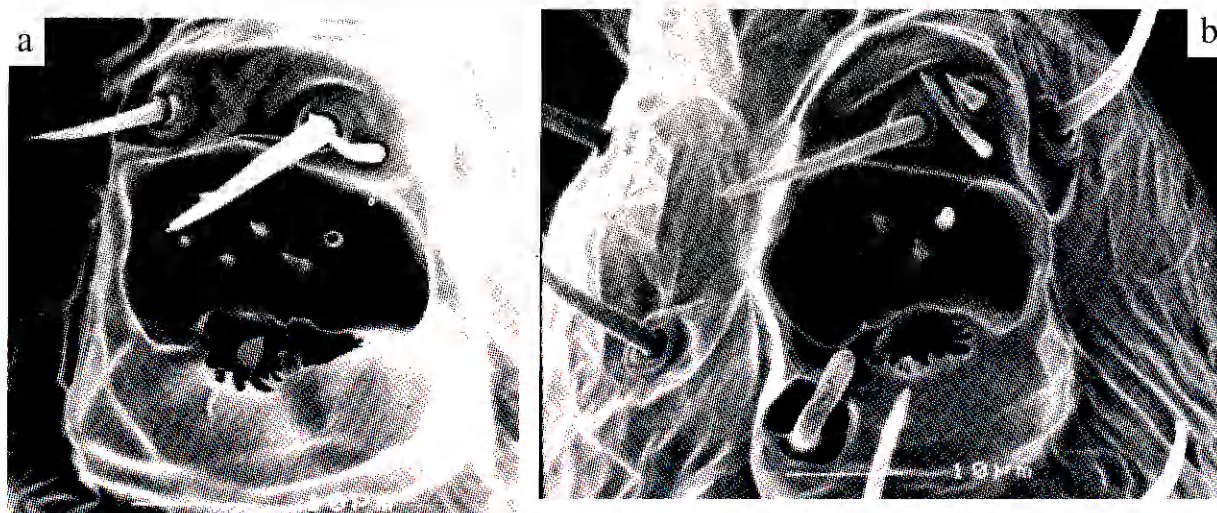


Fig.3. Two different cases of capsule duplication in regenerated Haller's organ of nymphal *Ixodes rubicundus* ticks. Bars = 10  $\mu$ m.  
Рис.3. Два примера удвоения капсулы в регенератах органа Галлера у нимф клеща *Ixodes rubicundus*. Масштаб = 10  $\mu$ m.

sule is undoubtedly underdeveloped here, but nevertheless is similar by shape with the additional capsule in *I. rubicundus* nymphs (Fig. 3,b).

#### DISCUSSION

Etiology of malformations and morphological anomalies in ticks is unknown, as a rule. There are some suggestions and conclusions, that they may be caused by disturbances in underlying morphogenetic processes during both embryogenesis and metamorphosis under the influence of environmental factors of physical or chemical nature [Pavlovsky, 1939; Campana-Rouget, 1959; Buczek, 1994, 2000; Zharkov et al., 2000]. It was also shown, that limb duplication in argasid ticks can be evoked by ultraviolet ray influence [Pavlovsky, Skrynnik, 1957].

The described case of capsule duplication in larval Haller's organ of *I. persulcatus*, the prostrate ixodid tick, belongs to category of manifold

larval malformations, originated from disturbances of embryogenesis and described previously in argasid and metastriate ixodid ticks only [Pavlovsky, 1939; Campana-Rouget, 1959; Buczek, 1994]. On the contrary, both mentioned cases of capsule duplication in nymphs of *I. rubicundus* and *I. ricinus* represent the other category of malformations, originated during postembryonic development of ticks (mainly of argasids and metastriate ixodids also), sometimes through regeneration.

Regeneration, as was shown experimentally, is an important etiologic factor of limb duplication in argasid ticks [Campana-Rouget, 1959; Obenchain, Oliver, 1972]. In ixodid ticks the limb duplication of such etiology is unknown. However, the capsule duplication in regenerated Haller's organ of *I. rubicundus* nymphs and adult ticks was found to be an usual phenomenon [Belozarov et al., 1997]. Recently this specific anomaly was discovered in *I.*

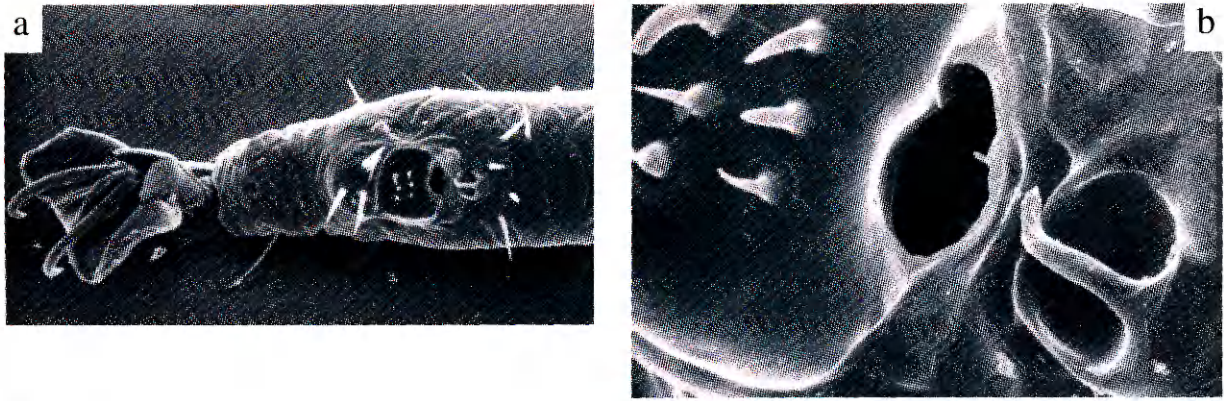


Fig.4. Haller's organ with duplicated capsule on tarsus of the left foreleg of *Ixodes ricinus* nymph after regeneration under the influence of retinoic acid (a) and the same capsule duplication under higher magnification (b).

Рис.4. Орган Галлера с удвоением капсулы на лапке левой передней ноги у нимфы *Ixodes ricinus* после регенерации при воздействии ретиноевой кислоты (а) и то же удвоение при большем увеличении (б).

*ricinus* nymphs [Belozеров, 2002], where capsule duplication originated in Haller's organ regenerates affected by retinoic acid. Similar effect of retinoic acid, resulted in the duplication of the anterior pit, another compartment of Haller's organ, was observed recently in the metastriate tick *Hyalomma anatolicum* [Belozеров, unpublished]. It is of importance that such a response to retinoic acid, expressed in duplication of axial structures in ixodid ticks, is in good correspondence to reactions to this compound in vertebrate animals [Maden, 1995; Tsonis, 1996].

The study of teratological effects of specific morphogens (like retinoic acid) to processes of embryogenesis and regeneration in ixodid ticks represent an important instrument for extending our knowledge on peculiarities in developmental biology of prostriate and metastriate ixodid ticks, which are characterized, as it is known, by essential differences in their developmental, ecological and ethological peculiarities, as well as in epidemiologic and epizootiologic significance [Oliver, 1989]. Prostriata and Metastriata are essentially different also in regard to their regenerative capabilities [Belozеров, 2001], and this problem deserves, of course, more attention in future investigations of tick developmental biology.

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