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Contribution to the Biology of the Ground Beetle *Laemostenus tauricus* (Dejean, 1828) (Coleoptera, Carabidae) from the Kyzyl-Koba Cave in Crimea*

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Abstract. Description of larvae and information on the mode of life of the ground beetle *Laemostenus tauricus* Dej. from the Crimean cave of Kyzyl-Koba are presented.

Keywords: Ground beetles; *Laemostenus tauricus*; Coleoptera; Carabidae; Crimea.

The Palearctic genus *Laemostenus* Bonelli, 1810 comprises about 150 species (Casale, 1988). Of the 24 species now living on E European Plain, in the Crimea and the Caucasus, only 5 species have known larvae (Emden, 1942; Sharova, 1958; Raynaud, 1976; Vereshchagina and Makarov, 1986; Hovorka, 1991).

Laemostenus tauricus (Dejean, 1828) is a representative of this genus living in Crimea. Casale 1988) considers this form a subspecies of *L. sericeus* (F.-W.). According to Vereshchagina (1986) who revised the tribe Sphodrini of the fauna of the USSR, this species should be named *Laemostenus tauricus* (Dej.). Below we describe the larval stages and the biology of this ground beetle from the Crimean Kyzyl-Koba cave.

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MATERIAL

Material was collected by A. G. Koval in the Kyzyl-Koba Cave, 18.VI.1990-3.VIII.1991.

Kyzyl-Koba (Red Caves) is a system of 3 caves constituting 6 underground floors. This is the longest limestone cave within the former USSR and one of largest such caves in the world. Length of the investigated part of the cave alone is 13.1 km, of which 2.5 km lie near the entrance. Depth 135 km. Entrance into the cave is situated on the W slope of the Dolgorukov Mts. of Crimean Range at elevation of 570 m. Air temperature in the cave is 9.8°-11.8° (Dublyanskiy and Goncharov, 1970; Dublyanskiy and Ilyukhin, 1982).

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Table 1

Variation of structure of forefemora of *Laemostenus tauricus* (Dej.) in Kyzyl-Koba Cave

Structure of forefemora	Average fraction of spms.	Range, $P = 0.96$
Teeth distinct on both femora	50.0	36.3-63.7
Teeth small on both femora	24.0	13.3-36.7
Tooth present on one femur only	14.0	5.9-24.9
Femora without teeth	12.0	4.6-22.3

Table 2

Measurements of head capsule of larvae of *Laemostenus tauricus* (Dej.), in mm

Instar of larvae	Length of head	Width of head
I	1.56	2.33
II	2.45-2.46 (2.45)	3.60-3.80 (3.70)
III	2.64-2.78 (2.71)	3.95-4.21 (4.08)

Note. Length of head capsule was measured from anterior margin of nasale to base of epicranial suture, width was measured as distance between anterior dorsal ocelli. Mean values are shown in parentheses.

Four Barber traps were placed on each floor, except the VIth. Traps were plastic containers with opening diameters of 38 mm and volume of 250 ml, emplaced in various deposits on the floor. A mixture of ethylene glycol and beer was used as a fixing solution. The traps we exposed for 41 days.

Total number of *Laemostenus tauricus* beetles collected in traps and manually was 160, plus 6 larvae. Imagines were found on floors III-V, 50 m from the entrance.

In collected beetles we determined the sex and length of body (measured from anterior margin of the labrum to the apex of elytra). In ♂s degree of development of teeth on forefemora was also recorded. Data were processed by the standard method. To minimize the distortion of the fraction of ♂s with different development of teeth, we chose the equation $\Phi = \text{arcin}\ (\sqrt{p})$ (Mencher, 1981), where p is the fraction in %. We have also investigated collections of this species from an orchard in the vicinity of Dobroye (several km from the cave), from winter wheat field N of Simferopol, from Yalta Cliffs, and from vicinity of Belogorsk.

Larvae of *L. tauricus*, i.e., spms. of instar III, 3 spms. of instar-II and 1 spm. of instar I, were fixed in 70% ethanol. For investigation of fine morphology, the instar-I larva and head appendages of larvae of instars II and III were placed in the Fore-Berlese solution. Our principal description concerns the instar-III larva, and characters of younger instars are described by comparison with instar III. Our designations of sensillae followed that of Bousquet and Goulet (1984), with modifications. One instar-III larva is preserved in the Zoological Institute of the Russian Academy of Sciences, St. Petersburg (ZIN), and remaining specimens are preserved in the Department of Zoology, Moscow State Pedagogical University.

BIOLOGY

The beetle catches per 100 trap-days over the period of observations (about 14 months) were: on

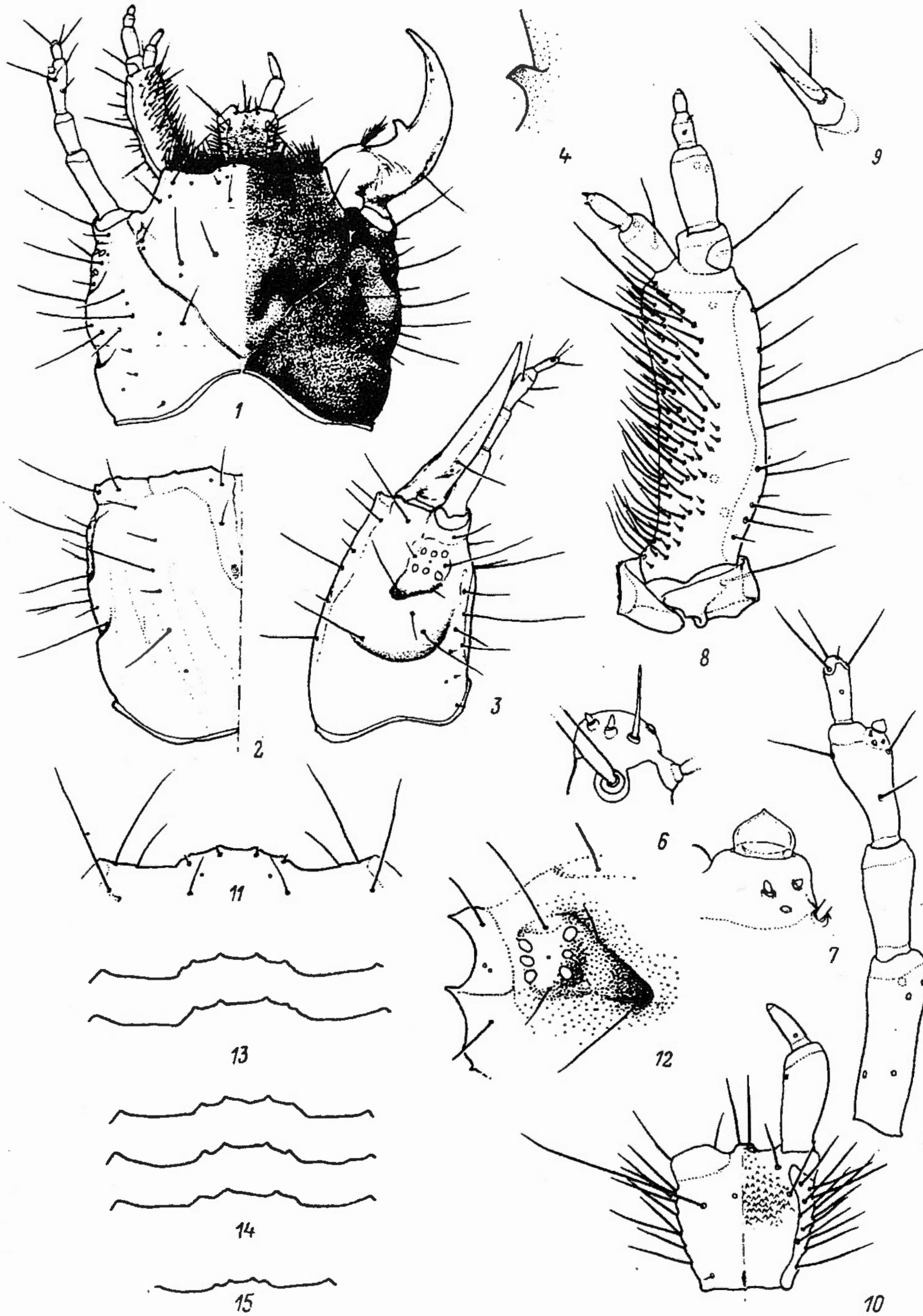

Fig. 1. *Laemostenus tauricus* (Dej.), larva. *1-15*) Instar-III larvae (*13*), II (*14*), and I (*15*). *1*) Head, in dorsal view (left mandible and labial palpus, right antenna and maxilla are removed; sculpturation is shown on the right), *2*) right half of head capsule in ventral view, *3*) head in lateral view (maxilla and labium are not shown), *4*) retinaculum, *5*) right antenna in dorsal view, *6*) apical complex of 4th antennal segment, *7*) sensory area of 3rd antennal segment, *8*) right maxilla in dorsal view (dotted line indicates sensillae situated ventrally), *9*) lacinia in dorsal view, *10*) labium (on the left in ventral view and on the right in dorsal view), *11*) anterior margin of frontal sclerite and in dorsal view, *12*) area of ocellar tubercle in lateral view, *13-15*) shape of nasale.

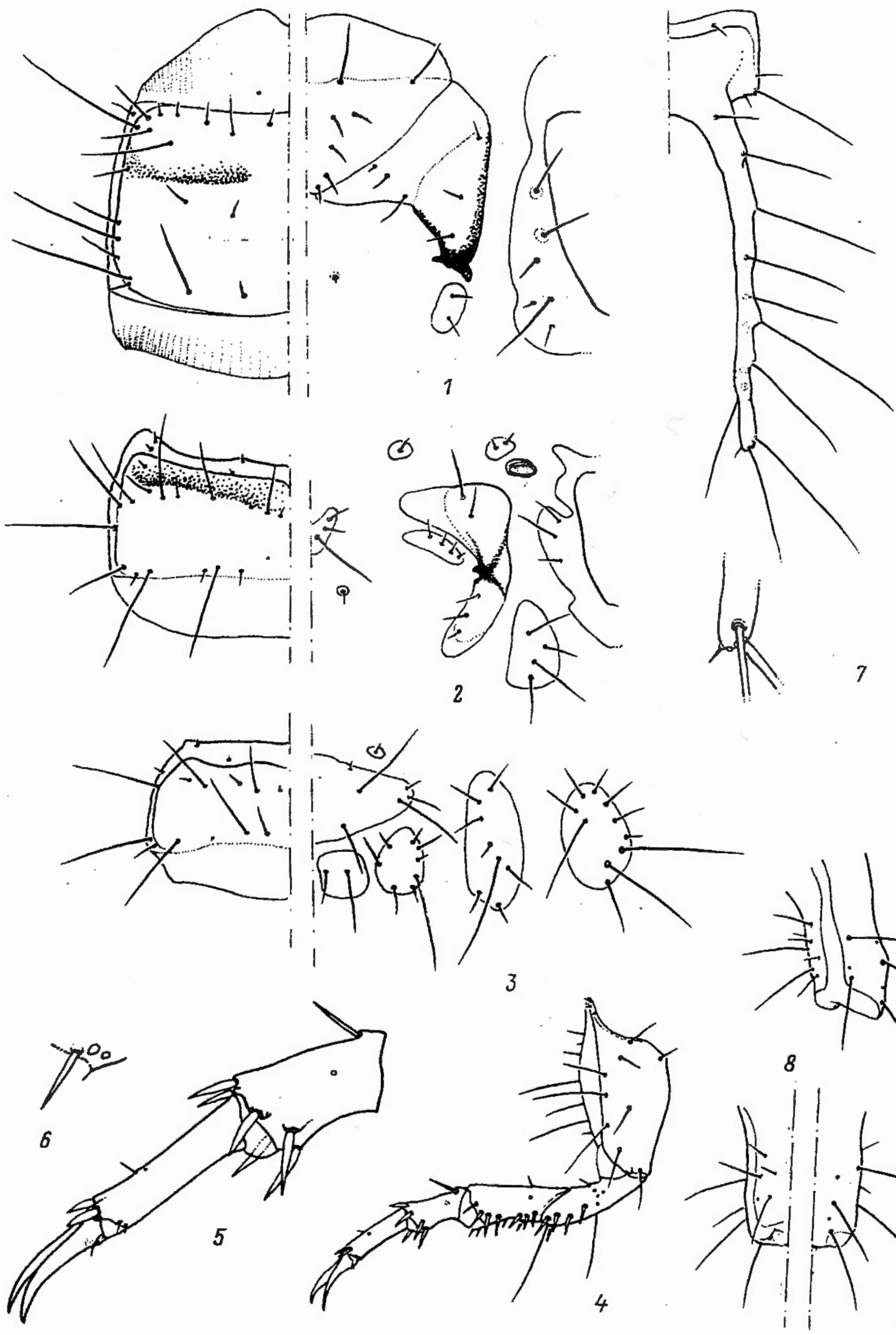

Fig. 2. *Laemostenus tauricus* (Dej.), instar-III larva: *1*) prothorax, *2*) mesothorax, *3*) abdominal segment IV (in Figs. *1-3* tergites on the left, pleurites and sternites on the right), *4-6*) right midleg in anterior view (*4* - general view, *5* - tarsus and tibia, *6* - area of sensillae $TA_{f,g}$), *7*) right half of abdominal tergite IX (apex of cerci shown separately), *8*) abdominal segment X in lateral view, *9*) same (on left in ventral view, and on right in dorsal view).

floor V, 50 m from the entrance 12.7 spms, in Organ Hall (floor V, 200 m from the entrance) 1.1 spms., and in Sukhorukov Hall (floor III, 400 m from the upper entrance and about 150 m from entrance to floor III) 2.4 spms. Ratio of ♀s and ♂s in the collection was close to 1.

The decline of catches in parts of the cave distant from the entrances indicates that most of the *L. tauricus* penetrate into the cave from the subaerial surface. Pliginskiy (1912) collected these ground beetles under large rocks next to the Kyzyl-Koba Cave. But the findings of larvae in the cave shows that they also reproduce there. It may be that this species can reproduce in various surface cavities, cracks, in rocky places, and in burrows. Therefore, in the classification of Racovitza (1907). *L. tauricus* would be considered a troglophilous species.

There are no *L. tauricus* on bottom floors (I and II) of the cave because the underground river there often floods these floors during high water periods. In the 19th century, the intermediate floors were often used as a cattle barn (Shchepinskiy, 1987), and the nearest-to-the-entrance part of the cave is populated by bats (now only a few colonies), and is regularly visited by people. As a result of this, guano, bones, phosphorite soil, plus various kinds of litter have accumulated here, creating a favorable microclimate for imagines of ground beetles.

Based on the time of collections (middle June-end of July), *L. tauricus* is tentatively classified as a species with a spring-summer type of reproduction.

Data on diurnal activity of *L. tauricus* are contradictory. Thus, on 18.VI.1990 on floor IV, active beetles were observed at 11 a.m., which contradicts the data of Pliginskiy (1927) who found that this species is active in Kyzyl-Koba only at dusk, which may be indicative of a variability of the diurnal activity rhythm in imagines of this ground beetle. However, the cause of such variation is not clear. It may be connected with seasonal dynamics, or individual variability, or with the duration of life of these spms. in the cave.

MORPHOLOGY OF IMAGINES

Mean length of the body of ♂s from the cave is 17.3±0.18 mm, and of ♀s 16.6±0.23 mm. Comparison of beetles from the cave with surface beetles from various habitats did not show any reliable differences in this character.

The structure of forefemora of ♂s exhibits considerable variation. According to Casale (1988), two subspecies of *L. sericeus* (F.-W.) live in Crimea, namely *L. sericeus hepaticus* (Fald.) and *L. sericeus tauricus* (Dej.). These differ in the presence (in *hepaticus*) or absence (in *tauricus*) of teeth on forefemora of ♂s. In the Kyzyl-Koba Cave, Casale recorded *L. sericeus hepaticus*.

Analysis of our material showed that in half of ♂s this character is well developed, while remaining spms. possess somewhat reduced teeth (Table 1). This confirms the opinion of Vereshchagina that the subspecies *L. sericeus sericeus* and *L. s. hepaticus* are Caucasian forms, and that all spms. fron. Crimea, particularly those from Kyzyl-Koba, should be considered to be *Laemostenus tauricus*[1].

DESCRIPTION OF LARVA OF *LAEMOSTENUS TAURICUS* (DEJ.)

Body of larva cylindrical, slightly narrowed at both ends, head slightly narrower than pronotum.

[1]Pliginskiy cites this species as *L. koeppeni* Motsch.

Color typical of Sphodrini larvae that live in hiding: head and pronotum reddish brown, mesonotum and metanotum yellow-brown, with darkened stripe along anterior margin. Tergites, and especially sternites, pigmented and pale yellow. Sigilla weakly developed, their pigmentation distinct only on thoracic sclerites.

Secondary microsculpturation not developed, primary sculpturation distinct only on thoracic sigilla. Irregularly distributed microtrichia present on all sclerites.

Some morphometric characters are shown in Table 2.

Head capsule (Fig. 1, *1-3*) weakly transverse, its relief formed of slight depressions bounding disk of frons, plus grooves in area of setae $PA_{5\text{-}7,\ 12\text{-}17}$. Postorbital (Fig. 1, *2*) groove short, distinctly depressed in the lower part, situated between setae PA_9 and Pa_{14}, occipital groove only slightly extends onto ventral and dorsal surfaces (to level of PA_{15}-$PA_{7\text{-}8}$, respectively). Ocellar tubercle slight, ocelli normally developed, in posterior row only middle ocellus somewhat smaller. Nasale (Fig. 1, *11*) slightly protruding, 4 distinct teeth, lateral parts of paraclypeus form short triangular lobes.

Overall, chaetome of head is characterized by presence of several secondary setae on parietal sclerites, groups of setae PA_6 and $PA_{16\text{-}17}$ being especially characteristic. Seta FR_8 almost twice as long as seta FR_9; $FR_{10,11}$ barely extends beyond margin of nasale (Fig. 1, *11*).

Appendages of head. Antennae (Fig. 1, *5-7*) of normal structures, sensillae $AN_{a,b,d}$ situated dorsally, apical complex of 4th segment (Fig. 1, *6*) comprises only 2 accessory basiconical sensillae. Retinaculum with humplike process on anterior margin. Seta MN_1 long and single. Maxillae (Fig. 1, *8*) are characterized by strongly developed group $MX_{2,3}$ and by short distal segments of palpus (3rd and 4th segments together not longer than 2nd segment). Structure of lacinia (Fig. 1, *9*) confirms data of Hovorka (1991): MX_6 situated asymmetrically and apex of lacinia forms short process normally hidden by robust base of seta. Labium (Fig. 1, *10*) slightly trapezoid, widened to apex. Lingua short, distinct, setae LA_4 developed, group LA_3 consists of 12-17 setae, LA_2 very long, apex almost reaching apex of basal segment of palpi.

Thoracic segments (Fig. 2, *1,2*) characterized by distinct increase in number of setae in lateral parts of tergites (especially in groups PR_6 and PR_9), secondary setae also often present on epipleura (as many as 4 setae on prothorax and 1-2 setae on mesothorax and metathorax). Seta PR_1 very small, shifted to medial line. Major part of primary basiconical sensillae also represented by setae. On sternites, PS_1 and MS_2 groups of setae; pleurites of prothorax with 1-2 setae, mesothorax and metathorax with 3-5 setae. Secondary setae present in groups TS_1 (3-5) and EM_1 (up to 3) (Fig. 2, *2*).

Leg (Fig. 2, *4-6*) of structure typical in Sphodrini, with strong long spines on femur and tibia. Claws long (0.71 length of tarsus) and of equal length. Setae of pretarsus (Fig. 2, *5*) very small, fit between sclerite and bases of claws. Secondary setae developed on ventral surface of femur and trochanter and also among setae of dorsal surface of coxa ($CO_{6,11,12}$).

Abdominal segments differ little from the generalized type. On tergites (Fig. 2, *3*) most of primary basiconical sensillae replaced by setae (except TE_d). Pleurites (Fig. 2, *3*) with numerous accessory setae, epipleurite bearing 4-8 setae in anterior part, hypopleurite 4-7 setae in anterior part (one of them very large) and 2-3 setae in posterior part. Sternal setae also multiple. Thus, in group ST_2 as many as 7 setae, gST_6 - 3-6 setae. Inner poststernites with single setae $ST_{3,4}$.

Cerci (Fig. 2, *7*) with 10 macrosetae (only UR_d is retained as basiconical sensilla), usually incomplete pale bands apically of $UR_{3,5,6}$. Usually 2 seta UR_2.

Support of normal structure, group *PY* - with 3-5 pairs of setae (Figs. 2, *8, 9*).

Individual variation. Instar-II larvae differ in size of head capsule and smaller number of secondary setae (in group Pl_1 and EM_1 1-2 setae on each, trochanter ventrally with 3-4 setae, femur with 5-6 setae). Larvae of instar I possess relatively weakly developed ovarial teeth and rather large number of secondary setae: setae $PA_{12,16}$, PR_{11}, $CO_{6,8}$, ST_6 single. Epipleura of pronotum with 1, mesonotum and metanotum with 1-2 setae. Shape of nasale in larvae of different instars is shown in Fig. 1, *13-15*.

Comparison. The larva described above differs from all known larvae of the genus in the peculiar hump-like retinaculum, strongly uneven setae $FR_{8,9}$, short 4th segment of maxillary palpus, developed groups of setae PA_6, PA_{12} and $PR_{6,7}$. In addition, this species differs from the sympatric terricola (Hbst.) in the long epicranial suture (its length exceeds the diameter of the 4th antennal segment) and in the more protruding lingua. Larvae of Caucasian troglophilous species of the group *koenigi* differ in the effaced nasale without developed teeth in area of setae $FR_{10,11}$ and small number of setae in the group PY_7.

Larvae of *L. tauricus* resemble morphologically larvae of *L. mannerheimi* (Kol.) (Hovorka, 1991). They differ from the latter in the shape of the nasale (distance between setae $FR_{11\text{-}11}$ is greater than distance between $FR_{10\text{-}11}$) and long PA_3, which is no longer than half length of PA_7.

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