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Edited by Alexandr Zamotajlov &
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Dr. Alexandr Zamotajlov
Entomology Department
Kuban State Agrarian University
ul. Kalinina 13
350044 Krasnodar, Russia

Dr. Riccardo Sciaky
Via Fiamma 13
20129 Milan, Italy

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Kirill MAKAROV

Larval morphology of *Carabophanus gestroi* Breuning and its position within the subtribe Calosomina (Coleoptera Carabidae Carabini)

Zoology and Ecology Department, Moscow State Pedagogical University

Abstract. Larval morphology of *Carabophanus gestroi* Breuning is described and its position within the subtribe Calosomina is discussed.

Резюме. Описана личинка *Carabophanus gestroi* Breuning и обсуждено ее положение в системе подтрибы Calosomina.

Key words: Carabidae Carabini, *Carabophanus gestroi*, description, taxonomic position.

INTRODUCTION

Two basic phylogenetic lines were traditionally distinguished within the tribe Carabini – the group of taxa clustered around the genus *Carabus*, and the group of genera allied to *Calosoma*.

The genus *Calosoma* Weber is the second largest genus in the tribe Carabini – it comprises about 300 known species (BREUNING, 1927-1928; KRYZHANOVSKIJ, 1962, etc.). In different periods *Calosoma* was considered by various authors either as one genus (BREUNING, 1927-1928; GIDASPOW, 1959, 1963), and as a number of related genera sometimes united in the subtribe Calosomina (JEANNEL, 1940). In the last case Jeannel recognised more then 20 genera of «*Calosoma*»-complex, and LAPOUGE (1929-1931) – only 7 genera. In the KRYZHANOVSKIJ's system (1954) the existence of 4 genera - *Callisthenes* Fischer, *Carabomorphus* Kolbe, *Haplothorax* Waterhouse and *Calosoma* Weber was considered. The genera *Callisthenes*, *Carabomorphus*, *Haplothorax* are specialized, geographically separated groups (their distribution covering the southern Holarctic, the high-mountains of Africa and St. Helena Isl., respectively). Inside "*Calosoma*" in the large sense, simultaneously with its quite complicated subgeneric structure, the setting apart of the group *Campalita* – *Caminara* – *Charmosta* as a distinct genus was assumed. It should be noted, that the taxonomy of the genus *Calosoma* is generally very intricate. So, to reflect relationships between its 300 members, almost 150 subgeneric names were suggested at different times. Such a diversity is partly determined by the ecological dissimilarity of the taxa: almost each evolutionary line of *Calosoma* includes both typical mesophylous representatives and species more or less deeply adapted to the dwelling in arid and semiarid landscapes. Analogous specialisation is characteristic for other taxa of Calosomina, namely *Callisthenes*, *Carabomorphus*, *Carabops* Jakobson, etc.

Larvae of very specialized representatives of Calosomina in the African fauna are still imperfectly studied. Relatively recent descriptions have been made only for two species of the genus *Carabops* (RAYNAUD, 1965; ROUGEMONT, 1983). The present investigation deals with the description of a single collected larva of the genus *Carabophanus* Kolbe as well as a discussion of the taxonomic status and position of this taxon.

Material and methods

The standard methods and terminology have been used in the description of larval morphology (Emden, 1942; Bitsch, 1966; Arndt, 1993; Luff, 1993). The chaetotaxy are given in agreement with Bousquet & Goulet (1984), including subsequent modifications and additions, having been regarded as the peculiarities of Carabini (Makarov, 1993), and principles of the chaetome modifications in carabid larvae in general (Makarov, 1996).

Material studied is kept at Moscow State Pedagogical University (MSPU).

Carabophanus gestroi Breuning, 1928

Material studied: One larvae of third instar (MSPU № 5.2 a/1-1): E Ethiopia, Bale province, Bale Nat. Park ~1 km from Dinshu, h=3160 m a. s. l., 22. XII. 1995, leg. S. Kruskop.

In the comparative analysis of the morphological features larvae of 11 species of *Calosoma* (*sycophanta* L., *maximowiczi* Mor., *inquisitor* L., *auropunctatum* Hbst., *maderae* F., *chinense* Kirby, *algiricum* Geh., *imbricatum* Klug, *reitteri* Roe., *denticolle* Gebl., *investigator* Ill., belonging to subgenera *Calosoma*, *Acalosoma*, *Campalita*, *Caminara* and *Charmosta*) and 7 species of *Callisthenes* (*breviusculus* Mnnh.; *elegans* Kirsch; *regelianus* Mor.; *pseudocarabus* Sem.; *semenovi* Motsch.; *kuschakewitschi* Ball.; *usgentensis* Sols.) with some reference data (Hurka 1978; Lapouge, 1908; Mikhailov & Dzhabarova, 1982; Raynaud, 1965; Rougemont G. M., 1983; Sharova, 1957, 1958, 1964; Shilenkov & Berlov, 1987; Thompson, 1979; Yablokov-Khnzoryan, 1962) were used.

Description

Habitus and coloration. Typically campodeiform caraboid larva with undilatated tergites and relatively short appendages (Fig. 1).

Head from above brown and dark-brown, with weak metallic lustre. Fore border and lateral parts of paraclypeus, sigillae of mandibular muscles light coloured, brownish-yellow. Lower surface of head lighter, brownish-yellow. Border of strongly pigmented dorsal part coincides with line connecting bases of setae PA_{12} – PA_{14}. Mandibles dark, brown-yellowish, on apices of terebra and retinaculum almost black. Other head appendages more pale, brownish-yellow, only external margin of stipes and apical joint of palpus darkened.

Dorsal sclerites dark brown, with significant metallic lustre; lateral margin slightly lightened. Only pretergum of prothorax notably light coloured. Urogomphi distally of dorsal tooth slightly lightened. X segment brownish-yellow. Pleurites and ventrites similar coloured, yellowish-brown.

Legs pale, only anterior surface of coxa brownish-yellow; segments very light distally, yellow.

Morphology. Head transverse (length/width ratio 0.65), slightly constricted basally (Fig. 2). Grooves on frontale and paritale not developed. Ocellar tubercle prominent, supraocellar tubercle distinct, skewed posteriad. Frontal sclerite of ordinary proportions, nasale typical for subtribe, with four obtuse teeth. Hypodon well developed, distinct. Anterior margin of paraclypeus nearly straight, its external lobes not extended.

Antennae short, their length is 0.7 of mandible length (Figs 2, 4). Antennomeres ratio as 1:1.4:1.7:0.9. Mandibles moderately curved, inner margin of terebra and retinaculum dentate. Retinaculum basally with distinct small tooth. Outer surface of mandible with longitudinal groove, inside which sensilla of group MN_1 are placed. Maxillae with moderately elongated palpus (Fig. 8), palpomeres ratio as 1:1.4:1.4:2.9. Palpomere 4 very long, with two weekly separated sensorial field apically. Galea 2.3 times shorter than maxillar palpus, its joints subequal.

Lacinia short, conical, hardly reaching the middle of galeomere 1. Stipes short and broad, only 1.3 as long as wide. Lateral margin of stipes fully sclerotized. Mentum subquadrate, regularly narrowed forwards, ligula slightly prominent (Fig. 7). Labial palpus massive, its apical joint with two sensorial fields apically, 1.3 times as long as basal joint.

Thoracic and tergal sclerites ordinary. All tergites transversal, length/width ratio on prothorax – 0.8, mesothorax – 0.5, metathorax – 0.45, abdominal tergites – 0.33–0.45. Abdominal tergites without extended lobes. Prothoracic epipleurite not combined with epipleures (Fig. 14), posterior part of abdominal epipleurites fully separated (Fig. 18). Sternites (except prothoracic) with additional lateral microsclerites, possessing a seta. Inner sternella separated.

Tergum of IX segment transverse, its posterolateral angles only slightly extended. Urogomphi short (1.5 time as long as tergum), moderately curved, with one dorsal tooth (Figs 19, 20). Tooth with simple apex, slightly slanted inward. Pygidium short, barely narrowed forwards. Its dorsal and ventral sclerites fully separated by longitudinal suture.

Legs short and robust (Fig. 10). Similar to many Calosomina, trochantera nearly as long as tibia. Tarsus cylindrical, slightly longer than tibia. Claws equal, uniformly curved, only 0.7 times as short as tarsus (Fig. 11).

MICROSCULPTURE. Primary isodiametric microsculpture located only in sigillae and membranous part of tergites. Dorsal sclerite with secondary transverse grooves, IX tergite and urogomphi weekly granulate.

CHAETOTAXY. In general, chaetotactic pattern of *Carabophanus* is very close to the typical one for tribe Carabini (MAKAROV, 1993): the absence of many ge-

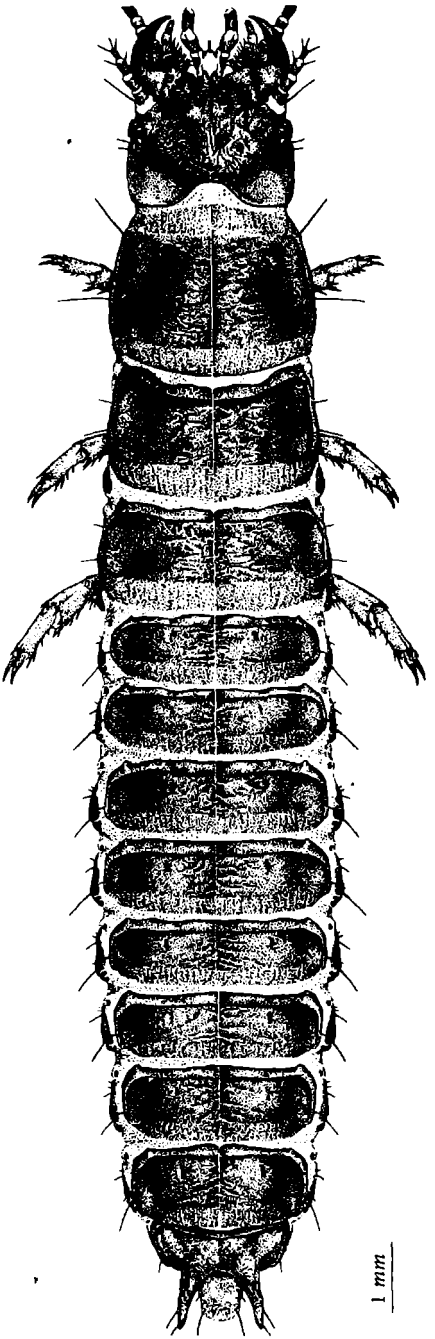
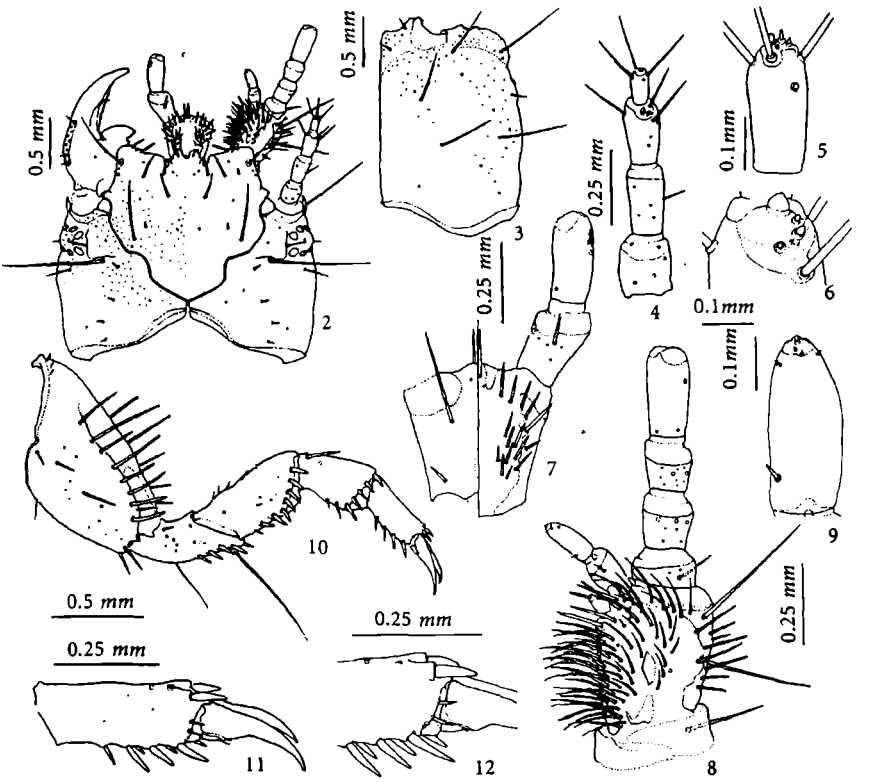


Fig. 1. *Carabophanus gestroi* Breuning, third instar larva.



Figs 2-12. *Carabophanus gestroi* Breuning, third instar larva: 2, head, dorsally; 3, left half of parietale, ventrally; 4, right antenna, laterally; 5, antennomere 4, dorsally; 6, apical part of antennomere 3, laterally; 7, labium (left – mentum, ventrally); 8, right maxilla, dorsally; 9, galeomere 2, dorsally; 10, left middle leg, frontal view; 11, tarsus of left middle leg; 12, apex of tarsus.

neralized sensilla is compensated by the development of numerous conical and, more rarely, campaniform sensilla.

Cranium characterised by absence of some generalized setae and by presence of small number of additional trichoid sensilla (Figs. 2, 3).

Frontal sclerite with additional microsetae in areas of FR_2, FR_6, and FR_7. Sensillae $FR_{1,2a}$ absent, FR_3 substituted by conical sensilla, setae of paraclypeus $FR_{8,9}$ single. Pairs of setae FR_4 and FR_5 moved apart. Parietal setae PA_{10}, PA_4, PA_{14} replaced with conical sensilla. Setae PA_9 and PA_{13} of subequal length; PA_{12} very long, scarcely shorter than PA_{17}.

Antennomere 2 with additional seta, its length hardly less than diameter of this joint. Setae AN_{1-5} and AN_7 rather short, their length only little more than length of antennomere 4 (Fig. 4). Seta AN_6 very short and stout. Sensorial complexes of antennomeres 2 and 4 weakly differentiated. In apical part of antennomere 3 one hemispheric and three conical sensillae of different sizes are situated (Fig. 6). Antennomere 4 apically, apart AN_6, with three different sensilla: conical, dull and peg-like (Fig. 5).

Mandibles with unusually long MN_2, not shorter than MN_1. In the area MN_1 the group of three setae and 6-8 dipped sensilla are developed (Fig. 2).

Group of gMX on maxillae well developed; it includes simple and bush-like setae of subequal size; only near MX_5 3-4 more thick straight setae present. Outer margin of stipes with 7-9 additional mesosetae between MX_2 and MX_3. Seta MX_8 placed on sclerotized part of apical joint of galea, MX_9 very small, hardly distinguishable from neighbouring conical sensilla. MX_{11} and MX_{12} reduced to conical sensilla (Fig. 8).

Seta MX_7 short, its length 2 times less than diameter of galeomere 1. Apical complex of galea includes central dull sensillum, surrounded by three campaniform sensilla and more peripherally – by three conical sensilla (Fig. 9).

Palpus maxillary with additional placoid sensilla in the area of MX_e - MX_f and MX_g. Maxillar palpomere 4 apically with numerous conical sensilla. These sensilla inserted concentrically around two larger basiconical sensilla and form two sensorial fields (Fig. 8).

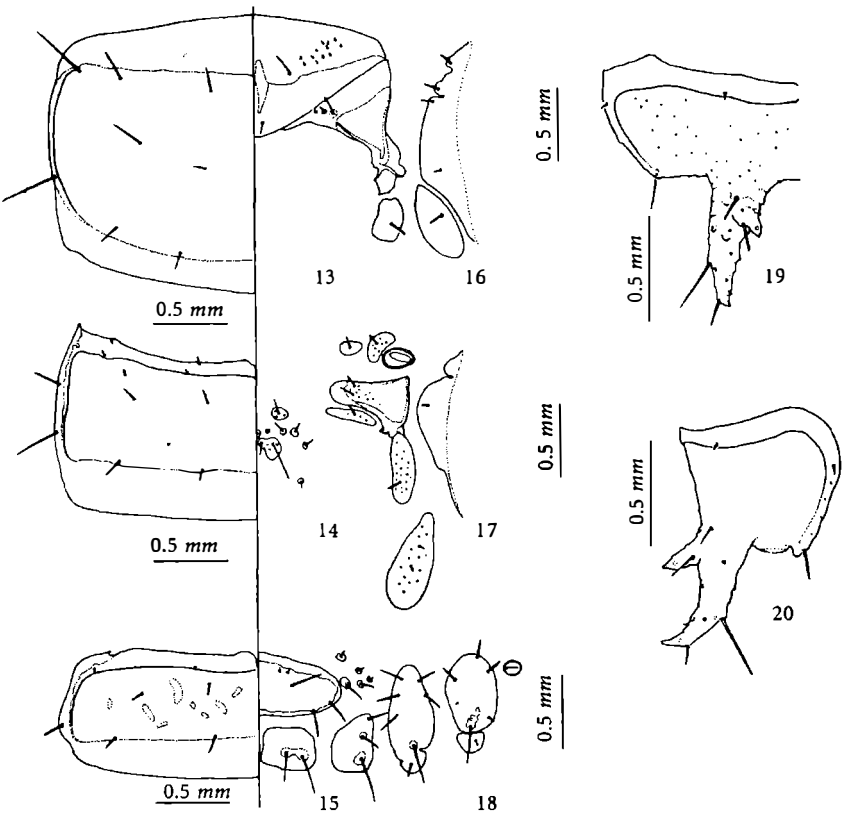
Labium ventrally with generalized set of setae. Dorsolaterally there is a group LA_3 - LA_5 consisting of 16-17 spiniform mesosetae (LA_3 stands out because its larger sizes). Ligula with setae LA_6 and conical sensilla in the area of LA_7 position (Fig. 7). Basal joint of labial palpus with additional seta and several placoid sensilla in group gLA_b. Labial palpomere 2 apically with two sensorial field, formed by numerous conical sensilla; lateral sensorial zone considerably moved to apex of joint.

Chaetome of tergal segments also similar to the typical Carabini pattern. The presence of complete set of meso- and macrosetae (PR_2, PR_3, PR_6, PR_8, PR_9, PR_{11}, PR_{12}, PR_{14} on prothorax and ME_1, ME_8, ME_9, ME_{11}, ME_{12}, ME_{13} on mesothorax) is characteristic (Figs. 13, 15). All microsetae on prothorax and ME_{10}, ME_{14} on mesa- and metathorax displaced by conical sensilla and can not be distinguished because of development of numerous secondary sensilla. Generalized sensilla also not distinguished among groups of additional sensilla. Epipleures of prothorax with 3-4 setae, meso- and metathoracic epipleures – only with 1 seta (Figs. 14, 16). Epipleurites with one (prothorax) or two (meso- and metathorax) setae. Epimeron and episternum without additional setae, with numerous conical sensilla (Figs. 16). Thoracal ventrites of typical structure, with ordinary chaetotaxy (Fig. 14), only near MS_3 secondary setae are developed (Fig. 15).

Abdominal tergites with shortened dull generalized setae TE_1, TE_6, TE_9, TE_{10} and TE_{11}; additional setae absent (Fig. 17). Seta TE_1 baccilliform. Pleurites and ventrites with several additional mesosetae: two setae in $glST_2$ and one seta - in gST_6; hypopleurites with 4-5 and epipleurites – with 3-4 setae in anterior part (Fig. 18).

IX tergite and urogomphi with one additional seta in basal part of lateral margin and one seta of indistinct homology inserted basally to UR_4. (it may be identical with UR_5, but UR_5 must be situated apically to UR_4). Seta UR_8 and especially UR_7 very short (Fig. 20).

Leg chaetotaxy rather complicated. Coxa with continuous anterior (CO_6 – CO_8) and posterior (CO_{12} – CO_{13}) groups of 6-10 meso- and macrosetae each. Trochanter ventrally with groups of spiniform setae TR_2-TR_3 and TR_5-TR_7. Sensitive setae TR_4 and TR_8 subtile, noticeably elongated - TR_4 2 times as long as diameter



Figs 13-20. *Carabophanus gestroi* Breuning, third instar larva: 13, left half of pronotum, dorsally; 14, left half of pronsternum, ventrally; 15, left half of mesonotum, dorsally; 16, left half of mesosternum, ventrally; 17, left half of abdominal tergite 4, dorsally; 18, left half of abdominal segment 4, ventrally; 19, IX tergite and urogomphi, left part, dorsally; 20, same, laterally.

of trochanter apex. Ventro-apical groups of spines also developed on femur (FE_2–FE_3, FE_4-FE_5) and tibia (TI_3–TI_4, TI_5–TI_6). Femur, besides that, with dorsal group FE_1 of 4-7 short stout setae (Fig. 10). Seta TI_1 stout, its length approximately equal to diameter of tibia basis. Tarsus on underside with parallel rows of 3-4 spines each (Fig. 11). Seta TA_1 and sensilla TA_a shifted apically. Seta TA_1 very short, scarcely differs from conical sensillae (Fig. 12). Apical setae TA_3 - TA_6 moderately long, thick. Setae UN_1 and UN_2 short, placed on pretarsal sclerite (Fig. 12).

Diagnosis. Larvae of *Carabophanus* are characterized by the following set of macromorphological features within the tribe Carabini: maxillar palpomere 4 almost 3 times as long as palpomere 1, ligula not protruding; tubercula supraocellare distinct, skewed posteriad; abdominal tergites without posterolateral lobes; urogomphi uniformly curved, with one dorsal tooth.

Chaetotactic pattern of *Carabophanus* is characterized by absence of FR_1 and FR_a, reduction of PA_{10} and PA_{14}, TA_1, UR_5; absence of additional setae on thoracic and abdominal tergites, dorsal surface of tibia and tarsus as well as on thoracic

epimerites and pleurites. Most of setae (except bacilliform ES_2, MS_1, PL_1 and TE_1) not modified.

The specific coloration preliminarily may be assigned to the number of the diagnostic features: its peculiarity is in combination of the heavily pigmented tergites with the light, almost yellow legs and head appendages.

DISCUSSION. Similar to imago, larva of *Carabophanus* exhibits the combination of typical «caraboid» and «calosomoid» features. As the «caraboid» characters we consider the general reduction of the chaetome, not accompanied by the development of secondary setae on tergites and urogomphi as well as the typical for *Carabus* urogomphi-form.

On the contrary, the presence of PA_6, the general structure of maxillae and the chaetotaxy of antenna and maxilla are typical for *Calosoma* (s.lato). Besides, the described larva have many features likely to be plesiomorphic in both subtribes. These are the four-toothed nasale, the absence of distinct tergal lobes, the single setae FR_8 and FR_9, presence of PA_5, the retention of all discal setae of tergites (PR_8, PR_{14}, ME_1, ME_8, TE_1 and TE_6), and the poor differentiation of pleurite and ventrite setae.

The comparison of our data on larval morphology of *Calosoma* with the descriptions of African species (RAYNAUD, 1965; ROUGEMONT, 1983) in general supports the expediency of broad treatment of *Calosoma* (BREUNING, 1927-28) including *Carabops*, *Carabomorphus*, e. c. as subgenera. Only the larva of *Carabops janssensis* Basilewsky displays the strong morphological peculiarity of being provided with a straight border of the paraclypeus, two-segmented urogomphi without teeth and others (RAYNAUD, 1965). But the larval morphology of another *Carabops* species - *C. abyssinicus* Gestro (ROUGEMONT, 1983) - is like *Calosoma*.

Taking into account the aforesaid, the described features of *Carabophanus*-larvae (mainly absence of FR_1 and FR_2, reduction of setae PA_{10} PA_{14} and especially - TA_1 and UR_5, relatively complete discal chaetome and the unusually long maxillary palpomere 4) supports its status as a separate genus. The presence of seta PA6 and the specific structure of the maxilla uniquely indicate its belonging to the subtribe Calosomina.

The genus *Carabophanus* occupies an isolated position within this subtribe owing to the specific «caraboid» type of secondary chaetome. Even such representatives of *Calosoma*, as *C. sycophanta* and *C. inquisitor*, possessing the least modified chaetome within this genus, differ considerably from *Carabophanus* in chaetotaxy. The chaetome dissimilarity between *Carabophanus* and *Callisthenes* is more evident.

The single feature, suggesting a relationship of *Carabophanus* is the structure of the apical sensorial complex of antenna, and especially the particular shape of seta AN_6. The analogous state of this character is known to us only within *Callisthenes* and was used till now as a single feature that distinguished this genus from *Calosoma* (contrary to MIKHAILOV & DZHABAROVA, 1982; SHILENKOV & BERLOV, 1987; YABLOKOV-KHNZORYAN, 1962).

It may be supposed that genera *Carabophanus* and *Callisthenes* make up a separate phylogenetic group, but discussion of its taxonomic status is not possible at present.

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Author's address:

Dr. Kirill V. Makarov, Zoology and Ecology Department, Moscow State Pedagogical University, Kibalchicha str. 6/5, 129278 Moscow (Russia).