Advances in Carabidology

Papers Dedicated to the Memory of Prof. Dr. Oleg L. Kryzhanovskij

Edited by Alexandr Zamotajlov & Riccardo Sciaky

With Original Contributions by

M. Baehr • G. Ball • I. Belousov • Y. Bousquet • A. Brinev
A. Casale • T. Erwin • S. Facchini • D. Fedorenko
V. Grebennikov • F. Hieke • N. Ito • I. Kabak • B. Kataev
D. Kavanaugh • M. Luff • K. Makarov • A. Matalin • P. Moret
J. Schmidt • R. Sciaky • V. Shilenkov • D. Shpeley
L. Toledano • K. Will • D. Wrase • A. Zamotajlov

MUISO Publishers
Krasnodar
1999
Cover illustration:

*Deltomerodes wrasei* Zamotajlov, 1999 (Carabidae, Patrobinae)
Cover design by Dr. A. Zamotajlov

This work is subject to copyright. All rights reserved and protected by the legislation of Russian Federation, whether the whole or part of the material is concerned, specifically those of translation, reprinting, re-use of illustrations, broadcasting, reproduction by photocopying machine or similar means, and storage in data banks or retrieval system.

© MUISO Publishers Krasnodar 1999
First published 1999
Printed in Russia

The use of registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
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 её 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 (Jeanne!, 1940). In the last case Jeannel recognised more then 20 genera of «Calosomina»-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., madera 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 Mnhn.; 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 PA12 - PA14. 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 MN1 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 palpûs 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). Stermites (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, trochanter 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-
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.

Generalized 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$_r$. Sensillae FR$_1$, 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$_{11}$, PA$_{14}$ replaced with conical sensilla. Setae PA$_2$ 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$_r$, 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 MN₂, not shorter than MN₁. In the area MN₁ 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 MX₉ 3-4 more thick straight setae present. Outer margin of stipes with 7-9 additional mesosetae between MX₆ and MX₉. Seta MX₆ placed on sclerotized part of apical joint of galea, MX₉ very small, hardly distinguishable from neighbouring conical sensilla. MX₁₁ and MX₁₂ reduced to conical sensilla (Fig. 8).

Seta MX₇ 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 MX₉ - MX₁ and MX₂. 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 LA₃ - LA₅ consisting of 16-17 spiniform mesosetae (LA₃ stands out because its larger sizes). Ligula with setae LA₆ and conical sensilla in the area of LA₇ position (Fig. 7). Basal joint of labial palpus with additional seta and several placoid sensilla in group gLA₆. 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 (PR₂, PR₃, PR₄, PR₅, PR₆, PR₁₀, PR₁₁, PR₁₂, PR₁₄ on prothorax and ME₁, ME₈, ME₉, ME₁₀, ME₁₁, ME₁₂, ME₁₃ on meso- and metathorax) is characteristic (Figs. 13, 15). All microsetae on prothorax and ME₁₀, ME₁₄ on meso- 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. Epipleurites with one (prothorax) or two (meso- and metathorax) setae. Epimeron and episternum without additional setae, with numerous conical sensilla (Figs. 16). Thoracic ventrites of typical structure, with ordinary chaetotaxy (Fig. 14), only near MS₃ secondary setae are developed (Fig. 15).

Abdominal tergites with shortened dull generalized setae TE₁, TE₂, TE₆, TE₁₀ and TE₁₁; additional setae absent (Fig. 17). Seta TE, baccilliform. Pleurites and ventrites with several additional mesosetae: two setae in gST₂ and one seta - in gST₅; 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 UR₄ (it may be identical with UR₃, but UR must be situated apically to UR₃). Seta UR₈ and especially UR, very short (Fig. 20).

Leg chaetotaxy rather complicated. Coxa with continuous anterior (CO₅ – CO₈) and posterior (CO₁₂ – CO₁₃) groups of 6-10 meso- and macrosetae each. Trochanter ventrally with groups of spiniform setae TR₂, TR₃, and TR₅, TR₆. Sensitive setae TR₄ and TR₅, TR₇, TW₁, TW₂, TW₃, TW₄ subtile, noticeably elongated - TR₄ 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 pronotum, ventrally; 15, left half of mesonotum, dorsally; 16, left half of mesonotum, 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 (FE₂₋FE₃, FE₄₋FE₅) and tibia (TI₁₋TI₄, TI₅₋TI₆). Femur, besides that, with dorsal group FE₄ of 4-7 short stout setae (Fig. 10). Seta TI₁ stout, its length approximately equal to diameter of tibia basis. Tarsus on underside with parallel rows of 3-4 spines each (Fig. 11). Seta TA₁ and sensilla TA₂ shifted apically. Seta TA₁ very short, scarcely differs from conical sensillae (Fig. 12). Apical setae TA₁ - TA₆ moderately long, thick. Setae UN₁ and UN₂ 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 FR₁ and FR₃, reduction of PA₁₀ and PA₁₄', TA₂, UR₃; 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 ES₂, MS₁, PL₁, and TE₁) 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 PA₆, 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 FR₈ and FR₉, presence of PA₃, the retention of all discal setae of tergites (PR₈, PR₉, ME₁, ME₈, TE₁, and TE₆), 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 FR₁ and FR₉, reduction of setae PA₁₀, PA₁₄, and especially - TA₁ and UR₅, 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 AN₆. 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-Khinzoryan, 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.
ACKNOWLEDGEMENTS

This work was possible because of unselfish help of colleagues who presented me with their material of carabid larvae for many years: I. Kh. Atamuradov, I. A. Belousov, A. E. Brinev, V. G. Gratchov, V. M. Dushenkov, B. M. Kataev, V. E. Karova, S. V. Kruskop, A. V. Matalin, V. A. Mikhailov, A. V. Puchtov, L. B. Rybalov, N. V. Tarusova, S. V. Utianskaja, V. G. Shilenkov, M. E. Tcherenjakovsky. The author remembers with peculiar warmth Prof. O. L. Kryzanovskij, whose erudition and influence contributed to the forming of the author's opinion on carabid classification and significantly determined the choice of the subject of his study. The research was supported by grants from the Russian Fund of Fundamental Researches, №№ 97-04-48327, 97-15-98079, 99-15-96069, and Governmental program «Biodiversity».

REFERENCES


Carabophanus gestroi larval morphology


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