Far Eastern Entomologist

Number 451: 6-15 ISSN 1026-051X (print edition) ISSN 2713-2196 (online edition) March 2021

https://doi.org/10.25221/fee.451.2
http://zoobank.org/References/D59B5F75-5388-4ED1-931C-BBB0E56F85E7

MICROSCULPTURE AND CHAETOTAXY OF ABDOMINAL TERGITES OF THE BARK AND AMBROSIA BEETLES (COLEOPTERA: CURCULIONIDAE, SCOLYTINAE): MORPHOLOGY AND NOMENCLATURE

D. G. Kasatkin

Rostov branch of FSI "VNIIKR", 20th line, 43/16, Rostov-on-Don 344037, Russia.
E-mail: dorcadion@yandex.ru

Summary. The structure of the chaetom and the microsculpture of the abdominal tergites surface are analyzed for 60 species of Scolytinae from different tribes and genera. The typification and nomenclature of these structures are proposed for the first time. Eight types of microsculptural elements and five types of setae are recognized. The taxonomic significance of these structures is discussed.

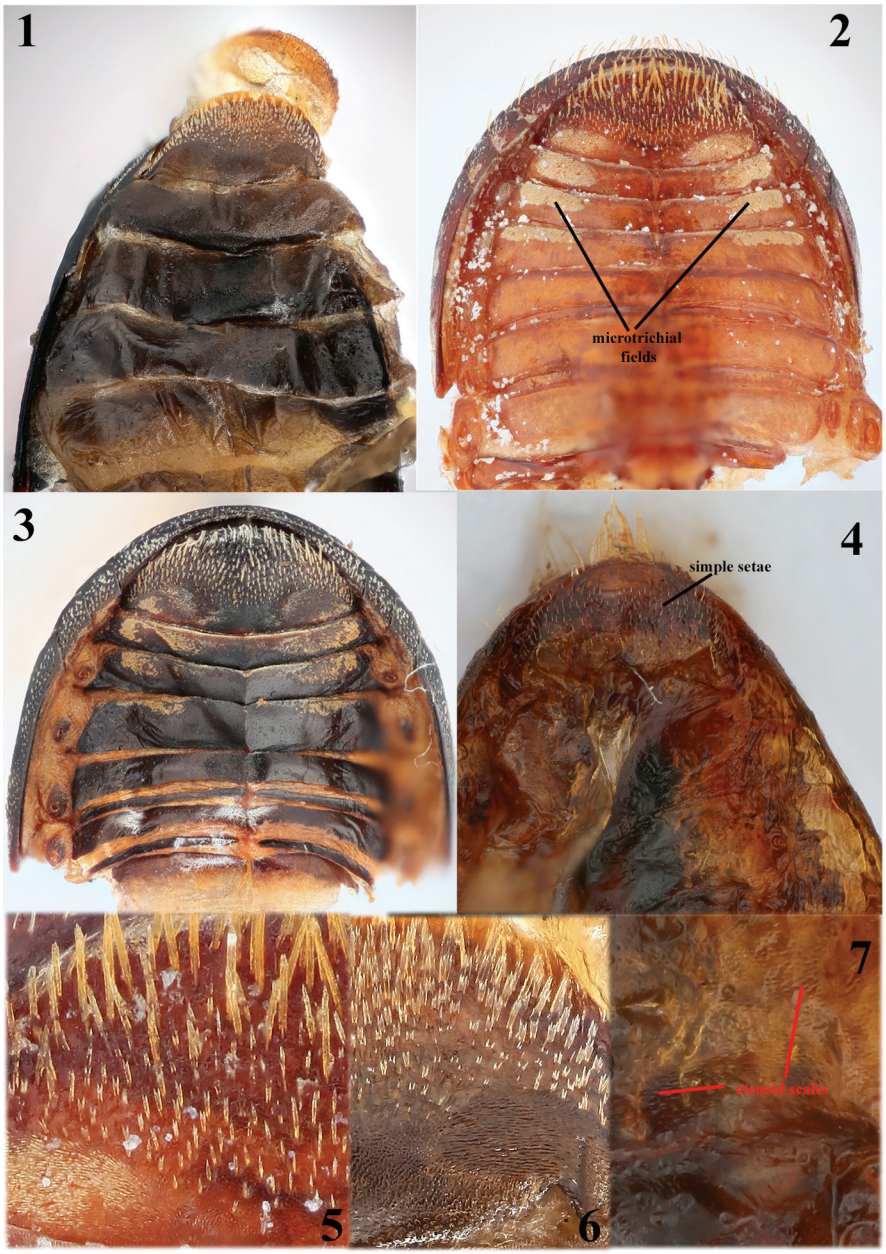
Key words: Scolytinae, chaetom, morphology, microsculpture, nomenclature, typology, taxonomical significance.

Д. Г. Касаткин. Микроскульптура и хетотаксия абдоминальных тергитов жуков-короедов (Coleoptera: Curculionidae, Scolytinae): морфология и номенклатура // Дальневосточный энтомолог. 2022. N 451. С. 6-15.

Резюме. Проанализирована морфология хетома и микроскульптуры поверхности тергитов брюшка 60 видов жуков-короедов из различных триб и родов. Впервые проведена типификация изученных структур и предложена их номенклатура: выделено 8 типов элементов микроскульптуры и 5 типов хет. Характер расположения этих структур свидетельствует о возможности их использования для таксономии.

INTRODUCTION

The abdominal tergites of beetles bear a complex of two types of arms: a chaetom and microsculpture (Figs 1–7). The chaetom is represented by various setae (chaetae) and sensillae, the microsculpture consists of various cuticular elements. The presence of chaetom on the abdominal tergites of bark beetles was noted by K. Lindemann (1875). He recorded that tergites 7–8 of *Scolytus* Geoffroy, 1762 bear hairs of several types, which are various in different species. Subsequently, these structures were ignored by further researchers. Lindemann didn't describe the tergo-abdominal microsculptures. In addition to the publication mentioned above, these structures were described only in the work of Davis (2009) devoted to the morphology of weevils of the subfamily Baridinae. In this publication, Davis noted that microstructures form fields or patches that differ in their number and shape both on different tergites and taxa. These structures have not been analyzed in detail by this author, and a typology of microstructures has not been given. But we cannot ignore the fact that the



Figs 1–7. Microscuptural fields and chaetom elements of Scolytinae. 1, 6 – *Hylurgus ligniperda* (Fabricius, 1787); 3 – *Camptocerus suturalis* (F., 1801); 2, 5 – *C. costatus* Chapuis 1869; 4, 7 – *Ips sexdentatus* (Börner, 1776).

more detailed description of tergal microstructures was given for Ephemeroptera (Gupta *et al*., 1999). In addition, two publications contain data on the microstructure of the abdomen and the thorax of Coccinelidae (Sun *et al.*, 2018) and Tenebrionidae (Quian *et al.*, 2015) with discussion of the functional purpose of these structures. According to these authors, thoracic and abdominal microsculptures, in conjunction with similar structures on elytrae, are used when folding and fixing the hind wings.

MATERIAL AND METHODS

A list of examined species is given below:

Tribe Xyleborini: *Xylosandrus crassiusculus* (Motschulsky, 1866) – Panama: Colon prov., San Lorenzo, STRI Crane Site, 9°17`N 79°58` W Fit – R-1-t, 28–30.X 2003, leg. A. Tishechkin; *X. germanus* (Blandford, 1894) – Russia: Krasnodar Reg., Tuapse Distr., NW Podkhrebtovoe settl., 44°22′84′′ N 38°57′55′′ E, 19–27.VI 2006, leg. I. Melnik; *X. morigerus* (Blandford, 1894) – Costa Rica: Heredia Est. Biol. La Selva, 50–150 m, 10°26′ N 84°01′ W, 14.VII 1993; *X. compactus* (Eichhoff, 1875) – USA, LA: Natchitoshes par., Kisatchie Bayou, ex: MV/blacklight, 05.IV 2003; *Diuncus haberkorni* (Eggers, 1920) – Vietnam, Dongkho Isl., 23.III 1987, leg. V. Kuznetsov; *Cnestus retifer* Wood, 2007 – Peru, Loreto prov., 58 km SSw from Iquitos to Nauta, Itaya River, 4°11′ S 73°28′ W, 6–7.V 2009, leg. A. Petrov; *Cnestus mutilatus* Blandford, 1894 – Korea, 30.VII 1961; *Cnestus testudo* (Eggers, 1939) – Vietnam, Dongkho Isl., 23 03 1987, leg. Kuznetsov; *Anisandrus dispar* (Fabricius, 1792) – Russia, Karachay-Cherkessia, near Kurdzhinovo, 02.VII 2020, leg. D. Kasatkin; Krasnoyarsk Reg., Berezovsky Distr., Berezovsky settl., 27.V 2020, leg. E. Akulov; *A. maiche* (Kurentsov, 1941) – Russia, Primorsky Reg., near Barabash, 15.VIII 2021, leg. D.Kasatkin & E.Akulov; *A. obesus* (LeConte, 1868) – USA, Tennessee, Gatlinburg, 30.VII 1957; *Xyleborus ?ferrugineus* (Fabricius, 1801) – Tanzania, near Morogoro, Kingolvira vill., 06–08.XII 2019, leg. D. Kasatkin; *Xyleborinus saxesenii* (Ratzeburg, 1837) – Russia, Primorsky Reg., Khasansky Distr., Primorsky, 14.VIII 2021, leg. D. Kasatkin & E. Akulov.

Tribe Hylurgini: *Hylurgus ligniperda* (Fabricius, 1787) – Russia, Rostov Reg. Tarasovsky Distr., Efremo-Stepanovka, VI 999, leg. D.Kasatkin; Turkey, Kayseri prov., Bashkonbesh Yaylasy, 18.IV 2021, leg. M. Nabozhenko; *H. palliatus* (Gyllenhal, 1813) – Krasnoyarsk Reg., Berezovsky Distr., Berezovsky, 01.VII 2012, leg. E. Akulov; *Tomicus minor* (Hartig, 1834) – Turkey, Kayseri prov., Bashkonbesh Yaylasy, 18.IV 2021, leg. M. Nabozhenko; Krasnoyarsk Reg., Berezovsky Distr., Berezovsky, 18IV 2017, leg. E. Akulov; *T. piniperda* (L., 1758) – Crimea, Yalta, ex Sequoia, 08.VI 2021, leg. D. Kasatkin.

Tribe Hylastini: *Hylastes opacus* Erichson, 1836 – Russia, Rostov Reg. Tarasovsky Distr., Yefremovo-Stepanovka, VI 1999, leg. D.Kasatkin; *H. ater* (Paykull, 1800) – Russia, Adygeya, Guzeripl, window trap, VI 2001, leg. A. Bibin; *Hylurgops interstitialis* (Chapuis, 1875) – Russia, Primorsky Reg., Spassk Distr., near Zelenovka, 05.VIII 2021, leg. D. Kasatkin.

Tribe Phloesinini: *Phloeosinus aubei* (Perris, 1855) – Russia, Rostov-on-Don, VI 2019, leg. D. Kasatkin.

Tribe Hylesinini: *Hylesinus toranio* (D'Anthione, 1788) – Russia, Rostov-on-Don, VI 2019, leg. D. Kasatkin; *H. varius* (F., 1775) – Russia, Rostov Reg., Millerovo, 07.VII 2021, leg. D. Kasatkin; *H. eous* Spessivtsev, 1919 – Russia, Primorsky Reg., Artem city, 03.VIII 2021, leg. D. Kasatkin; *H. tristis* Blandford,1894 – Russia, Primorsky Reg., Khasansky Distr., near Primorsky, 14.VIII 2021, leg. D. Kasatkin & E. Akulov; *Pteleobius vittatus* (F., 1787) – Russia, Adler, IV 2021, leg. E.A. Khachikov.

Tribe Polygraphini: *Polygraphus proximus* Blandford, 1894 – Russia, Krasnoyarsk Region, Emelyanovsky Distr., near Pamiaty 13 Bortsov, VII 2018, leg. E. Akulov; *Carphoborus perrisi* (Chapuis, 1869) – Crimea, Sevastopol, ex Pistatia, 11.VI 2021, leg. D. Kasatkin.

Tribe Phloeotribini: *Phloeotribus caucasicus* Reitter, 1891 – Russia, Rostov-on-Don, ex Fraxinus, 30.VI 2021, leg. D. Kasatkin.

Tribe Dryocoetini: *Taphrorychus lenkoranus* Reitter, 1913 – Iran, Gilan prov., near Assalem, 01.VI 2017, leg. D. Kasatkin; *T. villifrons* (Dufour, 1843) – Russia, Adygeya, Guzeripl, window trap, VI 2001, leg. A. Bibin; *Lymantor coryli* (Perris, 1855) – Russia, Krasnoyarsk, 19.VIII 2015, leg. E. Akulov; *Dryocoetes infuscatus* Murayama, 1937 – Russia, Primorsky Reg., near Barabash, 13.VIII 2021, leg. D. Kasatkin & E. Akulov.

Tribe Scolytini: *Scolytus multistriatus* (Marsham, 1802) – Russia, Rostov Region, Razdorskaya, 13.VI 2003, leg. E. Khachikov; *S. ensifer* Eichhoff, 1881 – Iran, North Khorasan Prov., near Dasht, V 2017, leg. D. Kasatkin; Rostov Reg., Ust-Donetsk distr., near Nizhnekundrjutchenskaya, ex Fraxinus, 01.VII 2021, leg. D. Kasatkin; *S. mali* (Bechstein, 1805) – Rostov Reg., Neklinovsky Distr., 1300 km station, V 2021, leg. D. Kasatkin; *S. koenegi* Schevyrew, 1890 – Rostov Reg., Ust-Donetsk Distr., near Nizhnekundrjutchenskaya, ex Fraxinus, 01.VII 2021, leg. D. Kasatkin; *S. jakobsoni* (Spessivtsev, 1919) – Russia, Primorsky Reg., Artem, 03.VIII 2021, leg. D. Kasatkin; *S. trispinosus* Strohmeyer, 1908 – Russia, Primorsky Reg., Artem, 03.VIII 2021, leg. D. Kasatkin; *Camptocerus noel* (Smith et Cognato, 2010) – Peru, Loreto region, 65 km SW Iquitos, 14.II 2008, leg. A. Petrov; *C. costatus* Chapuis 1869 – Peru, Junin Reg., 15 km NW Satipo, Rio Venado, 13.X 2015, leg. A. Petrov; *C. mandelshtami* Petrov, 2007 – Peru, Loreto region, 70 km from Iquitos to Nauta, 28.II 2008, leg. A. Petrov; *C. suturalis* (F., 1801) – Peru, Junin Reg., 15 km NW Satipo, Rio Venado, 14.X 2015, leg. A. Petrov.

Tribe Ipini*Ips sexdentatus* (Börner, 1776) – Russia, Rostov Region, Tarasovsky Distr., Yefremovo-Stepanovka, VI 1999, leg. D. Kasatkin; Russia, Primorsky Reg., near Zelenovka, 05.VIII 2021, leg. D. Kasatkin; Turkey, Rize Prov., Pokut Yaylasi, 17.VII 2011, leg. M. & S. Nabozhenko; *I. integer* (Eichhoff, 1869) – Mexico; *I. typographus* (L., 1758) –Russia, Adygeya, Guzeripl, window trap, VI 2001, leg. A. Bibin; *Ips* cf. *calligraphus* (Germar, 1824) – Mexico; *Orthotomicus laricis* (Fabricius, 1792) – Russia, Rostov Reg., Neklinovsky Distr., 1300 km train station, 28.V 2006, leg. D. Kasatkin; Russia, Krasnodarsky Reg., Utrish, leg. E. Khachikov; *O. proximus* (Eichhoff, 1867) – Russia, Krasnoyarsk Reg., Berezovsky Distr., Berezovsky, 19.VII 2020, leg. E. Akulov; *O. suturalis* (Gyllenhal, 1827) – Russia, Krasnoyarsk Reg., Berezovsky Distr., Berezovsky, 19.VII 2020, leg. E. Akulov; *Pityokteines curvidens* (Germar, 1824) – Turkey, Kayseri prov., Bashkonbesh yaylasy, 18.IV 2021, leg. M. Nabozhenko; Adygeya, Guzeripl, window trap, leg. A. Bibin; *Pityogenes chalcographus* (Linnaeus, 1761) – Russia, Krasnoyarsk Reg., Berezovsky Distr., Magaysk, 01.VII 2015, lag. E. Akulov; *P. conjunctus* (Reitter, 1887) – Russia, Rostov Reg., Ust-Donetsk Distr., near Nizhnekundrjutchenskaya, ex Pinus silvestris, 01.VII 2021, leg. D. Kasatkin.

Tribe Cryphalini: *Eidophelus spessivtzevi* Berger, 1917 – Russia, Primorsky Reg., Ussuriysk Distr., Bonevurovo, 11.VIII 2021, leg. D.Kasatkin & E.Akulov; *Cryphalus piceus* Eggers 1926 – Russia, Adygeya, Guzeripl, window trap, VI 2001, leg. A. Bibin; *Cryphalus* sp. – Kenya, Nakuru County, Shore of Naivasha Lake, near Kasanari, 0.44′196′′ S, 36.170′10′′ E, 06.V 2019, leg. S. Mukhanov.

Tribe Xyloterini: *Trypodendron signatum* (Fabricius, 1792) – Adygeya, Guzeripl, window trap, leg. A. Bibin; Russia, Primorsky Reg., Khasansky Distr., near Primorsky, 14.VIII 2021, leg. D. Kasatkin & E. Akulov; *Indocryphalus aceris* (Niisima, 1910) – Russia, Primorsky Reg., Khasansky Distr., near Primorsky, 14.VIII 2021, leg. D. Kasatkin & E. Akulov.

Tribe Scolytoplatypodini: *Scolytoplatypus tycon* Blandford, 1893 – Russia, Primorsky Reg., Khasansky Distr., near Primorsky, 14.VIII 2021, , leg. D. Kasatkin & E. Akulov.

Tribe Diamerini: *Diamerus* sp. – Kenya, Nakuru County, Shore of Naivasha Lake, near Kasarani, 06.V 2019, leg. S. Mukhanov.

Photographs were taken with Olympus BX41 microscopes using light and phase-contrast microscopy methods. Some images (dry not dissected abdomen) were made by Mitutoyo 10x Plan Apo connected with Canon Lens EF 200 mm. The abdomen was separated and placed in 15-20 % KOH in the Eppendorff microtube for preparation of abdominal tergites. Maceration produced in the microtermostate with time of exposition is one hour at the temperature 50–70 ^{o}C in dependent from abdomen sizes. Then, the abdomen was cleaned with distilled water and tergites were separated. Microstructures were examined on glass slides in the Hoyer's medium.

MORPHOLOGY AND NOMENCLATURE OF THE TERGAL CHAETOM AND MICROSCULPTURE

The tergal microsclupture is presented by two general types, scales and microspines, for which we propose the following preliminary typification:

Scales (microscales): the wide, flat structure sometimes elongated but everywhere with the distinct widened base. The surface of the tergites is covered with cuticular elements forming roof tiles structure. We distinguish the following types of microscales on the basis of the examined material:

a) Simple. The monoapical microscale; the apical margin can be rounded or angulated, sometimes prolongated in the small spine (Fig. 9i).

b) Multiapical. This is a variant of the simple microscale with two or more pronounced apices at the apical margin (Fig. 9k).

c) Crown-shaped. Wide scale (much wider than its length) with numerous long, sharp teeth at the apical margin (Fig. 8g). This is an extreme variant of the development of multiapical microscales and is differs by its large size and well-developed teeth.

d) Ampoule. Elongated microscales with the oval or elliptical basal half and thin apical part elongated into a spine (Fig. 9m). Scales of this type usually localized closer to the pleural area.

e) Ctenoid. Wide microscales with serrated apex, but teeth short and rounded (Fig. 9l).

Microspines also represent cuticular structures, but they have a bristle shape unlike scales. They can look like a very short chaeta with the conical or bell-shaped base, or like a small denticle. We have identified the following types of microspines:

a) Denticles. The fine conical, not elongated, bristle-like microstructure (Fig. 8e).

b) Simple microspine. The short spine oriented along the main axis of the abdomen (Fig. 8b); usually located at the edges of tergite.

c) Microtrichia. A characteristic feature of these structures is that they usually form well-defined fields. They are usually localized at the lateral region of tergites and oriented perpendicular to the main axis of the abdomen (Fig. 8f).

The tergo-abdominal chaetom of Scolytinae presented by various setae. Setae (microchaetae) are form the microstructure with a bristle-bearing pore at the base, elongate to varying degrees or evenly widened from the base to the apex. The pore can be simple or located in the pocket-like, triangular depression (more often on the tergite 7). The chaetom also includes basiconical sensilla, but we do not consider them in this study. The following types of microchaetae can be designated:

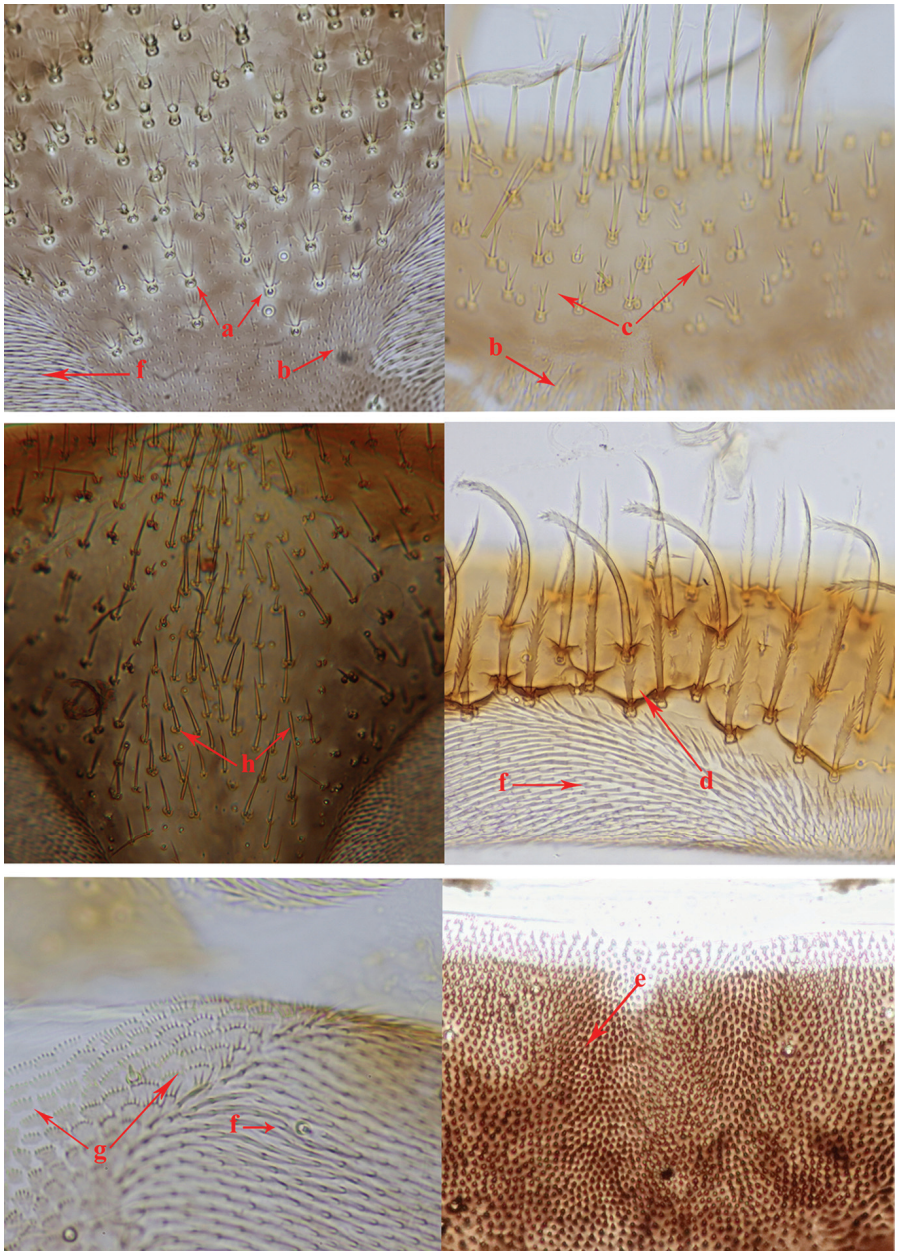


Fig. 8. Elements of chaetom and microsculpture of abdominal tergites of Scolytinae. a – fan-shaped setae; b – simple microspines; c – furcate setae; d – feathery setae; e – denticles; f – microtrichiae; g – crown-shaped scales; h – simple setae.

a) Simple. Common hairy microchaeta. Usually short but some taxa have long simple setae, principally at the distal margin of the tergite 7 (Fig. 8h).

b) Furcate. Microchaetae are with two apices (Fig. 10n), can be feathery.

c) Double. Microchaetae are with two trunks from the common pore (Fig. 9j).

d) Feathery. The trunk of the seta has additional sprouts that make it look like a feather (Figs. 8d, 10d), but in cross section are always round, not flat; can be biapical.

e) Fan-like. Multipath microchaeta with beam fused into a wide base (Figs 8a, 9a, 10a). Outwardly, it often resembles an achene of seeds of Compositae plants.

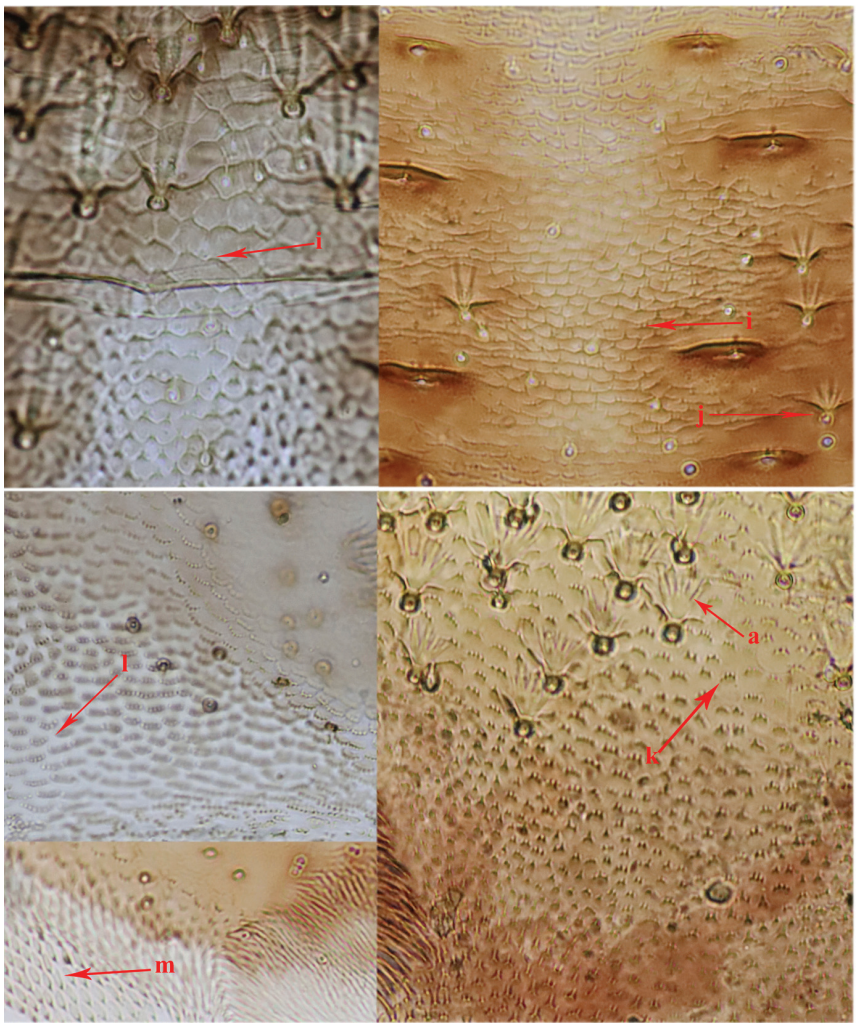


Fig. 9. Elements of chaetom and microsculpture of abdominal tergites of Scolytinae. a – fan-shaped setae; i – simple scales; j – double setae; k – multiapical scales; l – ctenoid scales; m – ampoule scales.

The tergites 5–7 demonstrate the highest diverse microstructures, therefore, we focused the most attention on them. The tergites 1–4 have a fairly uniform armament of 1–2 types of microstructures usually denser located and not form clearly delineated fields. Chaetom elements are relatively evenly distributed on the surface of the tergites; they do not form distinct fields or patches. Basiconical sensilla were found on all tergites, they are located between setae, not grouped and not numerous. The microsculpture, on the contrary, is not evenly located on the tergal surface: some of its elements form a “background”, occupying most of the area of the tergite, while others are concentrated in fields of a certain shape (Fig. 11). Tergite areas with microsculptural fields are often weakly sclerotized.

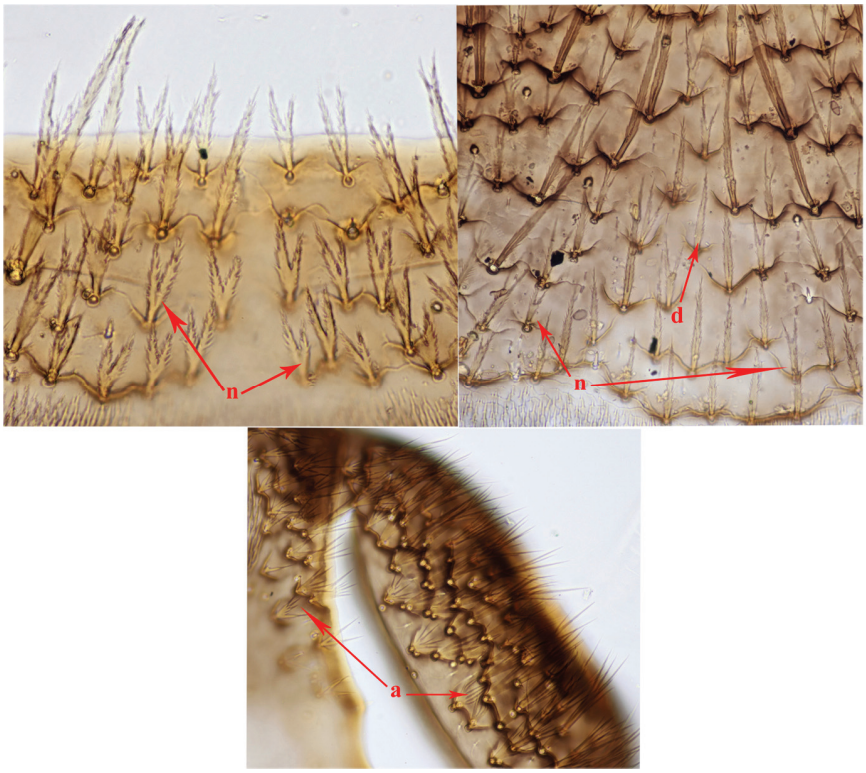


Fig. 10. Different setae of tergite 7 of Scolytinae. n – feathery furcate; d – feathery; a – fan-shaped.

Microstructures of similar types can successively replace each other throughout an entire tergite or its part. Thus, simple scales are located at the base of a tergite, then are replaced by multi-apical scales and then they are transformed into crown-shaped or ctenoid scales towards its apical edge. At the same time, both types of microscuptural elements replacing each other can be found at short surface patch. Notably, setae very rarely distinctly transformed from one type into another within the same tergite. Cases of a combined arrangement are more often observed: fan-shaped microchaetae and feathery, simple and double, etc. (Fig. 10).

The characters of microsculpture, shape and size of microsculptural fields, as well as type of chaetom elements obviously have a taxonomic significance, especially at the level of genus rank taxa and higher. For example, representatives of the tribe Xyleborini are characterized by the presence of three microsculptural fields on the tergite 7: two lateral microtrichial oval or

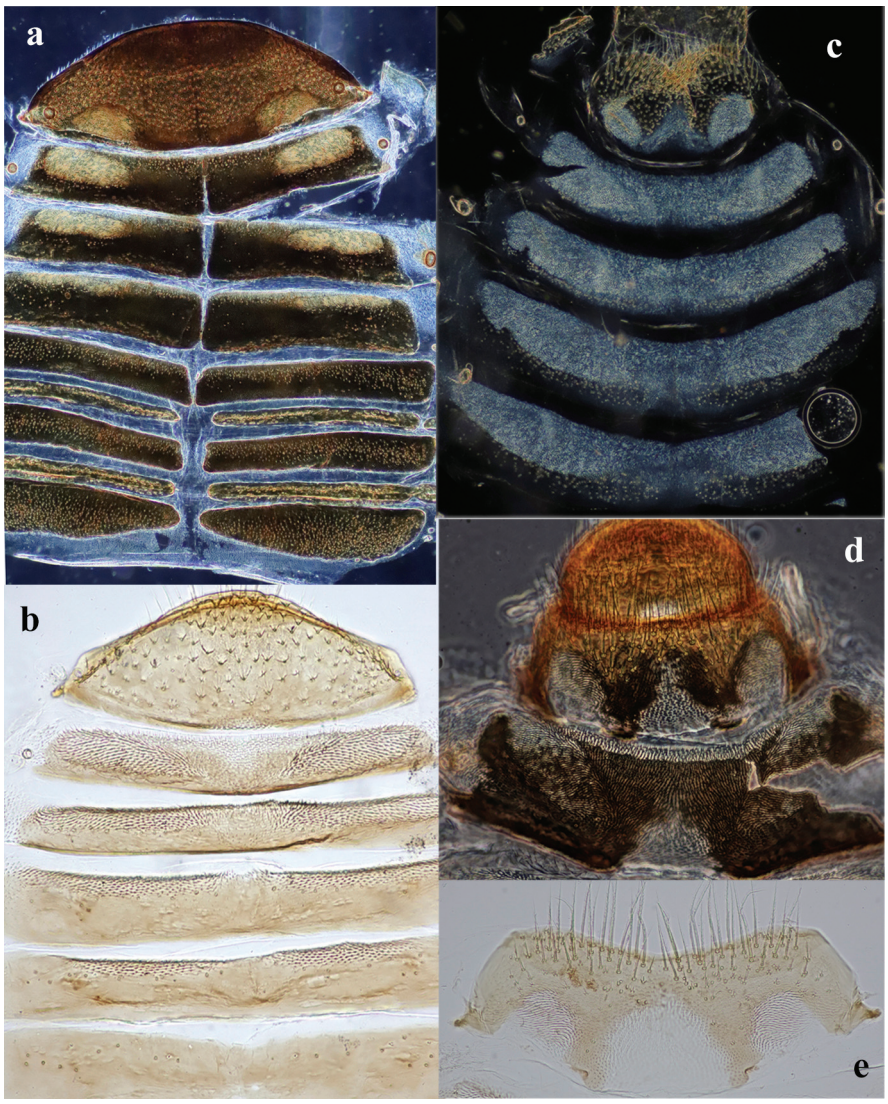


Fig. 11. Microscuptural fields and chaetom of Scolytinae (glass slides). a – *Camptocerus mandelshtami* Petrov, 2007; b – *Cryphalus piceus* Eggers 1926; c – *Cnestus testudo* (Eggers, 1939); d – *Xyleborinus saxesenii* (Ratzeburg, 1837); e – *A. obesus* (LeConte, 1868). Figs a, c, d – in phase contrast.

round fields and the central semicircular or triangular field with mixed simple and multiapical or crown-shaped scales (Fig. 11c–e). Setae of complex structure such as feathery or fan-shaped setae, were not found in members of this tribe. On the other hand, the bark beetles of the tribes Scolytini, Hylastini, and Hylesinini have a very diverse chaetom represented by almost all known types of setae (Figs. 1–3, 5, 6, 8). The tribe Ipini is characterized by numerous ctenoid, ampulae and crown-shaped scales (Figs 4, 7, 11a).

CONCLUSION

As a result of our research, various types of chaetae and microsculptures were found. They are characterized by considerable morphological diversity and differ between genus rank and higher taxa. The taxonomic significance of the microsculptural elements and chaetom examined by us has never been the subject of scientific discussion (at least in the Scolytinae). More detailed presentation of their diversity in different taxonomic groups will be presented in future. The functional purpose of microstructures of abdominal tergites in Scolytinae is still debatable in our opinion, because their diversity demonstrate in the majority of the examined taxa cannot be caused by the same type of mechanical function.

ACKNOWLEDGEMENTS

The author is grateful to Dr A. Petrov (Russia, Moscow), Dr K. Makarov (Russia, Moscow), Mr A. Gusakov (Russia, Moscow), Dr A. Shabalin (Russia, Vladivostok), Dr K. Grebennikov (Russia, Bykovo, VNIIKR), Mr S. Mukhanov (Russia, Bykovo), Mr E. Khatchikov (Russia, Rostov-on-Don), Mr E. Akulov (Russia, Krasnoyarsk) for provided materials and Dr M. Nabozhenko (Russia, Rostov-on-Don) for linguistic correction. The work was carried out in accordance with the state assignment No 121042600339-5.

REFERENCES

Davis, S. 2009. Morphology of Baridinae and related groups (Coleoptera, Curculionidae). *ZooKeys*, 10: 1–136. DOI: 10.3897/zookeys.10.47

Gupta, S., Gupta, A. & Meyer-Roshow, V.B. 1999. Cuticular microstructures of abdominal tergites and sternites of *Cloeon* sp. (Ephemeroptera; Baetidae) during post-embryonic development. *Entomologica Fennica*, 10: 51–59.

Qian, J., Chi, D., & Chai, R. 2016. Possible functions of the microtrichia on the cuticle of *Ulomoides dermestoides* (Chevrolat) (Coleoptera: Tenebrionidae). *Journal of Forestry Research*, 27: 1391–1405.

Sun, J., Liu, C., Bhushan, B., Wu, W. & Tong, J. 2018. Effect of microtrichia on the interlocking mechanism in the Asian ladybeetle, *Harmonia axyridis* (Coleoptera: Coccinellidae). *Beilstein Journal of Nanotechnology*, 6(9): 812–823. DOI: 10.3762/bjnano.9.75.

Lindeman, K.E. 1875. Monographia koroedov Rossii. (Fam. Scolytidae Lacord). Pt 1. *Izvestya Imperatorskogo Obshestva Estestvoznznya, Antropologii i Etnographii*, 18(1): 1–113. [In Russian]