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## EVOLUTION POTENTIAL OF EOCENE ENTOMOFAUNAS IN FORMATION OF CONTEMPORARY DIVERSITY OF COLEOPTERA OF THE FAMILIES MALACHIIDAE AND DASYTIDAE SENSU LATUM

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**Abstract.** Data on Dasytidae and Malachiidae beetles recorded from Eocene fossils are presented, evolution potential of the ancestral faunas of two families is discussed. It is shown that the younger family Malachiidae appear to possess more evolutionary potential in comparison with closely related Dasytidae being more conservative in taxonomic formation.

**Keywords:** Coleoptera, Dasytidae, Malachiidae, Eocene, insect fauna, evolution.

## ЭВОЛЮЦИОННЫЙ ПОТЕНЦИАЛ ЭОЦЕНОВЫХ ЭНТОМОФАУН В ФОРМИРОВАНИИ СОВРЕМЕННОГО РАЗНООБРАЗИЯ ЖЕСТКОКРЫЛЫХ СЕМЕЙСТВ MALACHIIDAE И DASYTIDAE SENSU LATUM

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**Аннотация.** Представлены данные о жесткокрылых семействах Dasytidae и Malachiidae, обнаруженных в эоценовых палеотложениях, обсуждается эволюционный потенциал предковых фаун этих семейств. Показано, что более молодое семейство Malachiidae обладает большим эволюционным потенциалом по сравнению с близкородственными Dasytidae, проявившими большую консервативность в формировании таксономического разнообразия.

**Ключевые слова:** Жесткокрылые, Dasytidae, Malachiidae, Эоцен, энтомофауна, эволюция.

The small to moderate sized (1 to 8mm) soft-winged flower beetles (Coleoptera, Malachiidae) and malachite beetles (Coleoptera, Dasytidae) [1, 2] are distributed in amber inclusions and fossils.

Malachiidae with unfused articulated sclerites and characteristic yellow, orange, or red evaginate vesicles on the lateral sides of the pronotum, and in Dasytidae with immovably commisured sclerites lacking evaginating vesicles on the pronotum. Representatives of these families are known as predators of small invertebrates, Malachiidae larvae have been recorded on trees under bark, and Dasytidae in soil litter.

Soft-winged flower beetles (Coleoptera, Malachiidae) are rather seldom found in paleontological material, but almost every find of fossil beetles represents a new taxon, often without analogue in the present day fauna. Conversely, the paleontological data on Malachiidae are far more sparse; a short survey was given by Kirejtshuk and Nel [3], and continued in articles by Tshernyshev [4, 5]. The oldest records of soft-winged flower beetles date to the terminal Eocene, where several species were described from the Florissant lagerstätten formation in Colorado [6], namely: *Collops desuetus* Wickham, 1914, *C. extrusus* Wickham, 1914 and *C. priscus* Wickham, 1914, and *Malachius immurus* Wickham, 1917 (= *Malachius pristinus* Wickham, 1916). Generic attribution some of the species mentioned above to the genus *Collops* Erichson, 1840 and a tribe Apalochrini is incorrect, because second antennomeres in imprint photos usual, round and well developed. Placement of another two species described from this deposit to the Malachini genera is also problematic, because none of the *Malachius immurus* Wickham, 1917 (= *Malachius pristinus* Wickham 1916) or *Cerallus* sp. have any characters typical for this tribe.

Several species provisionally attributed to *Colotes* were described from Amber inclusions: *Colotes sambicus* Kubisz, 2001 from Baltic amber, and two species, *Colotes constantini* Kirejtshuk, Nel, 2008 and *Colotes impexus* Kirejtshuk, Nel, 2008 from more ancient (earlier Eocene) French amber. Since both species were described from females, generic attribution is probably not certain. Probably, these species belong a genus/genera of Palpattalini.

Later, the first Eocene representative of the tribe Troglopini, *Protocephaloncus perkovskiyi* Tshernyshev, 2016 was described, and males of two species similar to *Colotes* were studied. These two species possess characters of two tribes, namely: modified pygidium as in Attalini, and enlarged palpomeres as in Colotini, both were described in a new genus, *Palpattalus* Tshernyshev, 2016, as *P. eocenicus* Tshernyshev, 2016 and *P. baltiensis* Tshernyshev, 2016. Further study of Baltic amber presented new forms, also combining characters of the tribes mentioned, but strongly different to *Palpattalus* Tshernyshev, it was a new genus and species, *Palpattalusinus transitivus* Tshernyshev, 2020. A new tribe, Palpattalini, for the two genera were described. A new representative of the tribe Malachiini, *Premalachius obscurus* Tshernyshev, 2020 was also described in this paper.

The data on extinct species of the closely related family Dasytidae were recently summarized [7, 8]. Representatives of the family Dasytidae are frequently found in amber inclusions, several new taxa have been described: two genera, *Eudasytites* Wickham, 1912 and *Aploceble* Majer, 1998 (with the subgenus *Aploceble* (*Chalcoaploceble*) Tshernyshev, 2012), and five species: *Eudasytites listriiformis* Wickham, 1912, *Eutrichopleurus miocenus* Wickham, 1917, *Aploceble* (*Aploceble*) *berendti* Majer, 1998, *A. (A.) fuscipes* Majer, 1998, *A. (A.) kunowi* Majer, 1998, *Aploceble (A.) lateantennata* Tshernyshev, 2019 and *Aploceble (Chalcoaploceble) viridiaeneus* Tshernyshev, 2012, two species of the genus *Aplocnemus* Stephens, 1830, *A. (Aplocnemus) hoffsorsorum* Tshernyshev, 2019 and *A. (Ischnopalpus) baltienseis* Tshernyshev, 2019, one species of the genus *Dasytes* Paykull, 1799, *Dasytes (Mesodasytes) ochraceus* Tshernyshev, 2019. Also, some fossil beetles were assigned, based on external morphology, to the extant genera: *Microjulistus* sp., *Aplocnemus* sp. and *Psilothrix* sp., *Xamerpus* sp., *Malthacodes* sp., *Pelecophora* sp. and *Aplocnemus cf. tarsalis* C.R. Sahlberg, 1822, and three species closely related to *Dasytes* sp. In addition, [9] identified three inclusions as *incertae sedis*, and noted that they belong to a separate genus closely related to *Xamerpus*.

An extinct genus *Eudasytites* Wickham and two species *E. listriiformis* Wickham and *Eutrichopleurus miocenus* (Wickham) were described from Upper Eocene–Oligocene shale deposits in Florissant Fossil beds, Colorado, USA. The replicas were poorly preserved and indistinct, without legs and antenna. Suffering difficulties Wickham referred *Eudasytites* to Dasytidae, based on the fact that the beetle imprinted from ventral side had no distinct male specific structures on elytra or abdomen, and, so it cannot be placed in Malachiidae, only Dasytidae. The characters given for the new genus were: «slender build and coarse sculpture, with vestiture inconspicuous or wanting [10]». The replica of the other species contrariwise was from dorsal side with distinct elytra and regular punctured rows. This character is close to the recent species *Trichochrous seriellus*, and the fossil species was described as *T. miocenus* Wickham. Later, genus *Eutrichopleurus* Blaisdell, 1938 with *Trichochrous seriellus* Casey, 1895 as type species was described, and *T. miocenus* Wickham was also transferred to this genus. All other Eocene fossil forms of Dasytidae were found in Baltic Amber.

We can see that greater number of Eocene Dasytidae belong to ancient genera still occurring at present time, only *Aploceble* Major is a good genus amongst extinct taxa. Malachite beetles are usual residents of forest and forest-steppe zones, ecosystems similar to those they inhabited many years ago. *Dasytes* species today can be found in coniferous forest, and, probably, *Dasytes ochraceus* Tshernyshev occurred also in Eocene biocenoses with

coniferous trees. Moving to open landscapes Dasytidae occupied soil litter whereas Malachiidae used the new type of plant communities that appeared and ecological niches in these. Special male characters played determinative role in adaptive morphogenesis of soft-winged flower beetles.

As an example, for special male structures morphogenesis can be shown in differences between tribes Palpattalini and Colotini and Attalini. The ancestral Palpattalini unite two strong characters, modified pygidium, that is used in copulation when the male needs to decline strongly backwards during copulation on trees branches of stems. The same we can see in Attalini, they do not use male palps when mating, but retained the strongly modified pygidium, most species of Attalini are usually found on trees or nearby.

Colotini started occupying open landscapes, and they do not need to strongly decline the posterior part of male body during copulation, but possess enlarged and modified palps which play a role in “wedding game” to attract female. In Palpattalini claw-shaped palps of *Palpattalusinus* were used to hold antennae or head of female, while the enlarged, rounded basal palpomere provided with long chaetae in *Palpattalus* are used to correctly position the male during copulation on a stem. Fast changes and high adaptive ability of male morphology enabled the Malachiidae to occupy a wide range of ecosystems.

Thus, all Eocene species of Malachiids belong to three tribes, Malachiini, Troglolini and Palpattalini, of which only two tribes are extant today. Most of the species are newly described in new genera, and has no analogue in the recent fauna. The morphology of soft-winged flower beetle imagines, probably, defined favourable evolution because of the males specific structures (protuberances and impressions, lamellar or spicular shaped appendages, and tuft of hairs and bristles etc.) on different parts of the body in the vast majority of Malachiidae species. Occurring in broadleaf forests (almost completely all malachiids in Eocene amber are preserved together with oak trees pollen), occupying new open ecosystems and producing a wide range of new taxa. The younger family Malachiidae appearing to have more evolutionary potential in comparison with closely related Dasytidae being more conservative in taxonomic formation.

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## МОРФОМЕТРИЧЕСКИЕ ОСОБЕННОСТИ ЖУЖЕЛИЦ (COLEOPTERA, CARABIDAE) ГОСУДАРСТВЕННОГО ПРИРОДНОГО БИОЛОГИЧЕСКОГО ЗАКАЗНИКА «ПУСТЫНСКИЙ» НИЖЕГОРОДСКОЙ ОБЛАСТИ

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**Аннотация.** В данной работе изложены результаты изучения морфометрических особенностей 8 родов жужелиц (*Amara*, *Calathus*, *Carabus*, *Cimindis*, *Harpalus*, *Notiophilus*, *Pterostichus*, *Synuchus*), сформировано единое морфопространство, в рамках которого были выделены четыре основные вариации формы. Также был проведен дисперсионный анализ изменчивости формы, на основе которого были