

How many genera and species of Galerucinae s. str. do we know? Updated statistics (Coleoptera, Chrysomelidae)¹

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Academic editor: C. Chaboo | Received 3 May 2017 | Accepted 27 September 2017 | Published 11 December 2017

<http://zoobank.org/D0C332DA-BE8C-4BCF-BDDF-5929A0189AEE>

Citation: Nie R-E, Bezděk J, Yang X-K (2017) How many genera and species of Galerucinae s. str. do we know? Updated statistics (Coleoptera, Chrysomelidae). In: Chaboo CS, Schmitt M (Eds) Research on Chrysomelidae 7. ZooKeys 720: 91–102. <https://doi.org/10.3897/zookeys.720.13517>

Abstract

Galerucinae s. str. is a rich group of leaf beetles. A new, up-to date checklist of Galerucinae genera in the world is provided, including the number of valid species of each genus. Genera and species were counted in literature published before the end of 2016. In summary, 7145 species (7132 recent, 13 fossils) and 192 subspecies from 543 genera (542 recent, 1 fossil) were quantified in Galerucinae s. str. In comparison with the previous catalogue of worldwide Galerucinae (Wilcox 1971–1973), an additional 91 valid genera, 1341 valid species (1337 recent, 4 fossils) and 38 subspecies have been published; 43 genera were synonymized, four genera were transferred into Alticini, two subgenera were elevated to genus rank, and one genus was downgraded to subgenus rank. The updated list of references to taxonomic publications on Galerucinae s. str. from the period 1971–2016 is provided.

Keywords

Biodiversity, checklist, Chrysomeloidea, leaf beetles, worldwide

¹ Contribution to the 9th International Symposium on the Chrysomelidae, Orlando, FL, USA, September 28, 2016

Introduction

Galerucinae *sensu stricto* (i.e., not including Alticini) belongs to Chrysomelidae (Coleoptera) and is one of the largest groups of leaf beetles (Yang et al. 2015). Adult Galerucinae can be identified by an oval to oblong body, with the head visible from above and inserted into the prothorax. The front coxal cavity is either open or closed. Tarsi are pseudotetramerous with the third segment bifid, and the fourth segment very small in size, and nested in the third one. The hind femur is slender without a femoral spring. The antenna has eleven segments; the antennal insertions are situated close together in front or between the eyes. Frontal tubercles are usually present and well developed. The elytral sensilla patch is usually single (Samuelson 1996; Nadein and Bezděk 2014).

Galerucinae *s. str.* is a key group to study the phylogeny of Polyphaga. The adults and larvae of Galerucinae *s. str.* are herbivorous, and most of them show host specificity. The special relationship of Galerucinae *s. str.* and its host plants makes the group a good model to study the evolution of herbivorous beetles, the convergent evolution of insects and plants (Futuyma and McCafferty 1990), and the evolutionary mechanisms of biodiversity (Farrell et al. 1992; Mitter and Farrell 1991). In addition, many species are used for biological control of weeds or are important pest species of agriculture (Vencl and Morton 1998; Xue et al. 2007; Bunnige et al. 2008; Xue and Yang 2008; Nie et al. 2012).

Among Chrysomelidae, the closest relative to Galerucinae *s. str.* is Alticinae (or flea beetles) discussed further below. Both groups have very rich diversity. Nadein and Bezděk (2014) estimated 6500 species in ca. 600 genera within Galerucinae *s. str.*; and about 8000 species in 534 genera within Alticinae *s. str.* The two groups have very similar morphological characters. The key morphological character used to distinguish both groups is the metafemoral extensor tendon (MET) in the hind femora (also known as metafemoral spring, metafemoral apodeme, or Maulik's organ), which is a structure that permits large jumps for predator evasion (Furth and Suzuki 1990; Furth and Suzuki 1998; Nadein and Betz 2016). The presence of MET was not always mentioned in the descriptions of genera or species. Actually some species with slender hind femora have MET, such as *Mandarella* Duvivier, 1892. In contrast, some species with swell hind femora are without MET such as *Orthaltica* Crotch, 1873 (Furth and Suzuki 1994; Konstantinov and Prathapan 2008). Some genera are called “problematic genera” with the presence or absence of a MET and not fitting other characters. Recently, some researchers found that the MET may have multiple origins, evolving at least two or three times (Ge et al. 2011; 2012; Nie et al. 2017).

The phylogenetic relationship of Galerucinae *s. str.* and flea beetles has been disputed for many decades and is still unclear and controversial. Some recent investigations support the inclusion of the traditional alticines in Galerucinae, yet classification remains a challenge as neither the traditional “Galerucinae” nor the traditional “Alticinae” are monophyletic (Bouchard et al. 2011; Nadein and Bezděk 2014; Reid 2014). Other studies suggest considering both groups as subfamilies (e.g. Löbl and

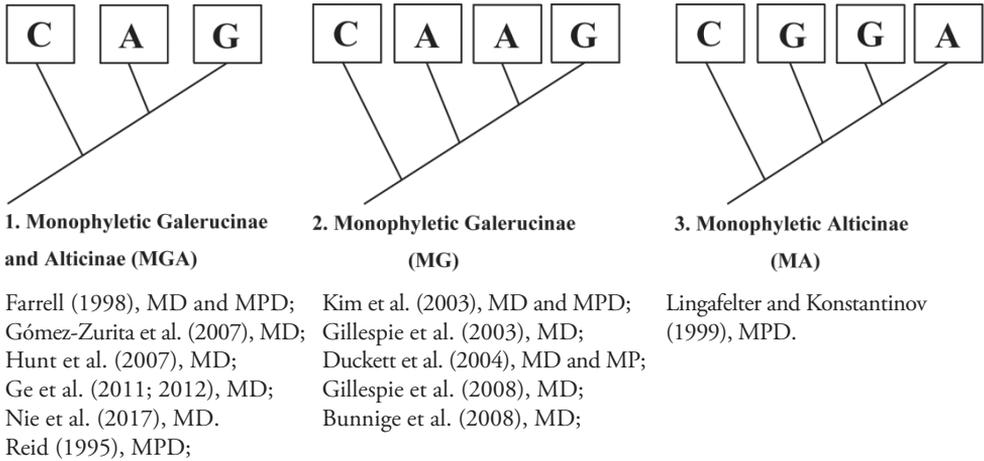


Figure 1. The three hypotheses of the phylogeny of Galerucinae and Alticinae. The supporters of each hypothesis are listed below each. Note: MD = Molecular Data; MPD = Morphological Data.

Smetana 2010, Ge et al. 2011, 2012; Haddad and McKenna 2016). So far, three hypotheses of evolutionary relationships have been proposed based on morphological or molecular data (Fig. 1). Among these tree hypotheses, a sister group relationship of Galerucinae and Alticinae was supported by the most molecular or morphological analyses (Seeno and Wilcox 1982; Doguet 1994; Farrell 1998; Gómez-Zurita et al. 2007; Hunt et al. 2007; Bouchard et al. 2011; Ge et al. 2011, 2012; Nie et al. 2017). Some of the recently established groupings, based on DNA sequences, still need further in-depth analysis because they are phylogenetically and biogeographically incomplete (Biondi and D’Alessandro 2012). In this study there is no attempt to resolve the relationship of both groups. The reason Galerucinae and Alticinae are treated as two equal groups is strictly technical in order to count the genera and the species correctly.

Some important catalogues of Galerucinae s. str. have been published during the 20th century. Weise (1924) catalogued 3678 species from 305 genera. The last comprehensive Galerucinae catalogue published by Wilcox (1971–1973) included 5802 species (including fossil taxa) in 476 genera. The summarized generic arrangement (495 genera) was presented by Seeno and Wilcox (1982). However, the taxonomy of Galerucinae s. str. has not been summarized during the last 40 years. Many new species, new genera, new names, or new synonymies have been proposed. This work seeks to provide a new detailed, up-to date, summary of global Galerucinae s. str. taxonomy.

Methods

All the currently valid genera names (in nomenclatorial sense, both recent and fossil) of subfamily Galerucinae s. str. in the world published before December 31, 2016 are listed.

The references are mainly based on the database Zoological records and Jan Bezděk's personal catalogue. Each genus includes the present number of recent species, subspecies and fossil species, generic distribution, list of subgenera and generic synonyms, and references to publications which influenced the number of genera and species from Wilcox's (1971–1973) catalogues to present (including important redescriptions). The references omitted in Wilcox's (1971–1973) catalogue are included.

For each genus, an outline of its present geographic distribution (based on Löbl and Smetana 2010) is provided. The abbreviation of fauna is as following:

- AFR** Afrotropical Region;
- AUR** Australian Region;
- NAR** Nearctic Region;
- NTR** Neotropical Region;
- ORR** Oriental Region;
- PAR** Palaearctic Region.

For genera with restricted distributions, the countries are listed. For the genera (e.g. *Pyrrhulta*, *Xanthogaleruca*, *Tricholochmaea*, *Galerucella*, *Galeruca*) with controversial classified rank, we follow the Palaearctic catalogue (Beenen 2010). The authorship of the genera published in Dejean (1836) follows the paper by Bousquet and Bouchard (2013).

Wilcox published his catalogue in four fascicles. The fascicles 1–3 (Wilcox 1971–1973) comprise the catalogue itself including precisely documented species and genera. The last fascicle (Wilcox 1975) included addenda, index, and references to the papers published in several previous years. For comparison of genera and species, we used only fascicles 1–3. The fourth fascicle will be included in subsequent publications.

Results

Wilcox (1971–1973) published 5802 species (5793 recent species + 9 fossil ones) and 154 subspecies in 476 genera. As of the end of December 2016, Galerucinae *s. str.* contains 7145 species (7132 recent, 13 fossils) and 192 subspecies from 543 genera (542 recent, one fossil). Among these 543 genera, 91 novel valid genera (including one fossil) have been published since 1974. Since 1974, 1341 valid species (including four fossils) and 38 subspecies have been added. A total of 194 genera is listed in synonymy, of which 145 were listed as synonyms in Wilcox (1971–1973). After 1973, 43 genera were synonymized, four genera were transferred into Alticini, two subgenera were elevated to genus rank, and one genus was downgraded to subgenus. The detailed statistics on the number of genera, species and subspecies, geographic distribution, as well as the subgenera, the generic synonyms and references can be seen in Supplementary information/data 1.

Since 1974, some genera have been increased by many species e.g. *Monolepta* (113 species), *Paleosepharia* (63 species), *Apophyllia* (47 species), *Paridea* (41 species), *Pyrrh-alta* (38 species), while 292 genera have not increased. Surprisingly, the species number decreased from 259 to 246 in African Monoleptites, a group deeply revised in last twenty years, because of many new synonyms. Similar decrease in species number is expected in other species-rich genera with color variability, e.g., *Diacantha* Chevrolat, 1836 (see Wagner 2017). The major contribution of new generic descriptions since Wilcox's (1971–1973) catalogue has been made by Medvedev (22 genera), Wagner (17 genera), Chen (eleven genera), Kimoto (seven genera), Mohamedsaid (seven genera), Silfverberg (six genera), Bezděk (five genera), Beenen (five genera), Clark (four genera), Shute (three genera), and Lopatin (two genera).

The distribution of Galerucinae s. str. is worldwide. Altogether 186 genera (34.3%) are distributed in the Oriental Region, followed by Afrotropical Region (174 genera, 32.0%), Palaearctic Region (159 genera, 29.1%), Neotropical Region (105 genera, 19.3%), Australian Region (62 genera, 11.4%), and Nearctic Region (34 genera, 6.3%). A very high level of generic endemism is exhibited for the Afrotropical Region where 148 genera from total 174 are endemic (31 genera are endemic for Madagascar) and for Neotropical Region with 76 endemic genera from total 105. In the Afrotropical Region high level of generic endemism in Galerucinae s. str. (85%) corresponds to Alticinae with 71% (Biondi and D'Alessandro 2010). In all other regions the level of generic endemism of Galerucinae s. str. is below 50%. For the total numbers of genera and endemic genera in all the regions see Fig. 2.

There are no cosmopolitan genera in Galerucinae s. str. The most diverse and most widely distributed genus is *Monolepta* with more than 700 species occurring in almost all the regions but missing in the Nearctic Region (Riley et al. 2003). Additional species-rich genera with wide distribution like *Luperus* Geoffroy, 1762 (97 species), *Luperodes* Motschulsky, 1858 (77 species), and *Calomicrus* Dillwyn, 1829 (85 species) are evidently polyphyletic and the future revisions will lead to the geographical restriction of these genera.

The distribution of many genera is shared with adjacent regions. For example, 37% of Oriental genera are endemic while 39% are shared with Palaearctic Region and additional 14% with Australian fauna. As expected only a low percentage (2%) of genera occurs in Nearctic/Neotropical regions and some another region (ORR-AFR 6%). On the other hand, 27 genera are shared with both Nearctic and Neotropical regions. It is necessary to mention that distribution of some genera is often only marginal in adjacent region (for example in the eastern border of Palaearctic and Oriental Regions). The generic endemism percentage in comparison with the percentage of the genera shared with other regions is graphed in Figs 3–8.

Among 92 genera proposed after Wilcox's (1971–1973) catalogue, the fauna of the Oriental region has increased by 36 genera (39.1%), followed by Palaearctic Region (24 genera, 26.1%), Afrotropical Region (22 genera, 23.9%), Neotropical Region (eight genera, 8.7%), Australian Region (six genera, 6.5%), and Nearctic Region (one genus, 1.1%).

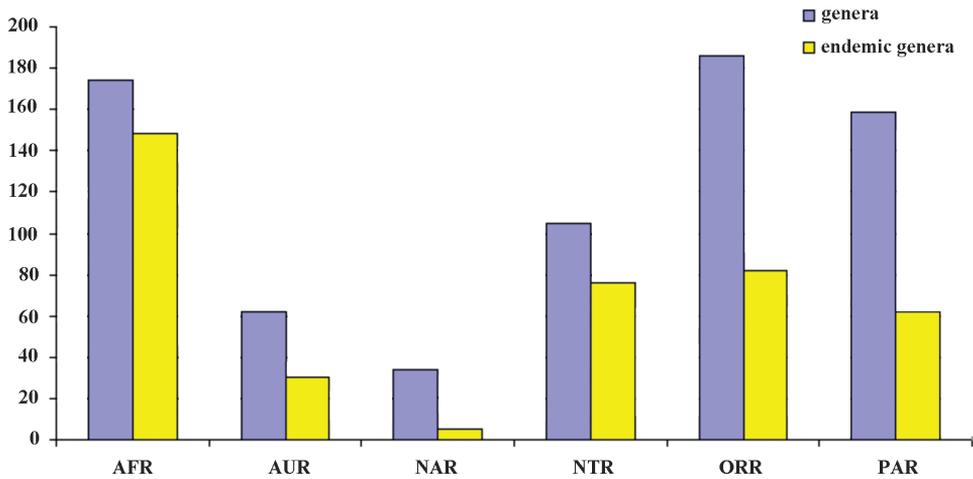
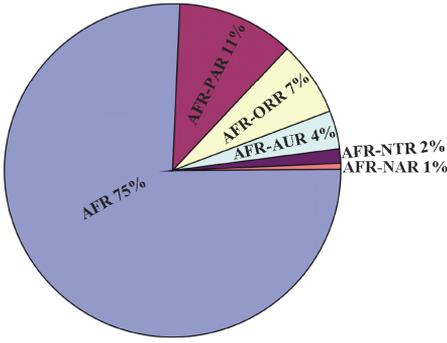


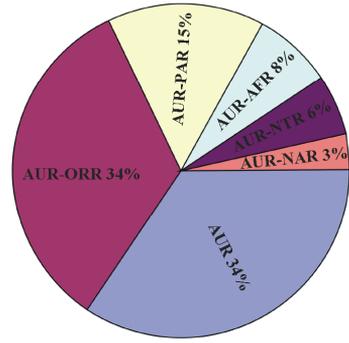
Figure 2. The numbers of genera and endemic genera in geographical regions.

The following taxa listed by Wilcox (1971–1973) or described later in Galerucinae *s. str.* have been transferred to other Chrysomelidae groups:

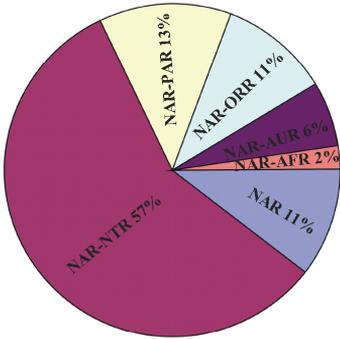
- *Hildebrandtina* Weise, 1910 belongs to Alticinae *s. str.* (see Biondi and D’Alessandro 2010, 2012).
- *Borbaita* Bechyné, 1958, *Micrantipha* Blackburn, 1896, *Neoclitena* Abdullah & Qureshi, 1968, *Philocalis* Dejean, 1836, and *Scelidopsis* Jacoby, 1888 were transferred to Alticinae *s. str.* by Wilcox (1975) and their position is widely accepted (see Seeno and Wilcox 1982; Döberl 2010).
- *Lochmaeina* Medvedev, 1956 and *L. rosea* Medvedev, 1956 are synonyms of *Sangariola* and *S. punctatostrigata* Motschulsky (Alticinae *s. str.*) (see Wilcox 1975).
- *Stenoluperus* Ogloblin, 1936 was synonymized with *Mandarella* Duvivier, 1892 which belongs to Alticinae *s. str.* (see e.g., Wilcox 1975; Medvedev 2012; Lee et al. 2016). However, its position is still questionable (Nie et al. 2017).
- *Luperodes antillarum* Blake, 1937 was synonymized with *Lysathia ludoviciana* Fall, 1910 which belongs to Alticinae *s. str.* (see Wilcox 1975, Virkki 1979).
- *Luperus uenoi* Kimoto, 1969 was transferred to *Mandarella* Duvivier, 1892 which belongs to Alticinae *s. str.* (see Lee et al. 2016).
- *Chaloenus* Westwood, 1862 belongs to Alticinae *s. str.* (see Konstantinov and Prathapan 2008).
- *Calomicrus sibiricus* (Csiki, 1916) was transferred to *Luperomorpha* Weise, 1887 which belongs to Alticinae *s. str.* by Bezděk (2007).
- *Oides neobengalensis* Rizvi & Kamaluddin, 2011 is synonym of *Clytra subfasciata* Lacordaire, 1848 which belongs to Clytrini of Cryptocephalinae (see Bezděk 2012, 2016).
- *Paramerista* Lopatin, 2011 is synonym of *Podontia* Dalman, 1824 and *Paramerista luteola* Lopatin, 2011 is synonym of *Podontia lutea* (Olivier, 1790) which belongs to Alticinae *s. str.* (see Bezděk 2012).



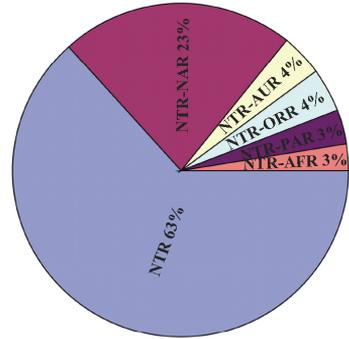
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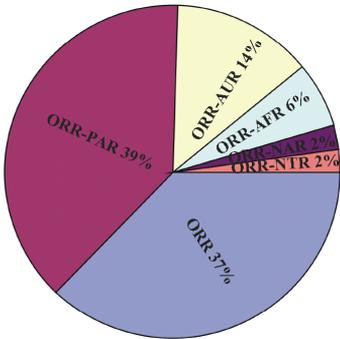
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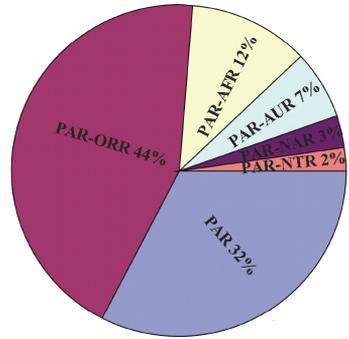
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Figures 3–8. Distribution of genera of Galerucinae s. str. in the different zoogeographical regions showing generic endemism percentage and percentage of the genera shared with other regions. **3** Afrotropical Region (AFR) **4** Australian Region (AUR) **5** Nearctic Region (NAR) **6** Neotropical Region (NTR) **7** Oriental Region (ORR) **8** Palearctic Region (PAR).

Acknowledgments

We would like to thank Vera Pfeiffer (University of Wisconsin, Madison) for checking the English language of the manuscript. We are grateful to Dr. HuaiJun Xue, Ming Bai, and the anonymous reviewers for valuable comments. This research was supported by a grant from the National Science Foundation of China (No. 31772496, 31301900, 3010300101), a grant (No. Y229YX5105) from the Key Laboratory of the Zoological Systematics and Evolution of the Chinese Academy of Sciences and Research Equipment Development Project of Chinese Academy of Sciences (YZ201509).

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Supplementary material 1

Genera list and related files

Authors: Rui-E Nie, Jan Bezděk, Xing-Ke Yang

Data type: species data

Explanation note: The list of all valid genera (both recent and fossil) of subfamily Galerucinae s. str. in the world.

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